Ecological Landscapes of Calais: Phase 2 Natural Resource Inventory

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Prepared for the Town of Calais by

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Inventory Overview

The Calais Natural Resource Inventory was undertaken with support from the citizens of Calais, their Conservation and Planning Commissions and the Selectboard, with the intention of developing a more comprehensive understanding of local natural resources relevant to town planning and policy making. The work was conducted in two-phases beginning in March 2015 and concluding in March 2017. Phase 1 focused on wetland mapping and beginning to identify ecologically significant natural areas; its results are summarized in the Phase 1 final report. Phase 2 focused on continuing to identify ecologically significant natural areas, assessing significant wildlife habitat features and connectivity areas, and on minor updates to Phase 1 wetland mapping. Phase 2 results are summarized here and supersede relevant sections of the Phase 1 report.

Phase 2 used the same methods as Phase 1, which involved gathering background information from existing sources, including local knowledge, public databases, and maps, integrating that information to map wetlands and identify high priority areas for fieldwork, and conducting new fieldwork to document significant features. Additionally, GIS analysis of numerous new and existing data sets was used to assess wildlife habitat in several ways. The results of the project include several public meetings to gather local input and share results; a comprehensive wetland map; a greatly expanded knowledge of ecologically significant features, including natural communities and rare species; documentation of significant wildlife habitats, habitat blocks and connectivity areas; and the final reports, maps, and data products documenting the project.

In brief, the updated wetland assessment maps 620 wetland and potential wetland units that collectively span just over 10% of the town (includes all lakes and ponds), demonstrating an unusually high density of wetlands in Calais. This provides substantially improved accuracy, comprehensiveness, and consistency over prior wetland maps. Classification of these units yielded 27 different wetland and aquatic natural community types, including a number of rare and uncommon types, underscoring the significant contribution wetlands make to Calais' biodiversity and natural heritage.

During Phase 1 numerous areas of potential significance were identified as priorities for site visits, but only a fraction were visited. An additional 15 sites were visited during Phase 2, following the receipt of landowner permission. These visits resulted in documentation of 23 new state-significant natural community occurrences, bringing the total of known records from Calais to 45 occurrences of 11 different community types. Numerous new rare species were recorded as well, bringing the known total to 54 rare, threatened, or uncommon species (4 vertebrate animals, 5 invertebrate animals, 38 vascular plants, and 7 mosses). These mapped features and their immediate surroundings are some of the most ecologically significant places in Calais. While most top priority sites were visited, additional areas with potentially significant features remain to be visited and documented.

Wildlife habitat assessments yielded maps and data sets for potential mast stands, bear wetlands, vernal pools, potential amphibian road crossings, and deer wintering areas. Detailed maps, analyses, and descriptions of Calais' 33 habitat blocks were created. High priority potential wildlife road crossings were mapped along with supporting wildlife sightings data from multiple sources.

Collectively this study provides a strong foundation of current information from which to build town policies and guide local conservation efforts.

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Acknowledgements

The formal work of this inventory unfolded over a few short years, but the citizen contributions in time, energy, information, and concern about your place have gone on for far longer. I thank the people of Calais for twice voting to fund this project and for giving me the opportunity to explore your fascinating landscape and share its ecological treasures with you. Thanks to the Selectboard and Planning Commission for supporting this work, and especially to all the Conservation Commission members who provided input to shape this inventory and devoted their time to the work of contacting landowners for permission to access properties. To the many generous landowners who opened their doors, woods, wetlands, and fields to me and shared knowledge of their own places – without you, little new would have been discovered in this effort. Thanks also to those who attended our kickoff session during Phase 1 and shared their knowledge of many interesting features around town. Special thanks to Candace and the late Bob Shaffer, Erica Frizzle, and others involved in previous citizen efforts to compile local wildlife sightings and verify vernal pools; your work provided valuable and hard to get field data to support the habitat connectivity analysis. Special thanks also to Eric Sorenson for his many contributions to this project, both as a Calaisian and as an architect of many of the statewide conservation planning datasets used herein. Finally, thanks to Dan Currier (CVRPC) and John McCullough for providing GIS-ready parcel/landownership data to facilitate our permissions process.

Introduction

The undertaking of Phase 2 of this natural resource inventory demonstrates a continued commitment by Calais' voters, Conservation Commission, Planning Commission, and Selectboard to obtaining a detailed town-wide natural resource inventory that will support town planning goals around natural resource protection and land use planning. Together with the results of Phase 1, this inventory provides a critical information base for town planning, future policy, and development review, in addition to supporting a sense of local identity and the recognition Calais' distinctive natural heritage.

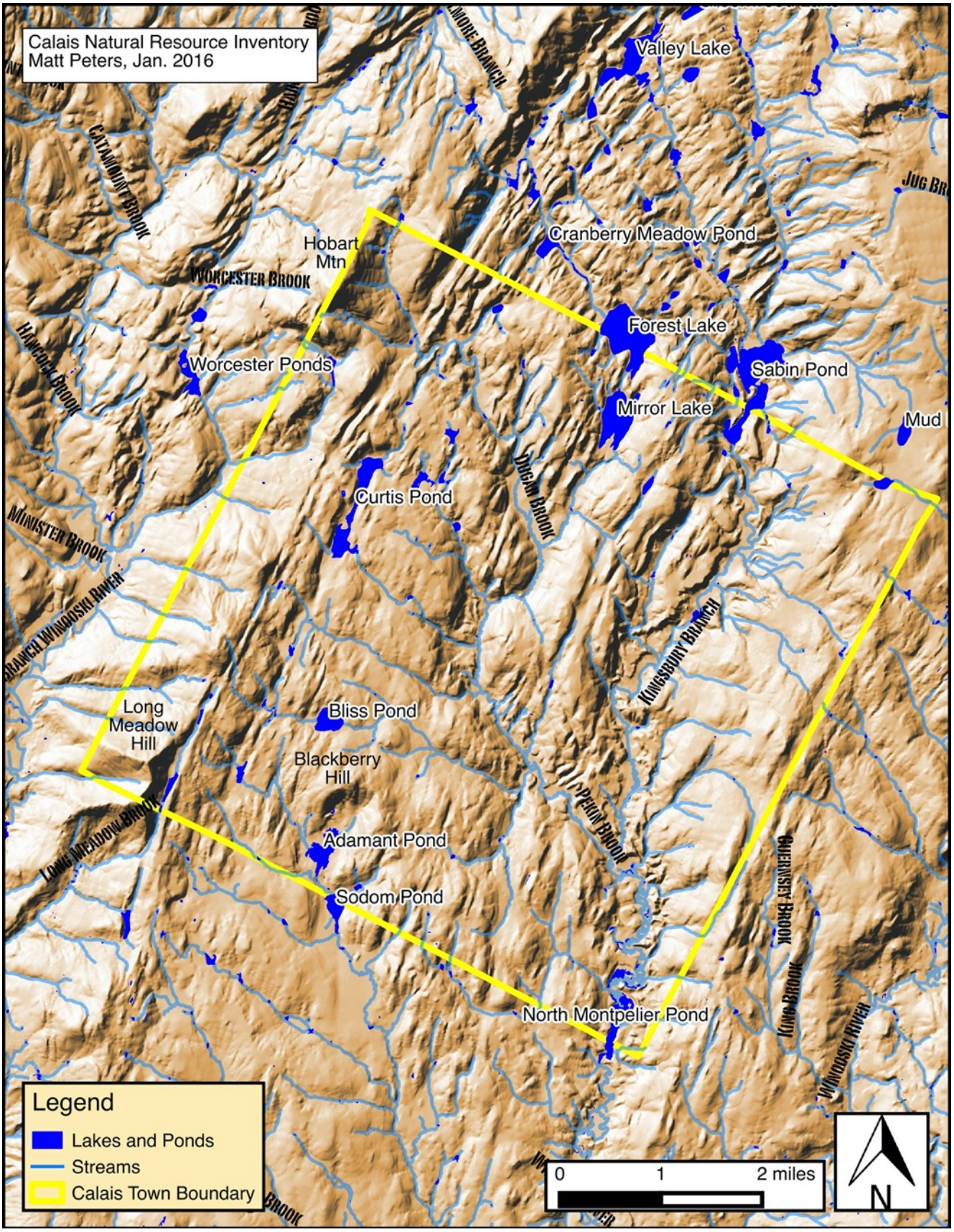
The Calais natural resource inventory was initiated in March 2015 and was envisioned to cover three primary components: A) a comprehensive wetlands inventory; B) identification of ecologically significant natural features, with a focus on state-significant natural communities and important habitats for rare species; and C) an assessment of significant wildlife habitat blocks, their connectivity, and their specific habitat features. The project was split into two phases for budgeting purposes. Phase 1 consisted of components A and B, and was completed in early 2016. Phase 2, initiated thereafter, focused on component C, as well as continuing work on component B, and making minor updates to component A. This report summarizes the results of phase 2 work and updates selected components of the Phase 1 report.

The Landscape Context and Ecological Setting of Calais

An understanding of Calais' landscape starts with the broad-scale patterns that underlie it. Topographically, Calais tops out at about 2,150 ft on Hobart Mountain, along the northwest edge of town, which drains all the way down to just under 700 ft elevation at North Montpelier Pond. Three general topographic regions are apparent: a line of taller, steeper hills forming a ridge along the northwest edge of Calais that culminates in Woodbury Mountain to the north of town; a broad central swath of generally low lying terrain, finely dissected by small ridges and valleys with many streams and wetlands; and a section of broader hills and plateaus east of the Kingsbury Branch. Almost the entire town is within the Kingsbury Branch watershed and its valley forms both the main artery for water and for people flowing along the Rte 14 corridor. Pekin Brook and Dugar Brook are the largest tributaries in town, creating a meandering path through the hills. Much of Calais has a distinct northeast-southwest fabric created by the compressive geologic forces that uplifted the Green Mountains. This topographic pattern results in both parallel and perpendicular landscape patterns visible in the network of wetlands and small streams as well as in the Town's road infrastructure and the Town's boundaries themselves.

Calais straddles the boundary between two biophysical regions, the Northern Green Mountains and the Northern Vermont Piedmont; these are regions that share features of climate, geology, topography, soils, natural communities, and, consequently, human history. This regional boundary coincides with one of the main geologic and topographic shifts in Calais and with settlement patterns. The taller western hills of the Northern Green Mountain region are composed of rocks such as granofels, quartzite, phyllites, and schists, that tend to be harder and result in more acidic, nutrient-limited conditions. This combination of factors has contributed to the limited number of homes and roads in this part of town and the correspondingly largest blocks of intact forests. However, the bulk of Calais is underlain by the upended phyllites (schist-like metamorphic rocks) and interlacing, crumbly limestone beds of the Waits River Formation.

Figure 1. Landscape Overview of Calais, Vermont



These sporadic limestone beds contribute significantly to the character of Calais' soils and its wetlands. The soft, readily weathered limestone is rich in calcium carbonate that creates locally enriched soils and groundwater of higher dissolved mineral content and pH. These conditions are a primary factor behind the abundance of rich northern hardwood forests and rare, enriched wetlands such as fens and calcareous red maple-tamarack swamps. Between these areas of enrichment, more resistant phyllite forms most of the abundant small ridges and outcrops. In the southwest quadrant of town numerous small areas of granitic pluton are also present. Largest and most notable among these is Blackberry Hill and the terrain around Adamant Pond, which was once home to a collection of small granite quarries whose quarry pit ponds and grout piles are still evident among the regenerating forests.

Small bedrock fins and outcrops are commonplace in Calais, but most of the landscape is cloaked in soil derived from glacial till, the ground-up mixture of rocks, sand, silts, and clays left by the retreat of ice-age glaciers. Relatively well-sorted soils are found along the Kingsbury Branch of the Winooski River and along Pekin Brook. These represent a mixture of origins, including recent alluvial soil deposits, soils deposited into a glacial lake that once existed in the valley bottom, and, further upstream, glacial outwash deposits of sands and gravels that gave rise to Calais' sand and gravel pits.

Atop this physical landscape, people have enacted many changes to the land in recent history. Like most of Vermont, Calais was predominantly forested prior to European settlement and subsequently experienced widespread land clearing for fuel, lumber, and conversion to agricultural uses. Over time intense agricultural use has waned with the resultant return of second growth forests that are the dominant feature of Calais' biological landscape today. Despite drastic swings in land use, Calais has remained home to a diverse and valuable array of wildlife, plants, natural communities, and ecological processes that are the focus of this inventory.

Inventory Methods

As in Phase 1, landscape analysis and new field inventory, along with GIS analysis of wildlife habitat related data, formed the core methods of this project; these efforts were followed by data processing and documentation to produce the final reporting, maps, and data products. The landscape analysis process involves gathering and analyzing existing information from a variety of databases and information sources to remotely identify certain types of features and prioritize areas for fieldwork. Information sources included digital maps, aerial imagery, and databases of wetlands, vernal pools, soils, topography, geology, wildlife habitats, and rare species/natural communities. This information was compiled in a GIS (geographic information system) platform to facilitate analysis and mapping. Most of the landscape analysis to identify sites for fieldwork was completed during Phase 1, thus Phase 2 landscape analysis focused on updating a small portion of the wetland mapping and on supporting the wildlife habitat analysis. Local knowledge was also an important information source and was gathered from many community members during an informational session at the outset of Phase 1, through ongoing conversations with landowners, and through previous citizen science efforts focused on documenting wildlife sightings and vernal pools. Field inventory efforts were guided by the results of the landscape analysis, but were necessarily constrained to those areas where landowners granted access. In a few areas "windshield surveys" from public roadways were also used. See **Appendix 1: Detailed Methods** for more specific information on project methodology.

Wetland Mapping Update

The wetland map produced during Phase 1 was updated during Phase 2 with a narrow focus on reviewing the newly available higher quality CIR imagery for the eastern third of town, where it had not been available previously. This brief review identified a modest number of additional small wetlands and brought the town-wide coverage to a consistent mapping resolution. Additional wetland information was also gathered during fieldwork and added to the wetland dataset, resulting in the final wetland data layer and map in Figure 2. The results of the wetland assessment were presented at length in the Phase 1 report and are presented in brief updated form here - see the Phase 1 report for more information.

The final Calais wetland map contains 620 individual wetland or potential wetland units. Whenever practical, units were mapped to correspond to areas of a single natural community type, but in some cases this was not feasible and a mixture of communities are encompassed in a single unit. This mapping provides a substantial improvement in accuracy and comprehensiveness over existing Vermont Significant Wetlands Inventory (VSWI) maps and National Wetlands Inventory (NWI) maps. Collectively, these wetlands (including all lakes and ponds) encompass about 2,516 acres, or about 10.1% of the town land base. Since all wetlands now fall within the purview of the Vermont Wetland Rules, regardless of their presence or absence on state and national wetland maps, this improved local wetland map will benefit landowners and others making land use planning decisions.

This new wetland map is now the most accurate wetland map available for Calais and should be used for planning and development review purposes. However, it is important to note that the map is advisory in nature and that, while very comprehensive, it is not a substitute for site-specific field evaluations where development activities are proposed.

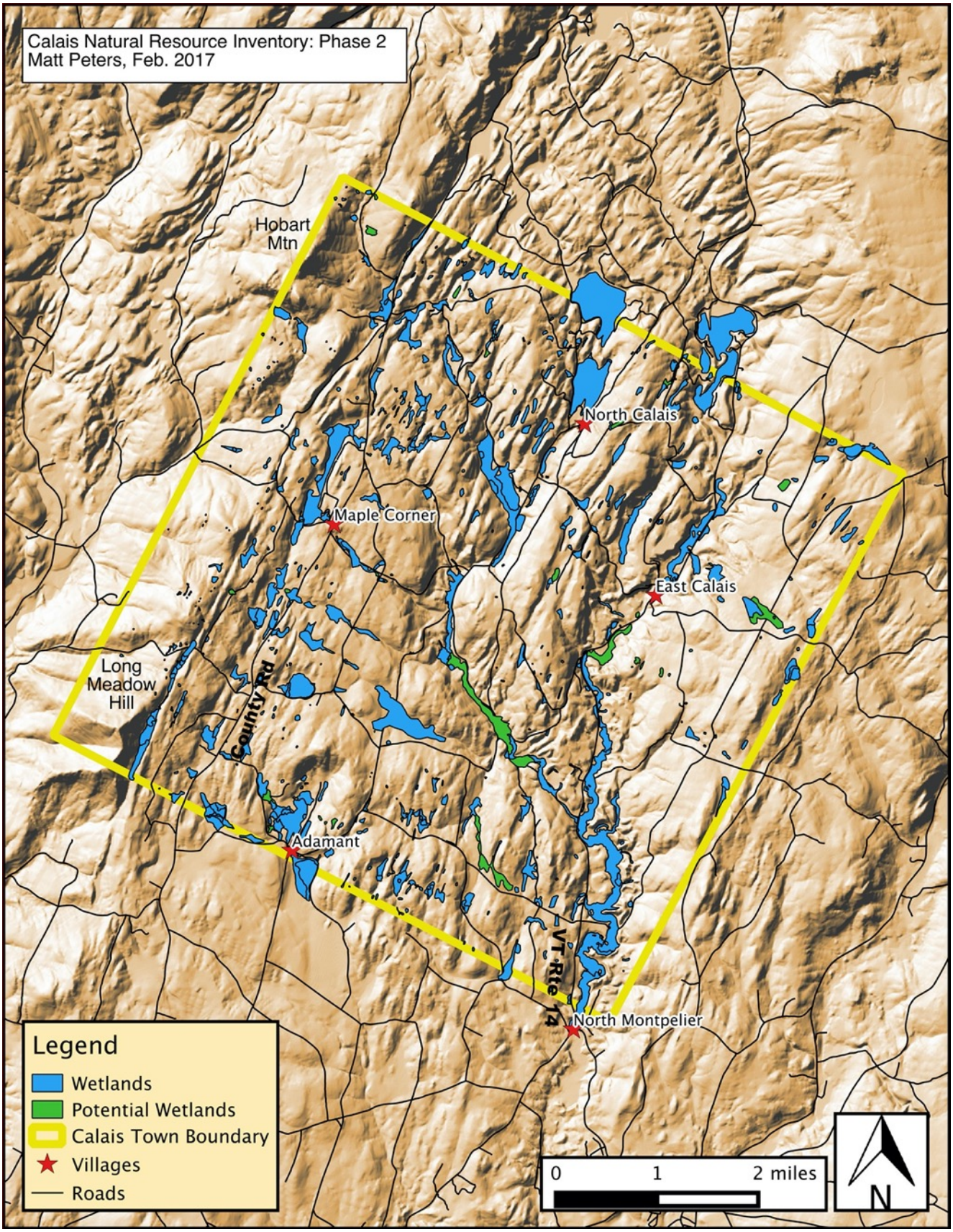
This assessment includes provisional wetland class determinations for each wetland unit (PROV_CLASS field in the wetland data); however, definitive class determinations for regulatory purposes are made by the Vermont Wetlands Program based on field data, thus the provisional classification data is advisory only. Of particular note relative to wetland classes is the pending decision to designate the Chickering Bog (Fen) complex as a class 1 wetland with a 300ft buffer zone. If approved, this would be the first and only class 1 wetland in Calais. Class 1 wetlands are considered exceptional or irreplaceable in their contribution to Vermont's natural heritage and receive the highest level of regulatory protection.

Table 1 presents an updated summary of Calais' wetlands based on natural community type. A total of 27 distinct wetland natural community types were identified by remote assessment, with selective field verification to improve accuracy. This diverse assemblage of communities makes a disproportionately large contribution to Calais' total biodiversity, given their limited spatial extent. Full descriptions of most community types can be found in *Woodland, Wetland, Wildland: A Guide to the Natural Communities of Vermont* (Thompson and Sorenson, 2005). Phase 2 updates resulted in many minor changes to the summary data in Table 1, but few major changes in community type presence, abundance, or extent. Most significant, perhaps, was the identification of several additional rich and intermediate fens, which are rare community types. Some reshuffling of seepage forest communities occurred as these are poorly understood and their classification has been in flux at the state level. Numerous additional small seeps were added and the Water Lily Aquatic Bed community was added (largely reclassifying some Deep Broadleaf Marshes).

Table 1. Summary of Wetland Natural Community Types in Calais, VT.
Listed by decreasing total acreage. State ranks are S1-very rare to S5-common, see Appendix 3 for details, N/A indicates communities that are not part of the ranking system.

Wetland Community Types	State Rank	Number of occurrences	Average size (ac.)	Total acreage
Pond, natural	N/A	24	25.5	612.1
Alluvial Shrub Swamp	S3	17	23.8	405.1
Hemlock-Balsam Fir-Black Ash Seepage Swamp	S4	84	3.0	255.2
Shallow Emergent Marsh	S4	54	4.7	253.5
Alder Swamp	S4	42	4.8	200.3
Wet Meadow	N/A	38	4.9	184.4
Hemlock-Hardwood Seepage Forest	S3?	9	13.8	124.6
Pond, constructed	N/A	105	0.7	77.8
Intermediate Tall Sedge Fen	S2	9	5.7	51.2
Northern White Cedar Swamp	S3	10	4.9	49.4
Red Maple-Black Ash Seepage Swamp	S4	19	2.2	42.5
Cattail Marsh	S4	6	5.5	33.2
Spruce-Fir-Tamarack Swamp	S3	9	3.2	28.8
Vernal Pool	S3	108	0.3	28.7
Sweet Gale Shoreline Shrub Swamp	S3	4	6.5	26.2
Calcareous Red Maple-Tamarack Swamp	S2	8	3.2	25.9
Seep	S4	37	0.7	24.2
Seepage Forest	S3?	3	6.1	18.4
Rich Fen	S2	6	2.0	12.0
Poor Fen	S2	4	2.9	11.6
Water Lily Aquatic Bed	S5?	3	3.7	11.2
Open Water	N/A	7	1.5	10.6
Deep Broadleaf Marsh	S4	5	1.9	9.7
Sedge Meadow	S4	5	1.6	8.0
Silver Maple-Ostrich Fern Floodplain Forest	S3	1	6.1	6.1
Red Spruce-Cinnamon Fern Swamp	S3	2	2.0	4.0
Northern White Cedar Sloping Seepage Forest	S3	1	1.5	1.5
Grand Total		**620**	**4.1**	**2516.0**

Figure 2. Wetlands of Calais, VT.



Ecologically Significant Natural Features

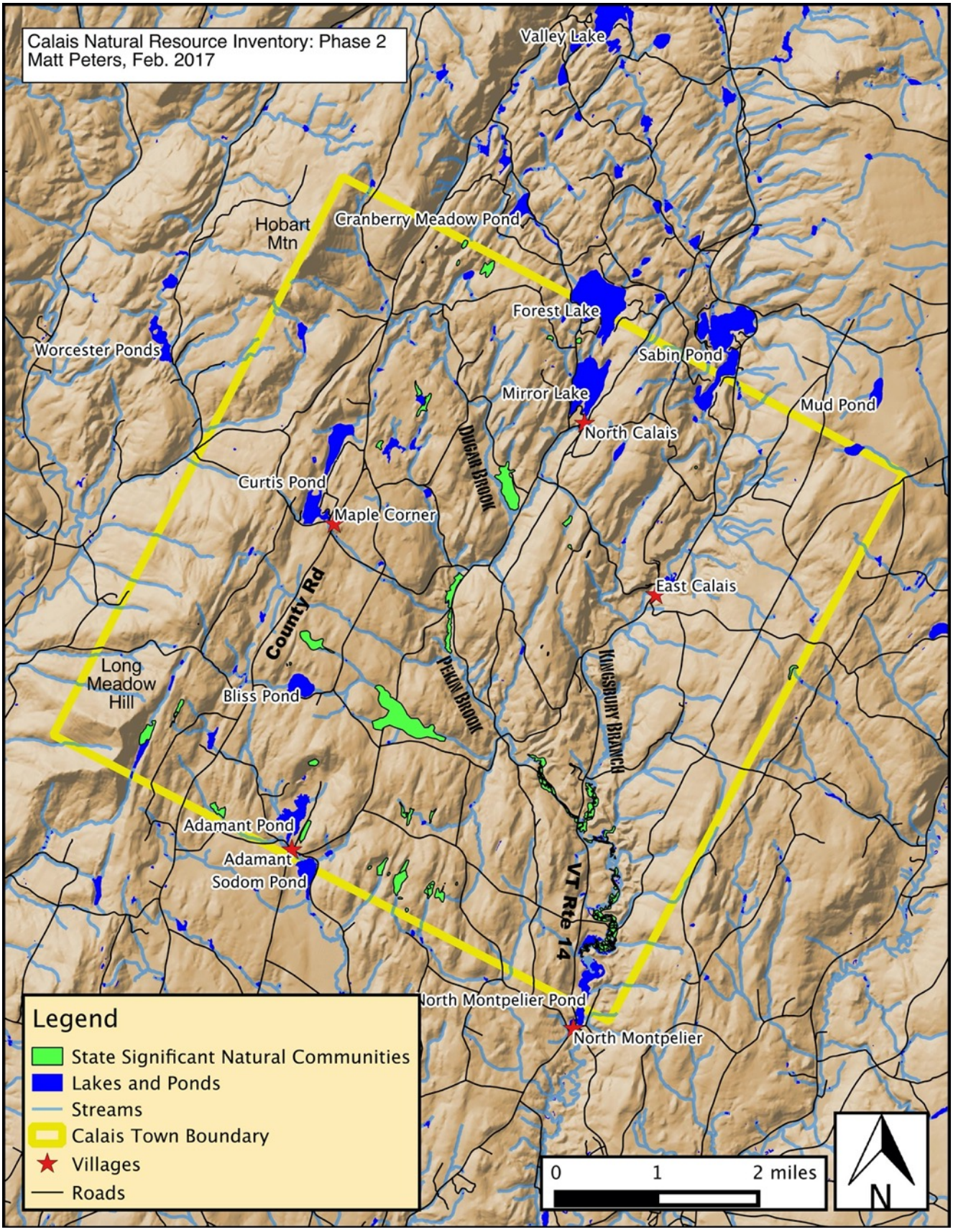
Fieldwork during Phase 2 focused on continuing to locate and document the most ecologically significant features in Calais with an emphasis on state and locally significant natural community occurrences. The importance of such features and the process of evaluating them is discussed at length in the Phase 1 report. In brief, they are discrete areas of a given natural community type that display a combination of high quality, rarity, and size sufficient to be ranked as significant in a state (or local) level perspective, thus they are areas that are exceptional for their intact ecological processes, biodiversity, and physical makeup.

During Phase 2 fifteen priority sites were visited, while 7 remained unvisited due to lack of access. Sites ranged in scale from a single small wetland to the miles-long alluvial shrub swamps along the Kingsbury Branch and Pekin Brook. Thirteen sites are described below; the remaining 2 were generally described in Phase 1 and were revisited only to assess major vernal pools (see Appendix 2). Over the course of this fieldwork 23 new state-significant natural community occurrences were documented, including 15 Vernal Pools, 3 Intermediate Tall Sedge Fens, 2 Rich Fens, 2 Alluvial Shrub Swamps, and a Hemlock-Hardwood Seepage Forest. The last of these is the first example of this newly defined community type to be documented as significant in the state. Numerous locally significant features were also documented. Combined with 16 state-significant community occurrences identified during Phase 1, and the 6 known previously, this brings the total to 45 state-significant natural community occurrences in Calais. This is a somewhat unusual abundance and is largely a result of conditions conducive to a number of rare, calcareous wetland types, including fens and enriched swamps, as well as the scale and condition of Calais' extensive floodplain wetlands, and the highly folded ledge topography that fosters so many large and productive vernal pools. All of these state-significant occurrences are shown in Figure 3 below, and those documented during Phase 2 are described in the following series of site descriptions (see Phase 1 report for descriptions of the other sites). Additionally, detailed technical descriptions of state-significant community occurrences were provided (with landowner permission) to the state Natural Heritage Inventory.

As discussed at length in the Phase 1 report, it is noteworthy that all but one of the state-significant communities identified in Calais are wetlands. In large part, this is because more common "matrix" forest types, such as Northern Hardwood Forest or Hemlock-Northern Hardwood Forest dominate Calais' uplands and these require very large acreages in relatively undisturbed condition to be considered state-significant. While most of these upland areas in Calais are not significant from a statewide natural community perspective, many are significant from the perspective of maintaining wildlife habitat, connectivity, and the continuity of ecological processes across the land. These topics are the focus of the *Wildlife Habitat Block and Connectivity Analysis* section below.

Despite two seasons of rigorous fieldwork there are undoubtedly additional features of state-significance that remain to be documented in Calais. This is due in part to Calais' unusual abundance of wetlands and enriched soils, as well as lack of access to certain areas thought to contain significant features. In particular, there are additional parts of the extensive floodplain swamps that were not visited, but which are likely significant occurrences of Alluvial Shrub Swamp similar to those documented herein. There are also many unvisited vernal pools that may be significant (vernal pool ranking is unusual in that it is largely based on a pool's productivity of certain amphibians). Other significant upland community occurrences that may remain unrecognized include large, mature, rich northern hardwood forests, various types of cliffs or outcrops, and additional small talus woodlands.

Figure 3. State-Significant Natural Communities of Calais, VT.



Bayne Comolli Road Wetlands

Location: North of Bayne Comolli Rd., northwest of Nelson Pond

Information Sources: Peters' site visits on June 23, 2016 and Oct. 19, 2015.

Ownership: Privately owned lands

Significant Features

Natural Communities and other features: Rich Fen*, Vernal pools*, Calcareous Red Maple-Tamarack Swamp*, Hemlock-Balsam Fir-Black Ash Seepage Swamps, Seeps, Red Maple-Black Ash Seepage Swamp, small Shallow Emergent Marsh, a small undeveloped natural pond, and upland forests (predominantly hemlock-, red spruce-northern hardwoods and northern hardwoods).
* Indicates occurrences that are State-Significant.

Rare, Threatened, & Endangered Species: slender cotton-grass (*Eriophorum gracile*), trailing stitchwort (*Stellaria alsine*), three-ranked hump-moss (*Meesia triquetra*), unconfirmed citizen report of Jefferson Salamander (*Ambystoma jeffersonianum*).

Uncommon Species: showy lady's-slipper (*Cypripedium reginae*), and Huron orchid (*Platanthera huronensis*)

Site Description

The eastern part of this macrosite was visited and described in the Phase 1 report (p.35-37); during Phase 2 additional landowner permissions allowed access to important features in the western part, which are the focus of this description. Overall, the site contains a diverse series of enriched headwater wetlands, vernal pools, and a small pond, nestled among the forested, low relief hills near the town boundary with Woodbury. The matrix forest of second-growth timber is primarily mixedwood, mostly hemlock- and red spruce-northern hardwoods in the east, with areas of pure northern hardwoods on the higher western ridges. These ridges include a small mast stand of bear-scarred beech, which reinforces other wildlife sighting data that suggest abundant bear activity in the area.

Showy Lady's-slippers in Rich Fen

In addition to the state-significant Calcareous Red Maple-Tamarack Swamp previously described from this area, the feature of greatest ecological interest is a small (~2.5) acre open wetland draining north into Woodbury. This area is a beautiful and state-significant Rich Fen tucked into a remote feeling crease between the hills. This fen is a bit unusual for its type, having relatively deep peat deposits (>4ft deep) and a very shallow slope with no obvious points of groundwater discharge, except the small stream that begins at its north end. The characteristic plants species requiring high pH, enriched groundwater seepage conditions are nonetheless

present, with irises and showy lady's-slippers dotting the saturated, mossy carpet amid a diverse array of sedges. These include the very rare slender cotton-grass (*Eriophorum gracile*), now known from 3 of Calais' fens.

South and west of this fen are numerous small, perched swamps, seeps, and pools tucked amid the ledges. These are diverse in their flora and make for a varied set of habitats in close proximity. The vernal pools appear to be state-significant, with good size, remote conditions, and some confirmed amphibian breeding. The very dry spring of 2016 led to poor conditions for assessing typical pool viability, so repeat visits in a more typical year could be beneficial. Additionally, a previous citizen inventory visit to these pools yielded an unconfirmed report of Jefferson Salamander egg masses. If confirmed this would be significant, since the species is otherwise unknown from Calais and is considered of Special Concern statewide. Reliable differentiation of Jefferson egg masses from those of the more common spotted salamander can be tricky and requires a practiced eye; unfortunately, 2016 did not yield a chance to confirm this.

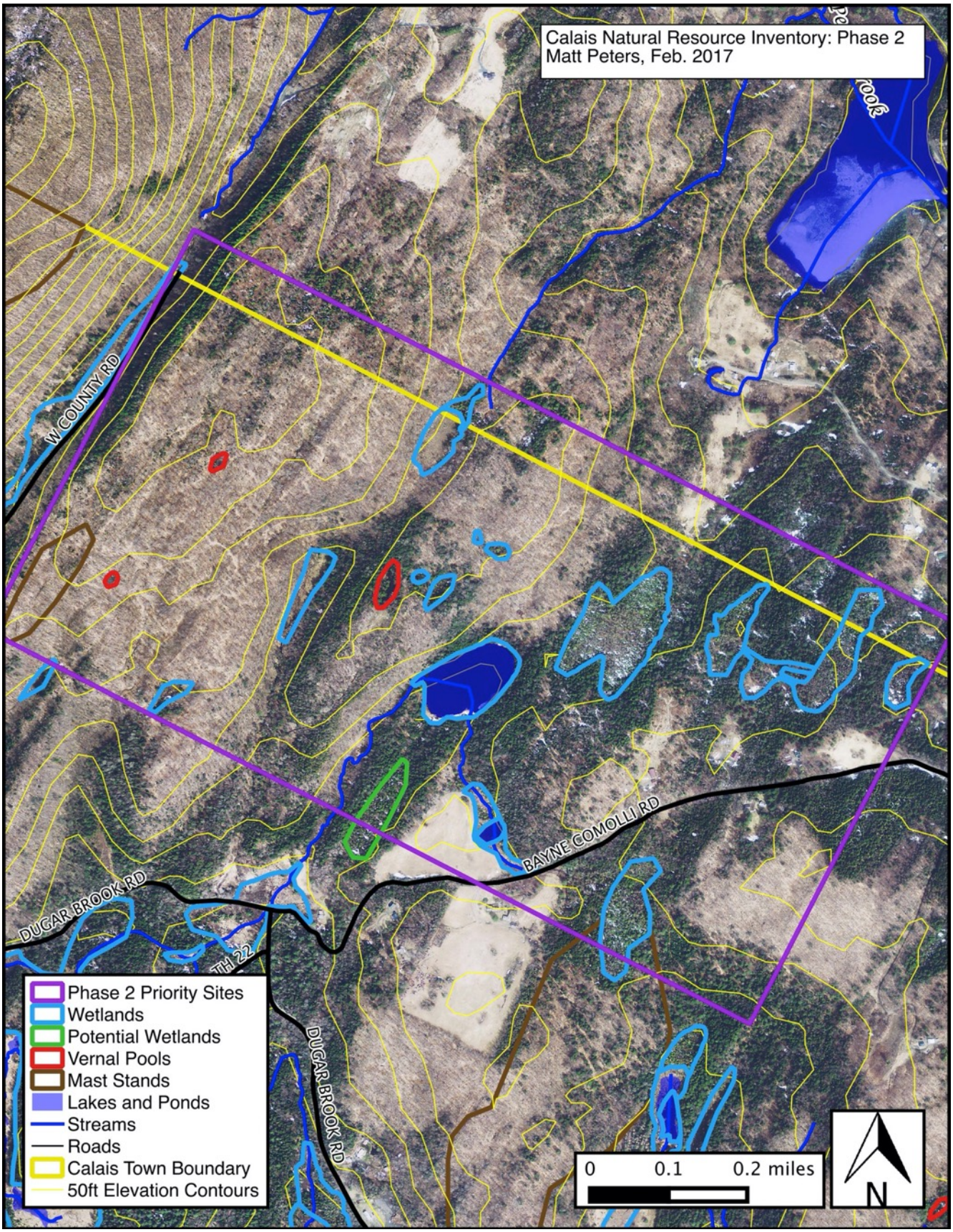
Management Considerations

As was previously noted for this site, the diverse wetlands are presently in good condition, however, they are sustained by groundwater seepage making them potentially vulnerable to any disturbances in their watersheds and groundwater source areas. Thus landowners are encouraged to minimize activities that might alter patterns or volumes of groundwater or surface water flow, particularly nearby ground disturbance or extensive clearing. This is especially true in the vicinity of the rich fen and vernal pools. Users of the private ATV trails near some of these features are encouraged to keep an eye out for any signs of significant trail erosion or off-trail use that could threaten these wetlands. Forest management activities around the wetlands should ideally maintain forested buffers and avoid cutting or operating within the wetlands.

Rich Fen

Rare Three-ranked hump-moss (*Meesia triquetra*) in the fen.

Figure 4. Bayne Comolli Road Wetlands Map



Kingsbury Branch and Lower Pekin Brook Floodplain Swamps

Location: valley bottom along Rte. 14 and Pekin Brook Rd following the streams north of North Montpelier Pond

Information Sources: Peters' site visits on July 27 and August 2, 2016; VT Natural Heritage Inventory.

Ownership: Privately owned lands

Significant Features

Natural Communities and other features: Alluvial Shrub Swamp*, Shallow Emergent Marshes, Alder Swamps, oxbow ponds, Deep Broadleaf Marshes, Water Lily Aquatic Beds, Hemlock-Balsam Fir-Black Ash Seepage Swamps, and upland riparian forests (predominantly hemlock-northern hardwood).
* Indicates occurrences that are State-Significant.

Rare, Threatened, & Endangered Species: none found

Uncommon Species: Sensitive Species-redacted, burbot (*Lota lota*), matted spikerush (*Eleocharis intermedia*), cyperus-like sedge (*Carex pseudocyperus*)

Site Description

The valley bottom wetlands along the Kingsbury Branch and Pekin Brook are some of the largest, most extensive, and most obvious wetlands in Calais providing a daily backdrop to commuters on Route 14 and Pekin Brook Road. Despite some encroachment from roads, fields, and a few homes, these floodplain swamps are among the most important in Calais, providing ecosystem services such as floodwater storage and water quality improvement that benefit all downstream settlements. These swamps also provide tremendous habitat value for a diverse array of animals and plants and function as important corridors for wildlife movement.

Historically, the Alluvial Shrub Swamps and other wetlands of the valley bottoms appear to have extended in nearly unbroken swaths for much of the length of town. From North Montpelier they would have stretched nearly to East Calais in a roughly 5 mile segment, that also forked and followed Pekin Brook well upstream. Above East Calais they extended another ~1.5 miles north toward Woodbury Lake. Some of the higher and drier sections of valley bottom have, not surprisingly, been cleared and used for agriculture, so the connectivity of these swamps has been somewhat reduced, but it is still impressive, with the largest intact section extending nearly 2 miles as the crow flies from North Montpelier Pond to the Still Brook Rd crossing and up Pekin Brook to the first bridge.

Bobcat tracks in shoreline mud.

The valley bottom is dominated by the alder shrub thickets typical of alluvial shrub swamps, so it is not the most inviting place for people; however, those willing to explore on foot, or more readily by

canoe or kayak, will be rewarded with many wildlife sightings. Once away from the road the dense thickets quickly lend a secluded feel to the place that helps all manner of wildlife go about their lives. Beaver are common along the slow winding channels, and their tracks, along with mink, raccoons, occasional otters, and many others are readily found in the exposed muddy shorelines. Bobcat tracks were also found along the shore, highlighting the significance of the riparian corridor for wide ranging wildlife. These streams are also important habitat for [redacted] an uncommon species considered a Species of Greatest Conservation Need by the state's Wildlife Action Plan. [redacted] Interestingly, Pekin Brook is also known to support burbot, a fish in the cod family, which is often associated with cold deep lakes, but can also live in small coldwater streams. Waterfowl and songbirds find a haven in these wetlands as well. Herons, bitterns, wood ducks, kingfishers, and many others are common sights along the shorelines and backwater marshes.

As mentioned, Alluvial Shrub Swamps are the dominant wetland type in the valley bottom covering over 70 acres here and constituting a state-significant site, one of the largest of its type documented outside the Northeast Kingdom. These shrub thickets line the stream banks spreading around old oxbow ponds and backwater marshes to fill the bottomlands. Alder shrubs are well adapted to the frequent flooding, ice scour, beaver activity and other rigors of this setting and the rich alluvial soils support a lush growth of many other robust herbs, ferns, and grasses. Large stands of pink Joe-pye weed blossom in late summer providing abundant nectar to bees and butterflies. Large colonies of ostrich fern are also present. Observers of these swamps driving the highway will probably have also noticed the abundant fuzzy seed heads of wild clematis or virgin's bower, a native vine that thrives in the bright, shrubby thicket or floodplains. Another type of fuzzy white form is often visible amid the alder thickets in the late fall – masses of woolly alder aphids – these native insects feed on alder and silver maple and congregate in large masses making the fuzzy, white waxy covering on their backs visible from a speeding car. Among the other interesting creatures that live here are a pair of uncommon plants. The matted spikerush is a small annual plant adapted to leading out its short life on exposed mud flats along the streams while the cyperus-like sedge favors mucky soils at the edges of backwater marshes and oxbow ponds.

Muddy shores provide matted spikerush habitat and good tracking conditions.

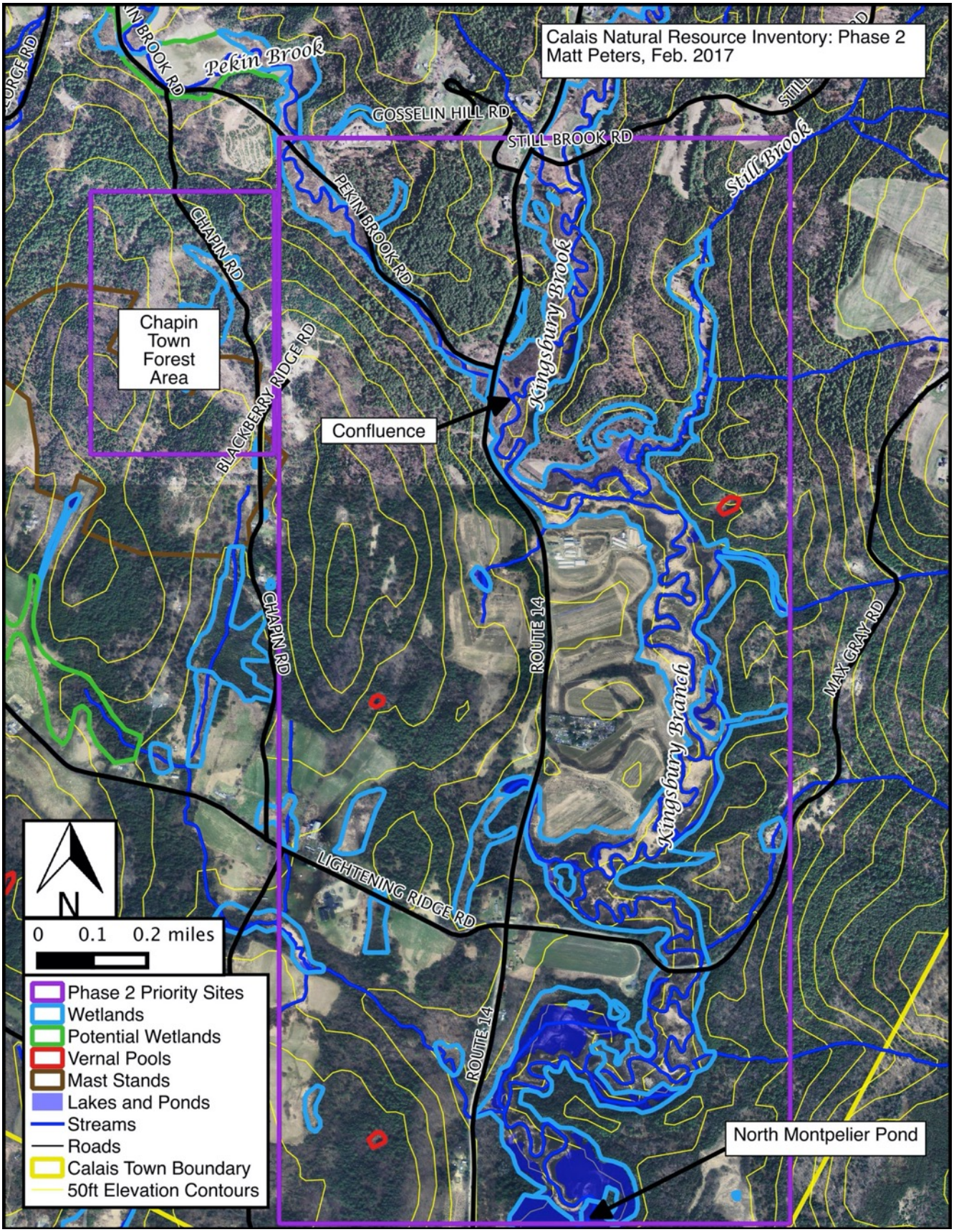
Management Considerations

Much of the floodplain bottomland is subject to frequent flooding and is unsuitable for development, agriculture, or forestry. Some of the slightly higher and drier sections have been cleared and used for agriculture or in some cases homes have been built on fill pads. Future development, filling, or land clearing in the floodplain swamps should be avoided as this impairs the beneficial functions of this area for both people and wildlife. Where opportunities exist to allow the reversion of formerly cleared bottomlands to more natural wetland conditions, this is to be encouraged, as it will increase ecological function and connectivity along this important riparian corridor. Rte 14 and Pekin Brook roads are the largest single impacts to the valley bottom swamps, but since these are unlikely to be removed management should focus on limiting any further encroachment from road related fill or

hydrologic alterations associated with bridges and culverts; refer to the relevant state river corridor plans for discussion of these issues. Dispersed pollution from road runoff of sediments, salt, and other chemical pollutants could also be an issue for these wetlands, but one that is not easily addressed. In general following best management practices for rural roads should help address sediment and erosion related concerns. Finally, riparian areas can be highly vulnerable to certain invasive plants. Exotic honeysuckle is abundant in some areas, but may be beyond the reach of ready control. Yellow iris (*Iris pseudoacorus*) is beginning to appear, widely scattered along the stream banks and backwater swamps, almost certainly the result of downstream movement from the large population in the pond at East Calais. While yellow iris has attractive showy flowers, it can displace many native wetland plants and ideally the source population and the dispersing plants downstream would be removed.

Kingsbury Floodplain Alluvial Shrub Swamps viewed from above (top left), a small Erosional River Bluff (top right), and typical alder-lined banks with beaver activity along the lower sections of Kingsbury Brook (bottom).

Figure 5. Kingsbury Branch and Lower Pekin Brook Floodplain Swamps Map



Upper Pekin Brook Floodplain Swamps

Location: valley bottom along Pekin Brook Rd from town office downstream ~0.8 miles past Singleton Road

Information Sources: Peters' site visits on August 3, 2016; VT Natural Heritage Inventory.

Ownership: Privately owned lands

Significant Features

Natural Communities and other features: Alluvial Shrub Swamp*, mixedwood seepage forests, seeps, and upland riparian forests (predominantly hemlock-northern hardwood).
* Indicates occurrences that are State-Significant.

Rare, Threatened, & Endangered Species: none found

Uncommon Species: Sensitive Species - redacted, burbot (*Lota lota*), matted spikerush (*Eleocharis intermedia*)

Site Description

This ~22.5 acre section of valley bottom wetlands along Pekin Brook is similar in many ways to the previously described riparian swamps about a mile downstream. The appearance, structure, and species composition are all quite similar, with dense alder thickets flanking the channel and tall lush herbs such as joe-pye weed and virgin's bower growing below and in the occasional gaps. However, being higher in the watershed, the stream channel is smaller, the valley bottom is somewhat narrower, and the intensity of flood and ice scour disturbances is probably reduced. Additionally there is somewhat greater tree cover, with scattered balsam fir, occasional basswood, white cedar, and hemlock thriving in the full sun above the alders. This community structure is somewhat reminiscent of the poorly understood Northern Conifer Floodplain Forest type, which can often be found intergrading with Alluvial Shrub swamps along Northeast Kingdom streams. Only the southern half of this site was examined in detail due to lack of access, but the section north of Singleton Road is readily visible from Pekin Brook Road and the entire area was mapped as part of this state-significant shrub swamp.

Like the shrub swamps of the Kingsbury and lower Pekin Brook, those in this section provide important ecosystem services such as floodwater storage and water quality enhancement, as well as creating an important corridor for wildlife movement and home for certain unusual species. The uncommon [redacted] burbot use this part of the stream as does the matted spikerush, which can be found growing on small, muddy exposed shorelines and bars. Numerous woodcock were encountered while surveying this site and the moist alluvial soils appear to provide good foraging and cover for them. Valley bottom areas north and south of the Singleton/Pekin Brook Rd intersection have good connectivity between the forest blocks on either side and are rated as medium priority wildlife road crossings.

The intervening section of valley bottom between this site and the Lower Pekin Brook shrub swamps discussed above is now largely cleared, with some parts in active agricultural use and others slowly reverting to more natural conditions. These cleared areas appear slightly higher relative to the stream

than most of the alluvial shrub swamps and were likely previously home to Calais' only true floodplain forests. The scattered boxelders along this section hint at this prior forest type.

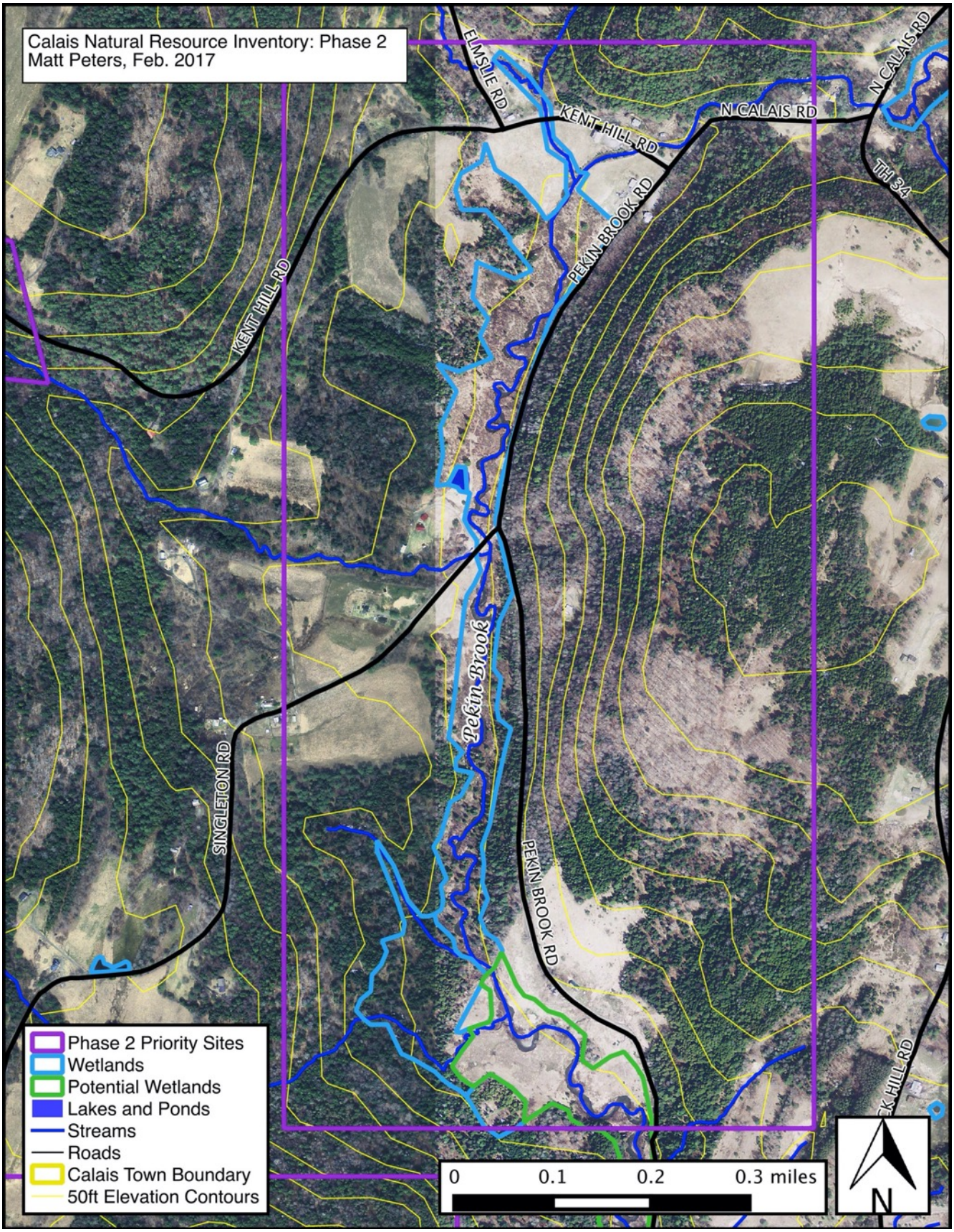
Time and access was not available to fully examine all sections of alluvial shrub swamp further upstream along Pekin and Dugar Brooks and the Kingsbury Branch, but is it quite likely that some additional areas of these swamps warrant designation as state-significant features. While many of these are visible from roads and discernable as alluvial shrub swamps, higher in the watershed they likely transition to the more common alder swamp type, which is less likely to be state-significant (though it still has many important values).

Management Considerations

Concerns are generally the same as for the previous site. Fortunately fewer invasives were noted here, though a large colony of goutweed (AKA bishop's weed, *Aegopodium podagraria*) was noted along a tributary stream at the south end of the site on the west side of Pekin Brook.

Views of Upper Pekin Brook, its Alluvial Shrub Swamps, riffles, and mud shores exposed at low water.

Figure 6. Upper Pekin Brook Floodplain Swamps Map



Singleton Road Seepage Forest

Location: either side of Singleton Rd along an unnamed tributary to Pekin Brook

Information Sources: Peters' site visit on Sept 12, 2016, E. Sorenson, landowners.

Ownership: Privately owned lands

Significant Features
Natural Communities and other features: Hemlock-Northern Hardwood Seepage Forest*, small stream. * indicates State-Significant occurrences.

Rare, Threatened, & Endangered Species: none found

Uncommon Species: none found

Site Description
This site is a broad area of unusual sloping wet woods arrayed along small, unnamed tributaries to Pekin Brook. Seepage forests are a poorly understood and little documented type of forested wetland in Vermont. They may be uncommon to moderately abundant on the landscape, but their variability and lack of a standard classification scheme has limited generalizations about them. There is much that is unknown about seepage forests: what their typical composition is, how they work hydrologically, and other basic ecological questions. This site was visited to assess its condition and to contribute information to current state efforts to better understand these types of forests. Several other areas of potential seepage forest in Calais were also identified during the remote wetland assessment, but this site appears to be the largest in town at around 80 acres. This site currently appears to be state-significant although its boundaries and conditions were not fully explored due to lack of landowner permission.

Seepage forests are usually a mosaic of low wet areas associated with groundwater discharge and higher, drier areas that often support the bulk of the trees. The balance between wetland and upland components can varying greatly, but in this particular example a majority of the area is clearly moist to saturated much of the time. Parts of this seepage forest are easily viewed from Singleton Road and the wetland/upland mosaic nature of these forests is readily apparent to the observant eye. At the upslope edge of the seepage forest a sharp slope break and perhaps a less permeable soil or bedrock layer forces ground water to the surface, resulting in broad areas of moss carpeted, moist, organic-rich, mucky soil. Water percolates slowly down the broad slope and concentrates into small stream channels near the margins of the area. The forest canopy is dominated by hemlock, giving this seepage forest a dark secluded feel, but diverse array of other trees are present too, including wetland species like black ash and white cedar, as well as upland species like ironwood (*Ostrya*), white ash, and a little sugar maple. Yellow birch, fir, larch, and occasional large red spruce are also present making for a diverse canopy and reflecting the variable wet and dry rooting conditions that are present. Many of the trees in the western portion of the seepage forest are of good size and there are few indications of recent disturbance here. The understory is quite open, apart from pockets of softwood saplings. The dark, moist conditions in the stand result in a nearly continuous moss carpet and incredible abundance of a striking, small, wiry species of horsetail called dwarf

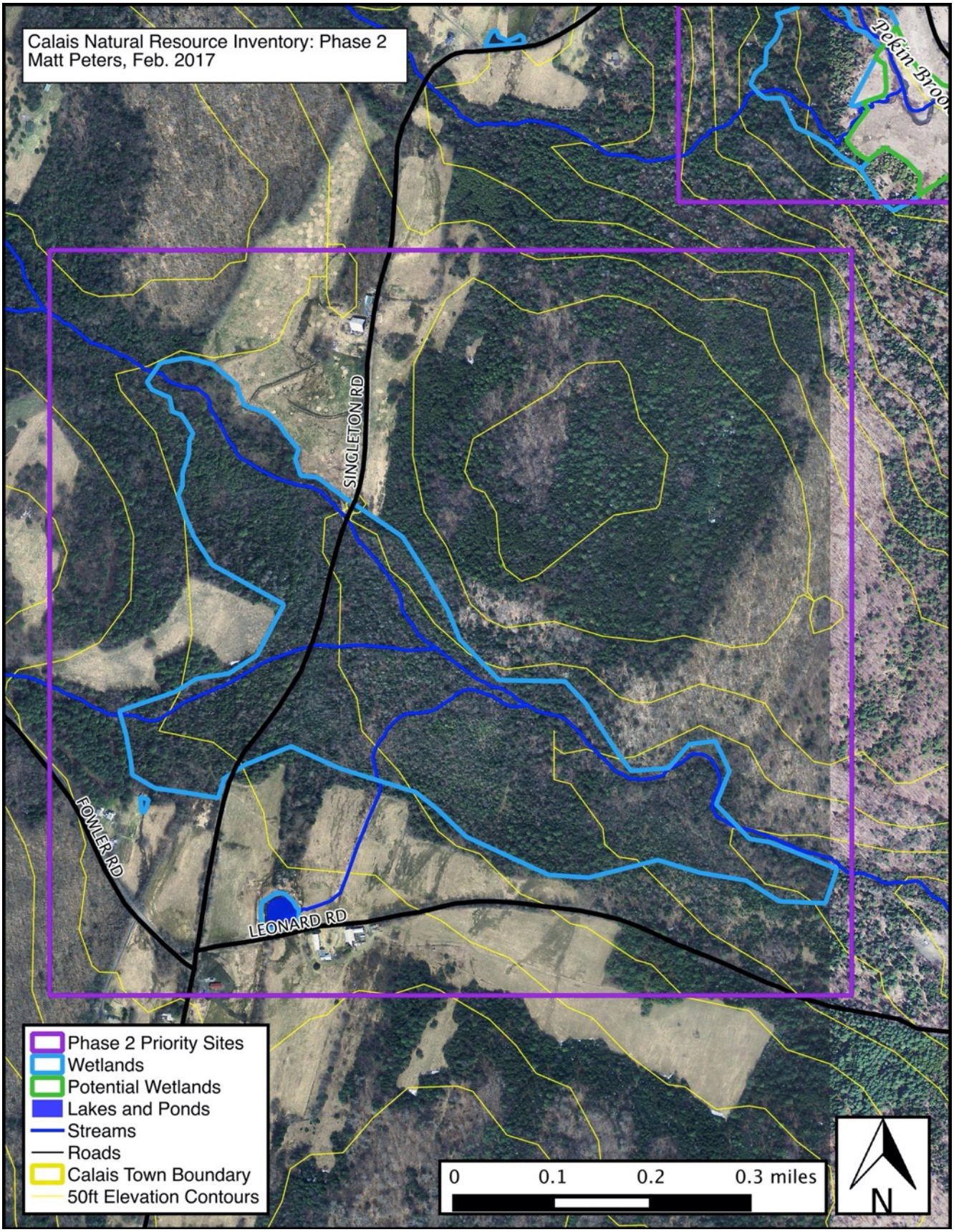
scouring rush (*Equisetum scirpoides*). Any wanderer through this area will quickly realize they are not in a typical patch of woods.

Management Considerations

As a wetland and a community occurrence of state-significance this area would ideally be left unmanaged and free from timber harvest. However, since it is a fairly extensive forest stand this may be a challenge for some owners. If any timber harvest is contemplated, owners should work closely with a forester to develop a plan to minimize impacts, and harvesting should only occur during frozen conditions. Owners enrolled in the Use Value Appraisal Program (Current Use) should note that state-significant community designation provides additional options for them to designate special treatment areas that are excluded from harvest or subject to different standards, while still fulfilling their management obligations under the program; they should consult their forester, the county forester, or the state natural community ecologist for more information. Singleton Road crosses this seepage forest, but does not presently appear to have major impacts on the area's hydrology. Future road maintenance activities such as culvert and ditch repair should be conducted so as to avoid modifying or substantially changing the drainage in the adjacent forest. Wetter sections of some adjacent fields to the north and west may once have been part of this seepage forest; if removed from production they may over a long time period revert toward such conditions and would provide additional buffer zones for the core of the seepage forest.

Dense hemlock-northern hardwood seepage forest with emerald green mosses, scouring rushes, and other herbs.

Figure 7. Singleton Road Seepage Forest Map



Ledge Hill Area

Location: east and west of Ledge Hill Rd., south of Moscow Woods Rd.

Information Sources: Peters' site visits on May 20 and June 30, 2016.

Ownership: Privately owned lands

Significant Features
Natural Communities and other features: Rich Fen*, Vernal pools*, Hemlock-Balsam Fir-Black Ash Seepage Swamps, Seeps, Red Maple-Black Ash Seepage Swamp, and upland forests (predominantly hemlock- and white pine-northern hardwoods and northern hardwoods).
* Indicates occurrences that are State-Significant.

Rare, Threatened, & Endangered Species: slender cotton-grass (*Eriophorum gracile*)

Uncommon Species: yellow lady's-slipper (*Cypripedium parviflorum var. makasin*), and Loesel's twayblade (*Liparis loeselii*), and mountain fly-honeysuckle (*Lonicera villosa*).

Site Description
This site is a broad area of forested parallel ridges flanking either side of Ledge Hill Road on the higher terrain between Pekin Brook and the Kingsbury Branch. Like many parts of Calais, the dissected topography of ridges and swales results in many small wetland features of interest. Among these are several vernal pools, a pair of enriched mixedwood swamps, a hardwood swamp, extensive seeps, and a rich fen, as well as other wetlands that were not visited. The ridgetops and other upland areas are a mixture of second growth hardwoods, hemlock and white pine, with ridges east of the road supporting a small mast stand with a concentration of bear-scarred beeches.

Approaching this area along Ledge Hill Road one is treated to an easy view of beautiful hardwood and mixedwood seepage swamps. In spring these are lush and vibrant with an abundant, sunny display of marsh marigolds. A closer look will reveal many species typical of these enriched, groundwater fed swamps such as golden spleenwort, water avens, and swamp saxifrage. The trees in these swamps are fairly small, and an abundance of large downed mossy logs in some areas suggests the stand may have blown down in the not so distant past. These swamps are somewhat unusual in that they drain in two different directions, north along the road and east toward the Kingsbury.

Further removed from the road are two very large and productive, state-significant vernal pools, one of which is among the few pools in Calais that supports abundant fairy shrimp. These pools each had well over 100 spotted salamander egg masses in 2016, among the highest levels of amphibian breeding observed at any pools in Calais, highlighting their importance as critical breeding habitats.

Venturing further west one encounters another mixedwood seepage swamp, this one also with dense young conifers growing up among abundant large, rotting, mossy logs, further suggesting a localized wind event in the past. This swamp has very well developed hummock and hollow microtopography with notable differences in the plant species between top and bottom. The hollows are wet and supplied with enriched groundwater supporting a diverse flora, including a few uncommon species

such as the yellow lady's-slipper (*Cypripedium parviflorum var. makasin*), while the hummocks are much higher, and drier, with species typical of more acidic boreal conditions, such as bunchberry and snowberry. Together with its strongly spruce and fir dominated canopy this makes the swamp a unique blend, that has elements of multiple community types. While this swamp did not quite reach the threshold for state-significance it is clearly of local significance and a unique spot in Calais.

The swamp drains west through dense hemlock and opens out into a large wetland meadow (~3 acres) that is a state-significant rich fen. Numerous springs and seeps feed this sloping fen from several directions including the base of small calcareous outcrops to the west. The old pasture pines, patchy stands of pole timber around the edges and an old springbox likely tell a tale of previous clearing and pasturing, from which the fen is now recovering. Much of the fen has abundant shrub willows and dogwoods and a somewhat reduced plant diversity that may be legacies of agricultural disturbance, but the north end remains in very good condition with a typical suite of rich fen herbs, sedges, and mosses, including colorful flowers such as golden ragwort, bog goldenrod, and white northern bog-orchid. The very rare slender cottongrass (*Eriophorum gracile*) grows here in abundance, one of a few fens it occupies in Calais. The uncommon plants Loesel's twayblade (*Liparis loeselii*) and mountain fly-honeysuckle (*Lonicera villosa*) also occur in scattered spots in the fen. With an intact watershed, continued time, and regeneration of the surrounding forest, the fen will likely continue its recovery from whatever the past impacts may have been.

Management Considerations

The diverse wetlands here are largely in good condition and should continue to be protected. Groundwater seepage is an important process supporting many of the wetlands making them potentially vulnerable to any disturbances in their watersheds and groundwater source areas. Activities that might alter patterns or volumes of groundwater or surface water flow, such as nearby ground disturbance or extensive clearing, should be minimized. This is especially true in the vicinity of the rich fen and vernal pools. Forest management activities around the wetlands should ideally maintain forested buffers and avoid cutting or operating within the wetlands. Given the significance and high productivity of the vernal pools appropriate buffering is important during any future logging; see the materials cited in the vernal pool section of this report for more detailed management resources. Finally, the proximity of Ledge Hill Road to some of the wetlands and one vernal pool is a concern. The road is currently a dead end with low traffic volume and impacts are minor, but any maintenance or future upgrades should be done in such as way as to minimize wetland impacts. Efforts to verify the potential amphibian crossing on Ledge Hill Rd would be beneficial given the high productivity of the adjacent pool.

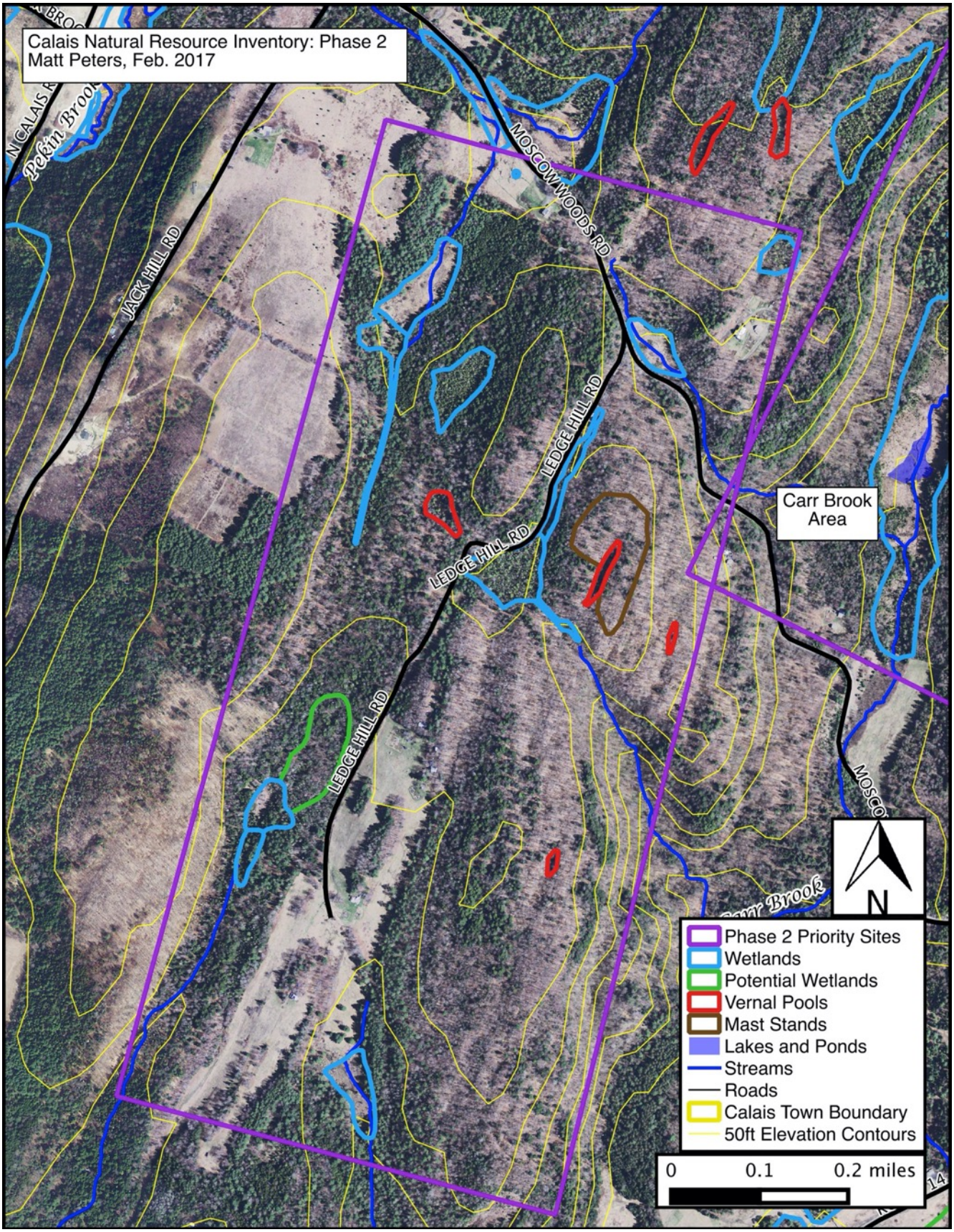
State-Significant Vernal Pool

Mountain fly-honeysuckle in fen.

Fairy shrimp (center) swimming above spotted salamander eggs and wood frog tadpoles

Rich fen in early spring

Figure 8. Ledge Hill Area Map



Peck Hill Pools

Location: West of Peck Hill Rd and north of Fifers Ride

Information Sources: Peters' site visit on May 5, 2016, landowners.

Ownership: Privately owned lands

Significant Features

Natural Communities and other features: Vernal pools*, Hemlock-Balsam Fir-Black Ash Seepage Swamps, Seeps, and upland forests (predominantly northern hardwoods, hemlock- and white pine-northern hardwoods).

* Indicates occurrences that are State-Significant.

Rare, Threatened, & Endangered Species: none found

Uncommon Species: cyperus-like sedge (*Carex pseudocyperus*)

Site Description

This site was visited early in 2016 with the primary purpose of assessing several potential vernal pools in the area between Peck Hill and Fifers Ride roads. The area presents a slope that rises somewhat steeply from the Kingsbury Branch valley bottom through ledgey terrain to form a broad hardwood covered ridgetop. The pools are tucked into small basins and creases in this ridge. Two of the pools turned out to be very nice, large in size, and with good amphibian egg mass abundance - over 150 wood frog egg masses in one case, indicating extensive breeding activity. One of these pools, in a small basin in the center of the hardwood covered ridge, is somewhat unusual in that it is large enough to form a significant gap in the canopy and has developed extensive cover of the coarse sedges *Carex utriculata* and *Carex comosa*, making it appear more like a small marsh than a typical pool. Even early in the season extensive cover of duckweed on the pool surface prevented good assessment of the breeding use of this pool, so its amphibian productivity is probably far greater than indicated in the vernal pool data. Both of these pools are considered state significant for their size, good condition in intact forest, and amphibian productivity.

Several other potential pools in the area turned out to be other types of small isolated wetlands, mostly seeps, underscoring the need to verify remotely detected potential pools with on the ground fieldwork. One of these areas turned out to be a linear pond, historically excavated into a small wetland, according to residents. Excavating wetlands to create ponds is now generally viewed as ecologically damaging; however, the historical impacts at this site inadvertently led to creation of what is essentially an artificial vernal pool. Over 100 spotted salamander egg masses were noted here, making it a significant breeding site. Additionally a few clumps of the uncommon cyperus-like sedge (*Carex pseudocyperus*) were found growing along its edges.

Management Considerations

The vernal pools and other small wetlands at this site are primarily embedded in intact forest, a condition which should be maintained. Any forestry activities in the area should strive to avoid the wetlands and maintain forested buffers around them. Around the vernal pools larger buffer areas are

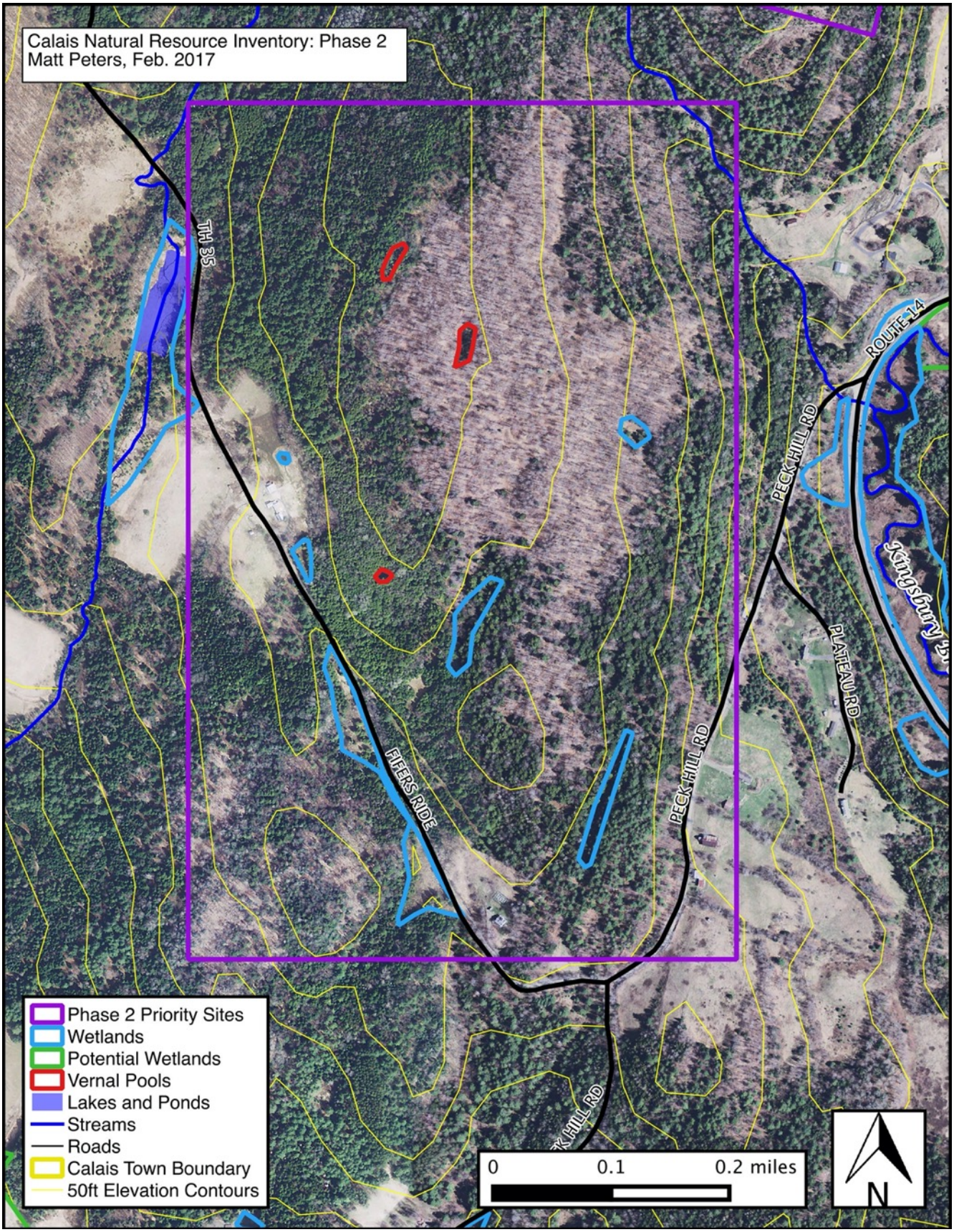
warranted, though these need not exclude all forestry activities. See the vernal pool section for more detailed management recommendations. Two short sections of Fifers Ride and Peck Hill Rd have some potential as amphibian crossing areas given the heavy breeding use of the natural and artificial pools in the area; these areas could be examined during spring migration conditions, though current traffic patterns are unlikely to pose a high threat here.

A hemlock-lined vernal pool fed by a spring

Wood frog eggs left on a mossy log by a predator.

A large marshy vernal pool atop the hill - spring water levels are usually much higher than this.

Figure 9. Peck Hill Pools Map



Interlacken Fens

Location: Along Bayne Comolli and Nelson Pond Roads, roughly between Mirror Lake and Nelson Pond.

Information Sources: Peters' site visits on Aug. 19 and Sept. 12, 2016, landowners.

Ownership: Privately owned lands

Significant Features

Natural Communities and other features: Intermediate Tall Sedge Fens*, small Hemlock-Balsam Fir-Black Ash Seepage Swamps, Seeps, enriched Alder Swamp, and upland forests.
* Indicates occurrences that are State-Significant.

Rare, Threatened, & Endangered Species: slender cotton-grass (*Eriophorum gracile*), bog willow (*Salix pedicellaris*)

Uncommon Species: blunt-leaf pondweed (*Potamogeton obtusifolius*), lesser bladderwort (*Utricularia minor*), Loesel's twayblade (*Liparis loeselii*), broad-headed rush (*Juncus brachycephalus*), fall dropseed muhly (*Muhlenbergia uniflora*) and wide-leaved beard moss (*Helodium blandowii*).

Site Description

Unlike most of the other sites this area is relatively small and encompasses several homes and field areas. The focus of site visits in this area was narrowly targeted to two small fens that were initially noted from the road during windshield surveys. There are several other small wetlands in the area that provide additional habitat diversity amongst the largely mixedwood forest patches between homes, but it is these two fens that are the standout features.

Kalm's Lobelia in the fen

Though small, each about 1.5 acres or less, both of these fens are state-significant and contain a number of rare and uncommon species. The fen along Bayne Comolli Road is part of a network of lands that host a local disc golf course and occurs in a small topographic basin along a tiny unnamed stream that feeds Mirror Lake. Ringed by a few stunted larches and shrub willows, this Intermediate Tall Sedge Fen is dominated by hairy-fruited sedge, whose fine, long, curling, grass-like leaves give the wetland a distinctive appearance that was discernable in a glimpse from the road. Several feet of peat have accumulated in this shallow basin and with a pH of nearly 7.0 it supports a diverse group of plants that need such relatively alkaline, nutrient enriched conditions. Among these are two indicators of strong enrichment, Kalm's lobelia (*Lobelia kalmia*) with its beautiful purple flowers, and Hudson's bay bulrush (*Trichophorum alpinum*), that are often found in rich rather than intermediate fens, suggesting this site has characteristics of both fen types. Additionally, the very rare

slender cottongrass (*Eriophorum gracile*) grows here, and its fuzzy white heads could be easily mistaken for the Hudson's bay bulrush, a somewhat more common plant. The uncommon plant Loesel's twayblade (*Liparis loeselii*) also grows here amid the fen mosses, which include an uncommon moss as well, the wide-leaved beard moss (*Helodium blandowii*).

The small fen off of Nelson Pond Road is similarly dominated by hairy-fruited sedge, as Intermediate Tall Sedge Fens typically are, though this fen is somewhat screened from the road by a band of taller larch. This fen also occupies a small basin that has filled with peat deposits over 4 feet deep and ultimately drains toward Mirror Lake. Its flora is similar to the previous fen and it also includes several rare and uncommon species. Most notable among these is a small colony of bog willow (*Salix pedicellaris*), which, as its name suggests, is tied to peatland habitats, though not necessarily bogs; this is the only known occurrence of this plant in Calais. The east edge of this fen has a small, deep pool that appears likely to have been historically excavated as a pond or water source, but has since been colonized by a couple of additional uncommon aquatic plants, blunt-leaf pondweed (*Potamogeton obtusifolius*), the carnivorous lesser bladderwort (*Utricularia minor*). It is not uncommon for fens to have been partly or wholly excavated to create ponds due to their constant supply of groundwater seepage, but, fortunately for the unusual creatures that live here, this fen was not greatly impacted by the small pool excavation. One additional concern in this small fen is a minor amount of purple loosestrife, which may by increasing, despite efforts by the conscientious owner to control its spread.

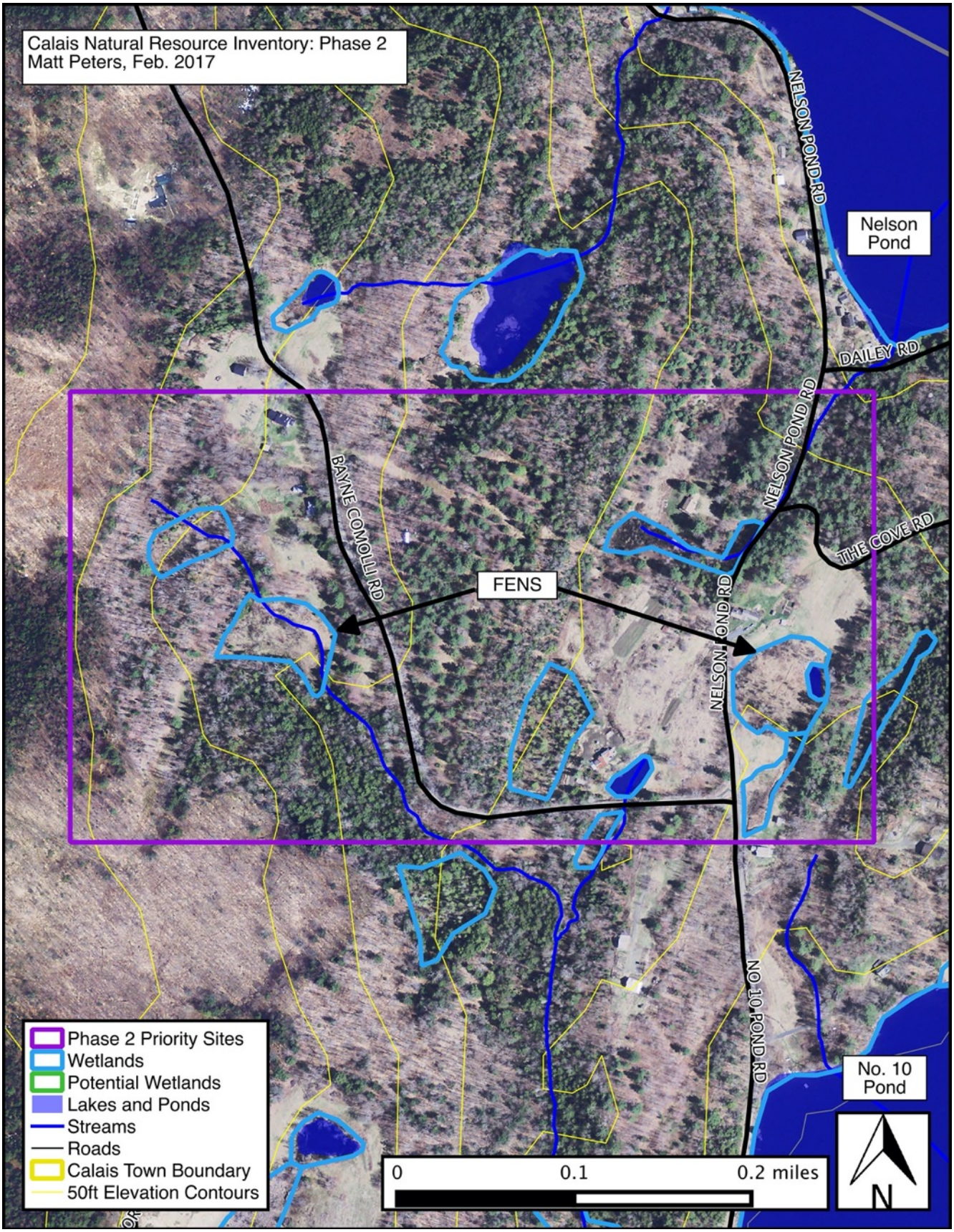
Bog Willow in the fen.

Management Considerations

Despite their close proximity to homes, roads, and lawns these two fens are still in good condition, thanks in part to the efforts of interested landowners. Groundwater seepage is a critical process supporting the fens and making them potentially vulnerable to any disturbances in their watersheds and groundwater source areas. Nearby activities that might alter patterns or volumes of groundwater or surface water flow should be carefully evaluated and minimized. Similarly, manipulation of the outflow from the fens should be avoided as this could result in excessive draining or flooding of the fens. Ideally significant communities like these would be surrounded by natural vegetation and would be free from any direct manipulation by people. Here, proximity to homes and other human uses has resulted in mowing up to the fen edges in places; if possible, additional buffer areas of unmanaged vegetation should be allowed to develop to further protect the fens. Any forest management activities around the wetlands should ideally maintain forested buffers and avoid cutting or operating within the wetlands. A small amount of the invasive plant purple loosestrife was found in one fen, and a larger source population is present nearby. This should be monitored for continued spread in the fen and the scattered plants removed by careful hand pulling or repeated cutting to avoid potential for loss of many unique fen species.

Intermediate fens: top right and bottom left from Disc Golf Fen; top left and bottom right from Interlacken Fen

Figure 10. Interlacken Fens Map



Beaver Meadow Brook Wetlands

Location: north of Haggett Rd., straddling Calais/East Montpelier town line west of Adamant

Information Sources: Peters' site visit on July 26, 2016, landowners.

Ownership: Privately owned lands

Significant Features

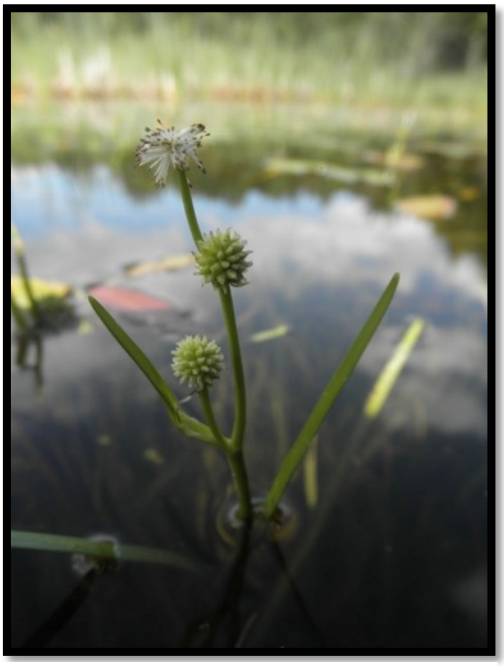
Natural Communities and other features: Intermediate Tall Sedge Fen*, Sweet Gale Shoreline Shrub Swamp, Shallow Emergent Marsh, Cattail Marsh, Hemlock-Balsam Fir-Black Ash Seepage Swamp, upland forests (predominantly hemlock- and red spruce-northern hardwoods).
* Indicates occurrences that are State-Significant.

Rare, Threatened, & Endangered Species: lesser bur-reed (*Sparganium* natans), water sedge (*Carex aquatilis*), bog-rush (*Cladium mariscoides*), three-ranked spear-moss (*Pseudocalliergon trifarium*), swollen scorpion moss *(Scorpidium scorpioides*).

Uncommon Species: Loesel's twayblade (*Liparis* loeselii), lesser bladderwort (*Utricularia* minor), cyperus-like sedge (*Carex pseudocyperus*), and a dragonfly: the Elfin Skimmer (*Nannothemis bella*).

Site Description

This site is the large beaver meadow complex visible to the north from a section of Haggett Road in East Montpelier. The open wetlands straddle the town line and are fed by Beaver Meadow Brook, a small stream that flows generally southeast along Calais' southern border from County Road through its namesake wetland complex down to Adamant village and hence into Adamant Pond. Like most beaver wetlands, the site includes a mixture of wetland natural communities and is mostly surrounded by second growth mixedwood forest with an abundance of fir and spruce near the water's edge. At the northwest end, where the stream enters, a roughly 4-acre mixedwood seepage swamp drains into the 28-acre open wetland meadow. The open wetland is currently actively beaver impounded at the southeast end and is filled with a complex mosaic of cattail marsh, shallow emergent marsh, intermediate fen, sweet gale shoreline shrub swamp, water lily aquatic beds, and open water channels. It is the large fen (~6 acres) and the many rare species in and around it that make this wetland complex especially significant. Five rare plants, including the state-threatened lesser bur-reed (*Sparganium natans*), occur in relatively large populations here, finding the nearly neutral pH peat deposits to be an ideal home. One of these, the bog-rush (*Cladium mariscoides*) is abundant enough here that its reddish-brown fruiting heads color the fen from a great distance in the right season.



State-Threatened Lesser Bur-reed in bloom.

In addition to these unusual plants, these wetlands support a great abundance of wildlife, large and small. Residents report occasionally seeing moose here, otters likely pass through on occasion, many waterfowl such as bitterns, herons, and geese frequent the mixture of open water and marshy edges, and even specialized fen dragonflies such as the Elfin Skimmer are to be found. Without a canoe however, this wetland is best seen from the edge. The dense fen mats that appear solid are actually floating in the middle and sink dramatically under the weight of an unwary foot! This probably works to the benefit of the fen species as their home can simply float up and down with the water levels as beavers come and go from the area. Indeed the wet meadow probably has a history of significant water level changes; residents know of an old foundation downstream of the present beaver dam that likely represents an old mill. Though hard to imagine today, it is possible that, like Adamant Pond, this beaver meadow was historically drained seasonally to allow for a harvest of bedding hay.

Uncommon Elfin Skimmer dragonfly male, about 1 inch long - note the diagnostic chalky blueish-white abdomen

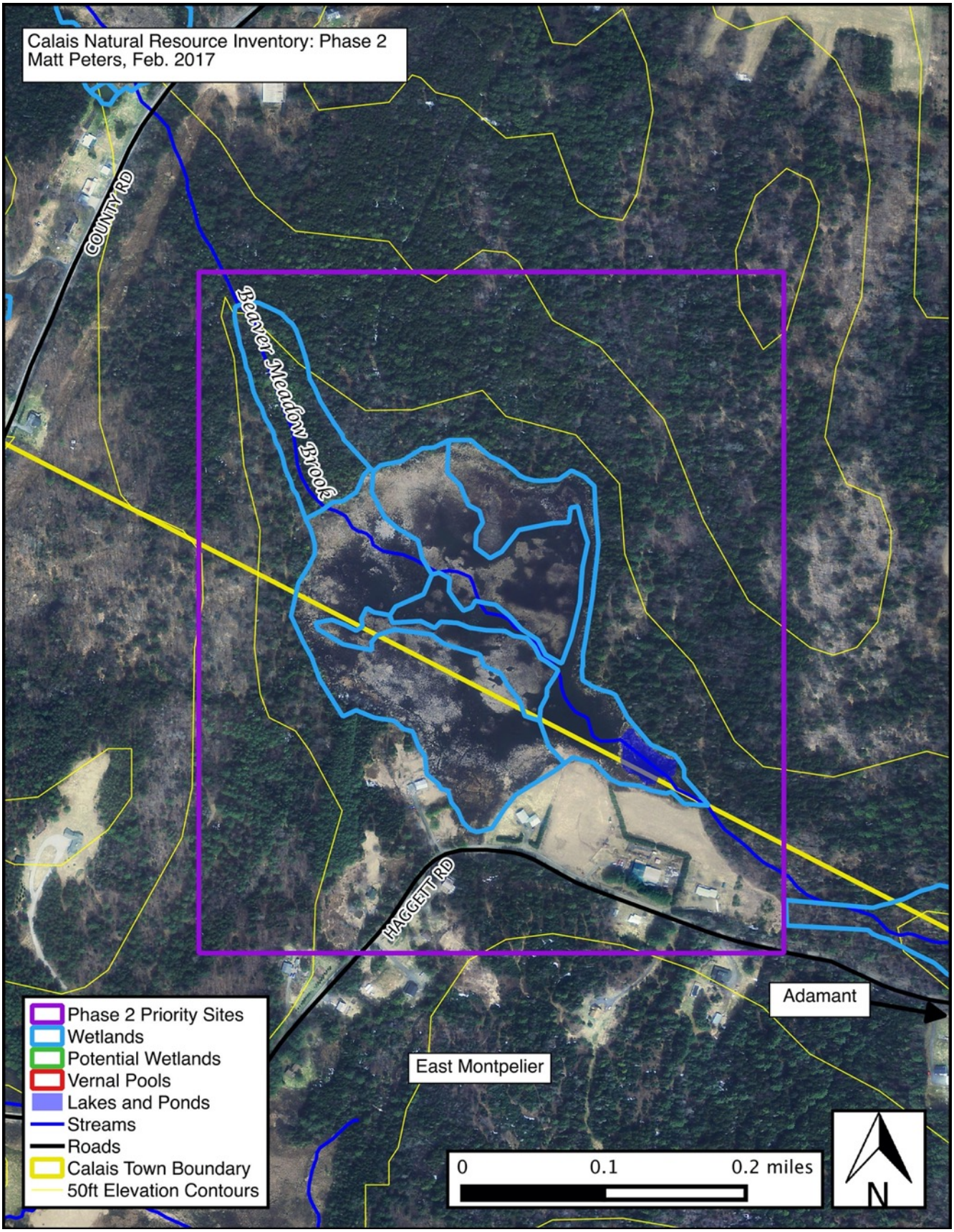
Management Considerations

The wetlands discussed above are in good condition, include numerous state-significant features/species, and should be protected from further impacts. Adequate forested buffers should be maintained and hydrologic alterations should be avoided. Surrounding landowners are encouraged to minimize activities that might alter patterns or volumes of groundwater or surface water flow, particularly ground disturbance or extensive clearing near the wetlands. Forest management activities around the wetlands should maintain forested buffers, avoid cutting or operating within the wetlands, and should follow all AMPs.

High water levels may present a concern due to the proximity of some homes to the water table of this wetland. While no human manipulation of the water level would occur under ideal circumstances, this may not be acceptable to all parties. If any water level manipulation is considered, it is recommended that a beaver baffle system be used and that appropriate consultation with state wetlands and natural heritage program staff must occur to address concerns about impacts on the state-significant features. Finally, parts of the southern edge of the wetland complex have been cleared in association with residences; ideally some form of buffer, preferably forested, would be allowed to redevelop here.

Beaver Meadow Brook Wetlands including Sweet Gale Shoreline Shrub Swamp and Cattail Marsh (above left), Intermediate Fen (below left), Aquatic beds with smartweed and cattails (above right), and rare Bog-rush flowers (below right)

Figure 11. Beaver Meadow Brook Wetlands Map



Chapin Road Town Forest

Location: West of the class 4 section of Chapin Rd, south of Pekin Brook

Information Sources: Peters' site visit on June 1, 2016, E. Sorenson.

Ownership: Town owned lands

Significant Features

Natural Communities and other features: Rich Northern Hardwood Forest, Temperate Calcareous Outcrops, fern glades, Hemlock-Northern Hardwood Seepage Forest, Alder Swamp, and upland forests, predominantly northern hardwoods.

Rare, Threatened, & Endangered Species: none found

Uncommon Species: glade fern (*Homalosaurus pycnocarpus*), fragile rockbrake fern (*Cryptogramma stelleri),* Hitchcock's sedge (*Carex hitchcockiana*), cutleaf toothwort (*Cardamine concatenata*), and American ginseng (*Panax quinquefolius*).

Site Description

This Town Forest property is tucked away at the end of Chapin Road and, with no developed trails, it requires a bit of bushwhacking to explore. It is well worth a visit, however, containing locally significant rich woods that encompass a series of small calcareous bedrock outcrops, fern glades, a seepage forest, a small enriched alder swamp, and several uncommon plant species associated with the rich soils and outcrops. Entering the stand from the road, enrichment indicators appear almost immediately, including herbs such as maidenhair fern, wild ginger, Dutchman's beeches and squirrel corn, the unique shrub leatherwood, and several large basswood trees. Further into the stand one crosses a low drainage area with an intermittent stream channel and seepy, wet woods that feed down to an alder swamp area that is recovering from past agricultural use. Continuing across this wet zone one ascends a short, but steep slope with many large mature sugar maples and basswoods and very little understory. Here are found beautiful fern glades, thriving in the rich black soil that receives nutrients from the calcareous bedrock outcrops above. Many of the ferns and other plants here are restricted to areas with the richest nutrient conditions, making this not only a beautiful spot, but a hotspot for rich woods plant diversity. Cutleaf toothwort and glade fern are two uncommon plants found in this zone, with the latter being quite abundant here. Hitchcock's sedge and even a few ginseng plants are present in other parts of these rich woods. In the crumbly, limey, Waits River Formation outcrops above several colonies of the uncommon fragile rockbrake fern can also be found. The rich woods beyond may have been a former sugar bush and the forest here shifts abruptly from hardwoods to hemlock at the parcel boundary, displaying the strong influence land use history can have on forest composition.

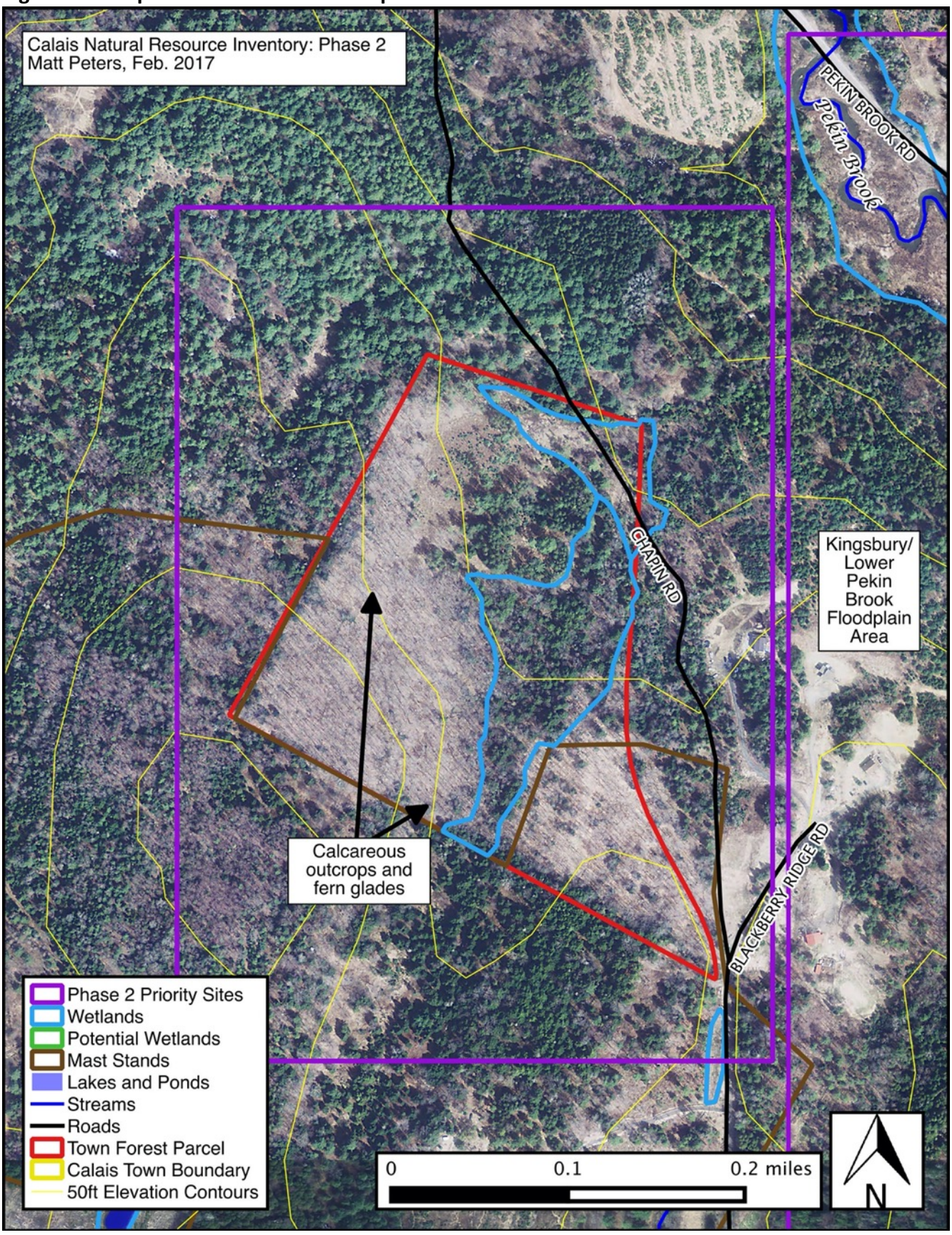
Management Considerations

The wetlands at the site should be protected during any further forestry operations, ideally with buffers and exclusion from harvest. At a minimum, operation in or around the seepage forest should only occur during frozen ground conditions to protect the soft, saturated soils. Parts of the rich woods and fern glades have large mature trees as well as heightened plant diversity with uncommon

species present; these areas would make good ecological reserve areas if they can be excluded from future timber harvest. At a minimum, limiting impacts to the uncommon species should be given special consideration in planning any harvests. Finally, rich forests can be especially prone to invasion by certain invasive plants, especially buckthorn and barberry. While only small amounts of buckthorn, exotic honeysuckle, and the exotic wall lettuce (*Mycelis muralis*) were noted at present, now may be a good time for limited control efforts to prevent further spread and degradation of these locally significant town forest areas. No harvest of the ginseng population should occur; with time it may spread, but at present the very small population could be easily wiped out by harvesting.

Rich Northern Hardwood Forest with extensive fern glades (top left) including the uncommon Glade Fern (top right). Calcareous Outcrops above rich woods (bottom right), uncommon Fragile Rockbrake fern living on outcrop (bottom left).

Figure 12. Chapin Road Town Forest Map



Carr Brook Swamps and Rich Woods

Location: West of Batten Rd and north of Moscow Woods Rd

Information Sources: Peters' site visit on Sept. 30, 2016, prior citizen inventory of vernal pools.

Ownership: Privately owned lands

Significant Features

Natural Communities and other features: Vernal pool, calcareous beaver meadows including Shallow Emergent Marsh and Hemlock-Balsam Fir-Black Ash Seepage Swamp, and upland forests, including a Rich Northern Hardwood Forest with Temperate Calcareous Outcrops, northern hardwoods, hemlock- and white pine-northern hardwoods.

Rare, Threatened, & Endangered Species: none found

Uncommon Species: wide-leaved beard moss (*Helodium blandowii*), walking fern (*Asplenium rhizophyllum*)(locally rare but not S3 state-uncommon)

Site Description

Enriched beaver meadow wetlands.

Carr Brook is a small tributary of the Kingsbury Branch whose headwaters arise in a narrow valley west of East Calais. The narrow valley creates ideal conditions for beaver impoundment and the uppermost reaches of the stream have become a series of linear beaver meadows. Beaver activity currently appears low in the upper reaches, and lowered water levels have allowed the development of alder and willow scrub and mixedwood seepage forest to encroach on the upper margins of the open marsh. As is true in many beaver wetlands, the diverse range of moisture, light, and substrate conditions promotes a high diversity of wetland plants in a small area, and nutrients from the slopes above make these wetlands somewhat calcareous. Correspondingly, patches of the uncommon wide-leaved beard moss, a species often associated with fens and other calcareous meadow habitats, grow here.

Above these wetland meadows the forests of the valley walls support many other calcium loving species. A long narrow band of rich northern hardwood forest largely covers the western slope. This forest supports the highly diverse complement of herbaceous plants typically found in rich, rocky woods. Large diameter sugar maples and basswoods are scattered along the steep slope, which has apparently been untouched by logging in recent times. Pockets of younger trees are present where the unstable soils and steep slope have toppled older trunks. The influence of the bedrock can clearly be seen in this area with punky limestone beds forming a long wall of calcareous outcrops near the top of the slope, gradually releasing calcium and other nutrients to create the rich woods below. Above the outcrops, the soils thin and the forest shifts sharply to hemlock, which thrives on rocky ridges with more acidic soil. The rich hardwood stand here is locally significant for its size, high

Steep rich woods topped by Calcareous Outcrops

diversity, and good condition without much recent human disturbance. At the north end of the rich stand an old road bed can be made out in the contours and is surrounded by a stand of young, pole-sized trees clearly indicating a past boundary in land use.

Across the valley the forest is a more typical hemlock-northern hardwood stand, but scattered large boulders of calcareous bedrock are strewn about. On a few of the mossy boulders the unusual and attractive walking fern can be found. The walking fern is so-called because the tips of its tapered triangular fronds can root to form new plants, allowing it to 'walk' around on its rock. Moist calcareous boulders and bedrock are the typical habitat for this fern, making it more common in parts of the Champlain Valley with limestone. Despite the relatively abundant calcareous bedrock in Calais and other parts of central Vermont, the fern is quite unusual in this part of the state. In Calais it is known from only one other location.

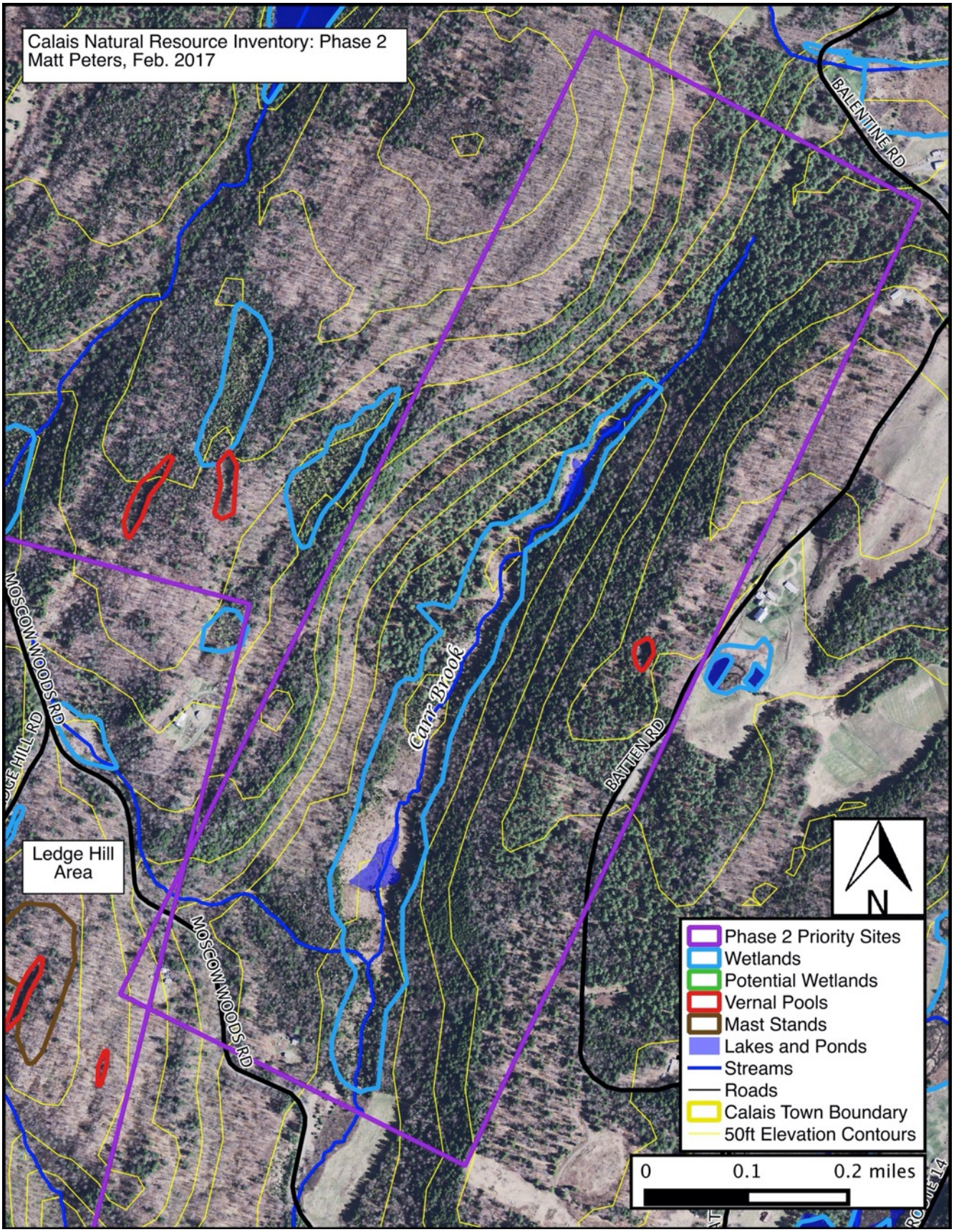
Additionally, a vernal pool is present in the woods not far west of Batten Road. This pool was, not surprisingly, dry during the September site visit, but it was visited in 2009 during citizen pool verification efforts. Data from that visit suggest the pool is highly productive and may potentially meet the threshold for state-significance. Confirming this would require another spring site visit, but, regardless, it is a quality pool of local significance. The proximity to Batten Road also makes this an area to examine as a potential amphibian crossing zone.

Management Considerations

The vernal pool and other small wetlands at this site are embedded in intact forest, a condition that should be maintained. Forestry activities in the area should strive to avoid the wetlands and pool and maintain forested buffers around them. Larger buffer areas may be warranted around the vernal pool, though these need not exclude all forestry activities. See the vernal pool section for more detailed management recommendations. The rich woods area is largely on steep, loose slopes that are not ideal for forestry; excluding these areas from harvest would maintain the currently high quality of the community and its diverse plant life, and limit the potential for introducing exotic species.

Walking fern on a limey boulder.

Figure 13. Carr Brook Swamps and Rich Woods Map



Hersey Hill Area

Location: Vicinity of Hersey Hill, north of the end of Long Meadow Hill Rd.

Information Sources: Peters' site visit on June 14, 2016.

Ownership: Privately owned lands

Significant Features

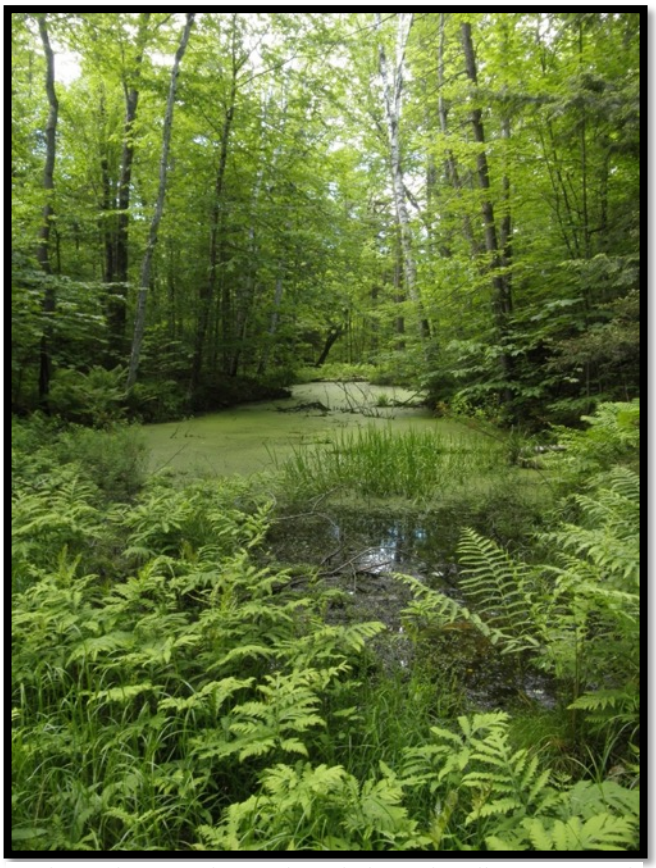
Natural Communities and other features: Vernal pools, extensive Seeps, Hemlock-Balsam Fir-Black Ash Seepage Swamp, and upland forests, including a small, mature Rich Northern Hardwood glade, northern hardwoods, hemlock- and red spruce-northern hardwoods.

Rare, Threatened, & Endangered Species: none found

Uncommon Species: none found

Site Description

This site, centered on the roughly 1,900 ft summit of Hersey Hill, is a small part of the extensive forest block that spans the western hills of Calais and stretches beyond into neighboring towns. The area was visited mainly to assess the abundant potential vernal pools and to investigate the summit area on Hersey Hill, which appeared from aerial images to have some intriguing bare spots. In the field these bare spots turned out to be simply larger gaps from pockets of poorly rooted trees blown down in the shallow summit soil, rather than the more unusual summit balds or rock outcrops I had hoped for. Several small vernal pools high in the hills turned out to be somewhat marginal, likely supporting successful amphibian breeding only in wetter years. However, a larger pool along the Ellis-Bruce Trail, which follows the class 4 extension of Long Meadow Hill Rd., appears to be better breeding habitat and probably stays permanently filled due to its connection with a small nearby seepage swamp. This pool is visible at the edge of the trail about a tenth of a mile from the parking spot, and may in fact have been slightly impounded by creation of the roadbed/trail long ago. Woodfrog tadpoles were abundant here though thick, obscuring duckweed cover made full assessment of amphibian productivity impossible.



Duckweed covered vernal pool along the Ellis-Bruce Trail.

High on the hill slopes and saddle to the north of the Hersey summit there are several other interesting features. There are several large, very lush forest seeps here, which are used for grazing by bears, as was visible in the abundant nipped off jewelweed plants. Their presence in the area was

Lush seep draining a small rich woods glade in the saddle.

also noted in a small mast stand of bear-scarred beech nearby. In the saddle there is a pocket of rich northern hardwoods with large, mature trees flourishing where the bowl-like slopes concentrate nutrients and moisture. Diverse rich woods herbs are present in this special glade including Goldie's, maidenhair, and silvery glade ferns. A small calcareous outcrop and boulder piles are also present, as is a small marginal vernal pool. Descending from this glade is another lush seep, this one with obvious signs of nutrient enrichment in the presence of such plants as Braun's holly fern, wood nettle, and plantain-leaf sedge.

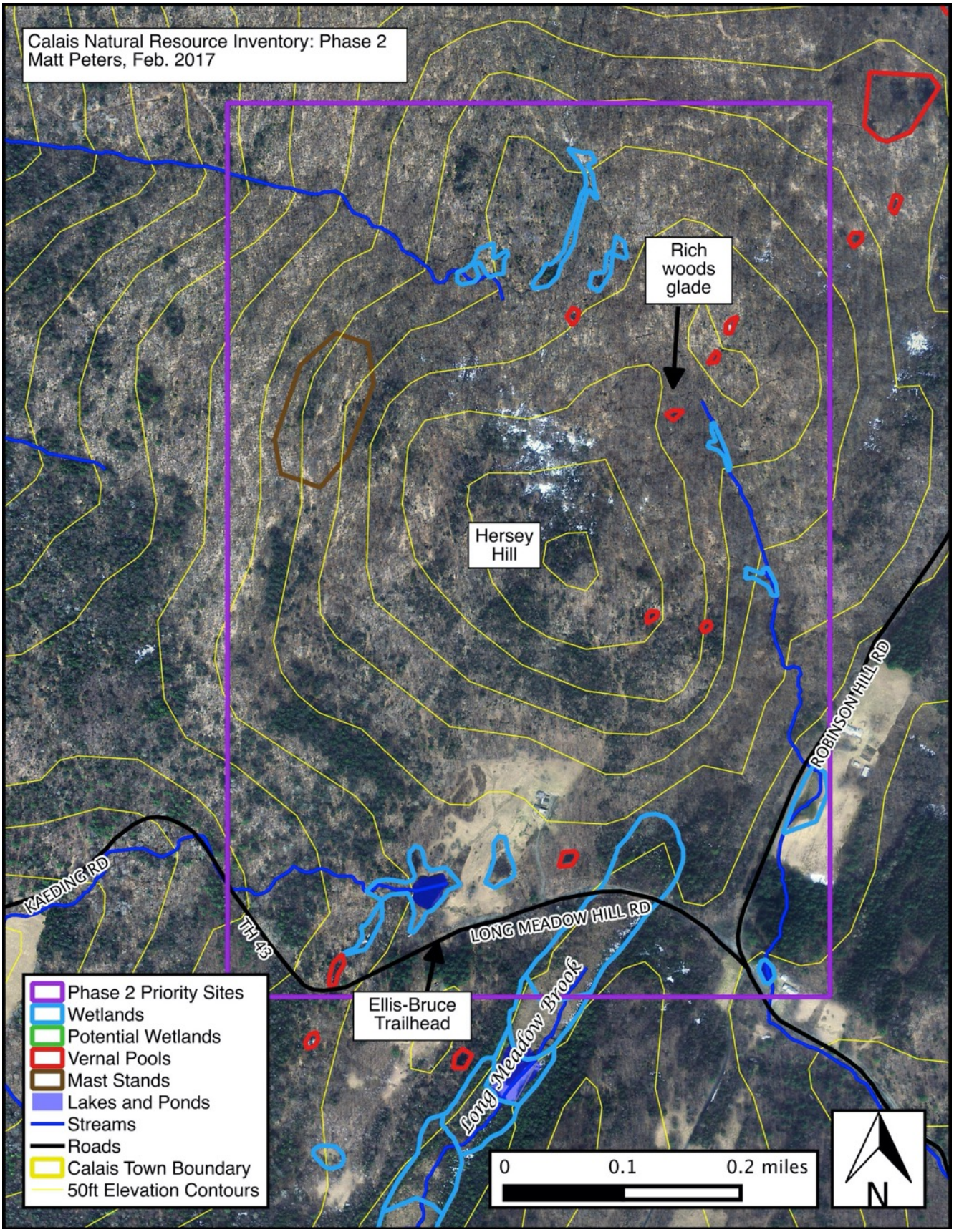
Management Considerations

This area has high value as core habitat in a large habitat block and it should be maintained as unfragmented forest. The class 4 road is presently just a footpath, but could present a potential pathway for future impacts or development. Such possible future concerns should be carefully evaluated for their impacts on wildlife habitat values and the specific resources discussed above, especially the vernal pool immediately adjacent to the path. In general the vernal pools and other wetlands should be appropriately buffered during any forestry operations in the area.

Puzzle piece-like leaf scraps dropped by forest tent caterpillars feeding on sugar maple.

Healthy bear-scarred beech trunks.

Figure 14. Hersey Hill Area Map



Other Small Sites

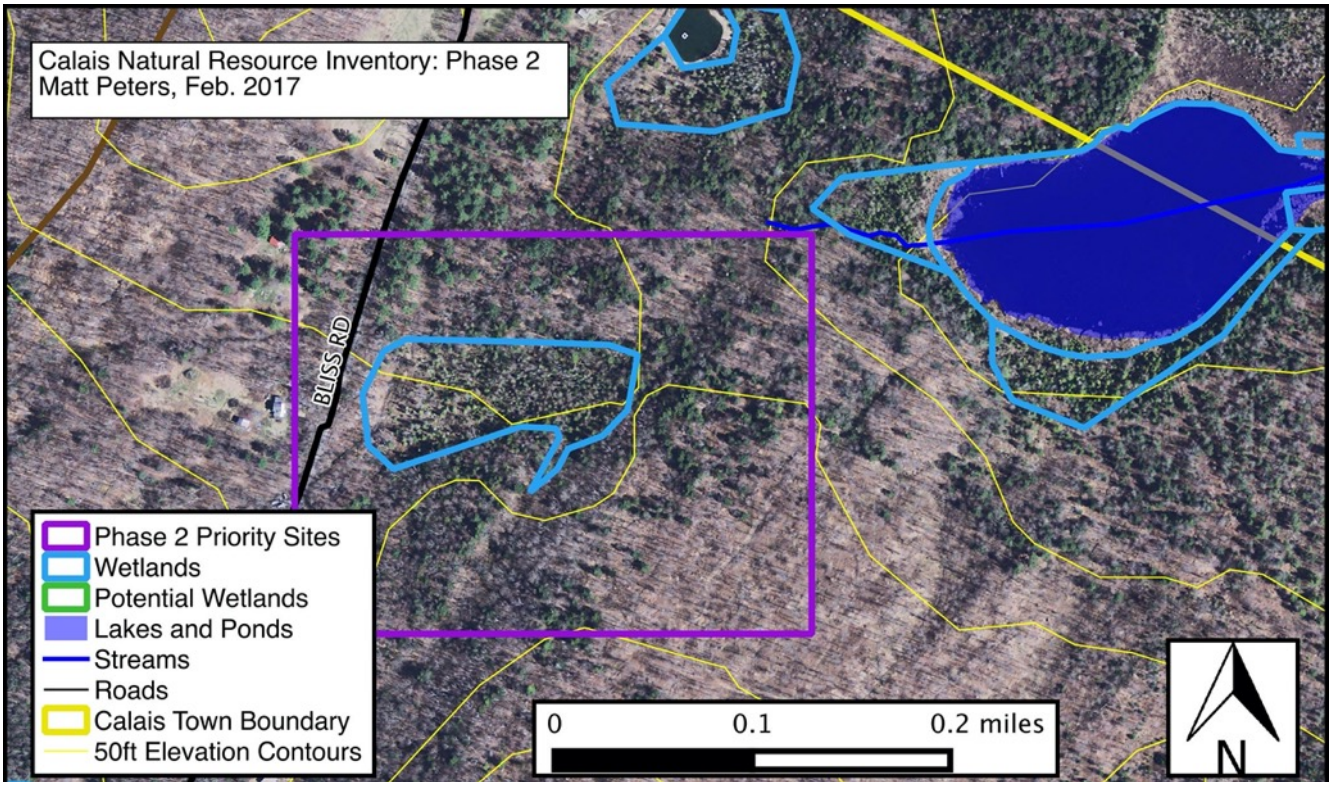
Bliss Road Swamp
Location: west of Bliss Rd. in the northeast corner of town
Information Sources: Peters' site visit on July 6, 2016, Natural Heritage Inventory.
Ownership: Privately owned lands

Significant Features
Natural Communities and other features: Hemlock-Balsam Fir-Black Ash Seepage Swamp
Rare, Threatened, & Endangered Species: bog wintergreen (*Pyrola asarifolia*)
Uncommon Species: cyperus-like sedge (*Carex pseudocyperus*)

Site Description
This swamp sits southwest of Mud Pond, a known significant site, and was briefly visited to verify and update a previous record of the state-threatened bog wintergreen (*Pyrola asarifolia*) from the swamp and to investigate the possibility that the swamp is an unusual Hemlock-Sphagnum Acidic Basin Swamp. This proved not to be the case, and the swamp, while still quite interesting and in good condition, was of the more enriched Hemlock-Balsam Fir-Black Ash Seepage variety, which is quite common in Calais. The bog wintergreen is still present in approximately the previously known location, though most of the plants were not blooming. Additionally, a few plants of the uncommon cyperus-like sedge (*Carex pseudocyperus*) were found growing in the swamp.

Management Considerations
As with other wetlands, the swamp should be buffered and protected from direct impacts in any forestry operations or nearby development.

Figure 15. Bliss Road Swamp Map



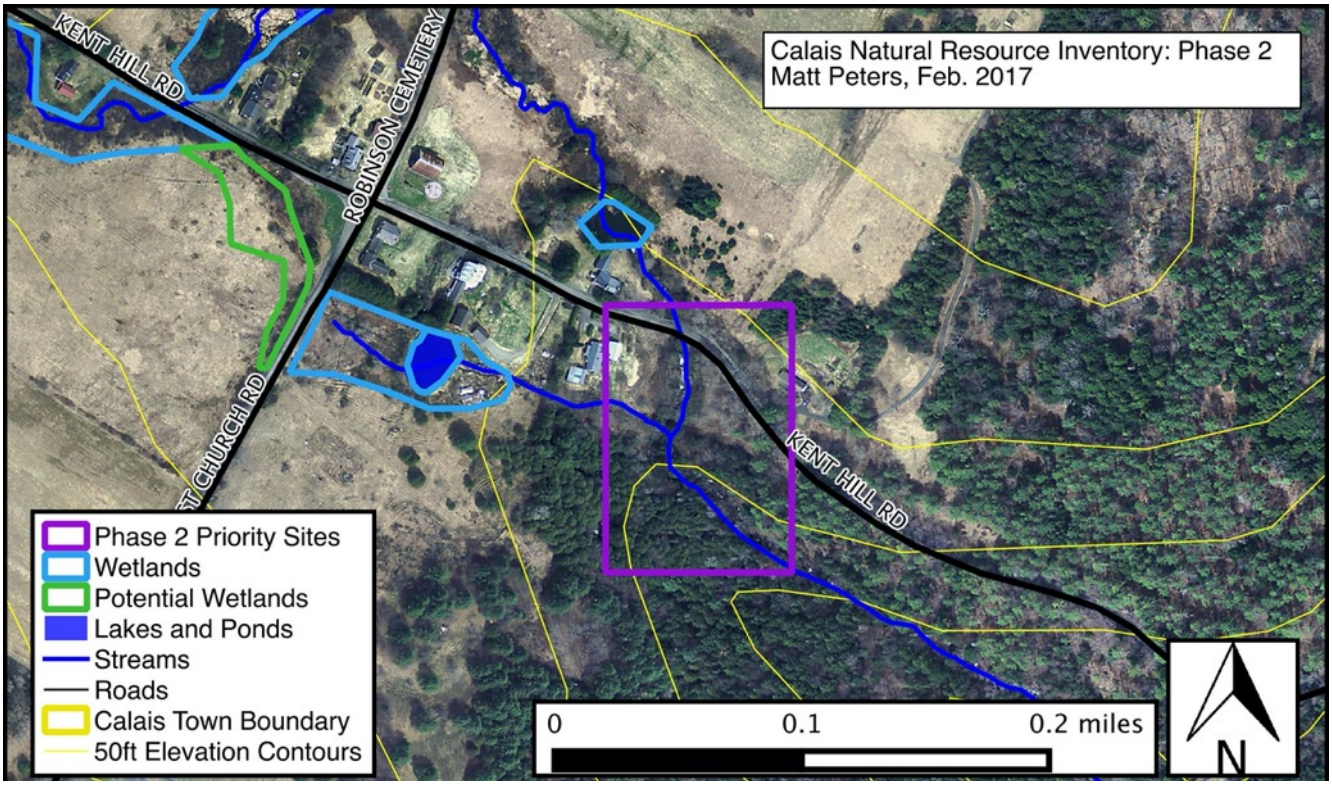
Kents Corners Waterfall
Location: just west of the Kents Corners intersection on Kent Hill Rd
Information Sources: Peters' site visit on June 1, 2016.
Ownership: Privately owned lands

Significant Features
Natural Communities and other features: small waterfall or cascade

Site Description
This site was briefly visited as a physical landscape feature of interest. Few waterfalls are known to exist in Calais, though they may have previously been present (now submerged) near the dam sites in East Calais and North Montpelier. The Kents Corners falls occurs on a small, unnamed stream just below the crossing of Kent Hill Rd. More a cascade than a true waterfall, this section of stream drops perhaps 40ft over a series of broken boulders and bedrock slabs that line the narrow gully, cloaked in overhanging hemlocks. While not a major falls this feature adds to the diversity of stream habitats in Calais.

Management Considerations
No special management required other than maintaining appropriate riparian buffers.

Figure 16. Kents Corners Waterfall Map



Rare Species

Rare and uncommon species of plants and animals are unique and important components of Calais' natural heritage. Since many rare species are associated with the high quality habitats and state-significant natural communities that were the main focus of fieldwork, it is not surprising that additional rare species were discovered. During Phase 2 fieldwork 17 rare or uncommon species that are new to Calais were documented from numerous sites, including a new state-threatened species, lesser bur-reed (*Sparganium natans)*. Additionally, new locations were found for 12 rare and uncommon species that were previously known elsewhere in Calais, and updated records for 4 of the rarest previously known species were provided to the Natural Heritage Inventory.

Combined with discoveries during Phase 1 and previous records, Calais is now known to provide important habitat for 54 rare and uncommon plant and animal species. This is an impressive total and is much higher than is found in many towns that have received similar inventory effort, giving Calais a special role in protecting these species. Many of Calais' rare species are associated with nutrient enriched, calcareous habitats, including rich woods, calcareous bedrock outcrops, and various enriched wetland types, such as rich and intermediate fens, hardwood and mixedwood seepage swamps, cedar swamps, and calcareous red maple-tamarack swamps. Thus the relative abundance of rare species can largely be attributed to the calcium-rich bedrock (mainly Waits River Formation) that underlies most of Calais, working in combination with the complex topography and drainage networks, and resulting in the abundance of enriched wetlands and woods found throughout the town.

Table 2 below summarizes Calais' 54 rare and uncommon species, their rarity status, number of known locations, and when they were last seen (or reported to VNHI). A species' rarity status is designated at different geographic scales, such as global or state levels, by a 1-5 rank, with 1 being extremely rare and 5 being common. Typically S1 species have 5 or fewer populations statewide, S2 have 5-20 populations, and S3 have 20-100 populations. Species that are common globally can be rare at state or national levels, and, thus, can be of conservation concern even though the species as a whole is not at risk. Species ranked S2S3 or rarer are considered state-significant, thus Calais includes state-significant populations for 26 rare plant and animal species. These ranking systems are explained in greater detail in Appendix 3.

Legal threatened or endangered status is distinct from the numeric rarity ranks in Vermont and provides additional regulatory protection for 5 of Calais' rare species that are listed as state-threatened. These include the newly discovered lesser bur-reed (*Sparganium natans*), dragon's mouth (*Arethusa bulbosa*) and white adder's mouth (*Malaxis monophyllos var. brachypoda*) orchids, bog wintergreen (*Pyrola asarifolia)*, and pale sedge (*Carex livida)*.

It is important to note that the rare species information presented here represents only what has been discovered to date and is not a complete inventory of the entire town. It is likely that additional rare species or populations occur but are not yet known and await discovery. One such rare species that awaits discovery and confirmation is the Jefferson salamander (*Ambystoma jeffersonianum*), a rare, Special Concern species of vernal pools, which is known from a few central Vermont towns, including neighboring Woodbury and Middlesex. Jefferson salamander eggs were reported from a Calais vernal pool during past citizen inventory efforts, but no confirming data are available and the pool was dry when visited in 2016.

Table 2. Rare and Uncommon Plants and Animals of Calais, VT.

Shaded species were discovered or updated during Phase 2 fieldwork. State and global ranks are G1/S1=very rare to G5/S5=common, B indicates that only breeding locations are tracked (loon, great blue heron). T= State Threatened, E= State Endangered.

Scientific Name	Common Name	Global Rank	State Rank	VT T or E	# of Sites	Other Status Lists*	Year Last Seen
VERTEBRATE ANIMALS							
Ardea herodias	Great Blue Heron	G5	S3S4B		1	SGCN	1983
Gavia immer	Common Loon	G5	S3B		3	SGCN	2011
Sensitive Species	Redacted				4	SGCN	2010
Lota lota	Burbot	G5	S3S4		2	RSGCN	1998
INVERTEBRATE ANIMALS							
Aeshna verticalis	Green-striped Darner (dragonfly)	G5	S3S4		1	SGCN	1994
Arigomphus furcifer	Lilypad Clubtail (dragonfly)	G5	S3S4		1		1994
Dorocordulia lepida	Petite Emerald (damselfly)	G5	S3		1	SGCN	2006
Nannothemis bella	Elfin Skimmer (dragonfly)	G4	S3		3		2016
Williamsonia fletcheri	Ebony Boghaunter (dragonfly)	G4	S1S2		1	SGCN	2008
VASCULAR PLANTS							
Arethusa bulbosa	Dragon's mouth orchid	G4	S1	T	1	FC, SGCN	2016
Calopogon tuberosus var. tuberosus	Tuberous Grass-pink	G5T5	S3		1		2009
Cardamine concatenata	Cutleaf Toothwort	G5	S3		1		2016
Carex aquatilis ssp. altior	Water Sedge	GNR	S2S3		5		2016
Carex hitchcockiana	Hitchcock's Sedge	G5	S3		1		2016
Carex livida	Pale Sedge	G5	S1	T	1	FC, SGCN	2016
Carex pseudocyperus	Cyperus-like sedge	G5	S3		13		2016
Ceratophyllum echinatum	Prickly Hornwort	G4?	S2S3		2	SGCN	2012
Cladium mariscoides	Bog-rush	G5	S2S3		2		2016
Cryptogramma stelleri	Fragile Rockbrake	G5	S3		1		2016
Cypripedium parviflorum var. makasin	Yellow Lady's-slipper	G5	S3		1		2016
Cypripedium reginae	Showy Lady's-slipper	G4	S3		2		2016
Eleocharis intermedia	Matted Spikerush	G5	S3		4		2016
Eriophorum gracile	Slender Cotton-grass	G5	S1		3	SGCN	2016
Homalosaurus pycnocarpos	Glade Fern	G5	S3		1		2016
Juncus brachycephalus	Broad-head Rush	G5	S3		1		2016
Liparis loeselii	Loesel's Twayblade	G5	S3		5		2016
Lonicera villosa	Mountain fly-honeysuckle	G5	S3		4		2016
Malaxis monophyllos var. brachypoda	White Adder's-mouth	G4Q	S2S3	T	2	FC, SGCN	2004
Muhlenbergia uniflora	Fall Dropseed Muhly	G5	S3		1		2016
Myriophyllum alterniflorum	Water Milfoil	G5	S2S3		1	SGCN	1983
Ophioglossum pusillum	Northern Adder's-tongue	G5	S1		1	FC	1981
Panax quinquefolius	American Ginseng	G3G4	S3		3	FC, SGCN	2016
Platanthera huronensis	Huron Orchid	G5?	S3		1		2016
Pogonia ophioglossoides	Rose Pogonia	G5	S3		1		1991
Potamogeton bicupulatus	Snail-seed Pondweed	G4	S2		1	SGCN	1983
Potamogeton hillii	Hill's Pondweed	G3	S3		1	FC, SGCN	2005
Potamogeton obtusifolius	Blunt-leaf Pondweed	G5	S3		2		2016
Potamogeton strictifolius	Straight-leaf Pondweed	G5	S2S3		2	SGCN	2007
Potamogeton x ogdenii	Ogden's Pondweed	G1G2	S1		1	FC, SGCN	2010
Pyrola asarifolia ssp. asarifolia	Bog Wintergreen	G5T5	S2	T	2	SGCN	2016
Ranunculus aquatilis var. diffusus	White Water-crowfoot	G5T5	S3		4	SGCN	2005

Scientific Name	Common Name	Global Rank	State Rank	VT T or E	# of Sites	Other Status Lists*	Year Last Seen
Rosa nitida	Shining Rose	G5	S2		1	SGCN	2015
Salix candida	Hoary Willow	G5	S3		1		2000
Salix pedicellaris	Bog Willow	G5	S2		1	SGCN	2016
Sparganium natans	Lesser Bur-reed	G5	S2S3	T	1		2016
Stellaria alsine	Trailing Stitchwort	G5	S2		1	SGCN	2016
Utricularia minor	Lesser Bladderwort	G5	S3		3		2016
NONVASCULAR PLANTS							
Hamatocaulis vernicosus	a moss	G5	S2		1	SGCN	2016
Helodium blandowii	a moss	G5	S3		3		2016
Meesia triquetra	a moss	G5	S2		2	SGCN	2016
Pseudocalliergon trifarium	a moss	G4	S1		1	SGCN	2016
Scorpidium scorpioides	a moss	G4G5	S2		2	SGCN	2016
Tomenthypnum falcifolium	a moss	G3G5	S1		1	SGCN	2005
Tomenthypnum nitens	a moss	G5	S3		1		2016

*FC= Flora Conservanda, a New England regional list of vascular plants of conservation concern, developed by the New England Wildflower Society, SGCN= Species of Greatest Conservation Need, a list developed in conjunction with the state's Wildlife Action Plan, whose aim is to prevent species from becoming endangered.

Wildlife Habitat

Wildlife habitat can be assessed in a wide variety of ways at spatial scales from individual habitat features, such as a vernal pool, to studies of habitat suitability over state, national, and continental scales, and can emphasize particular focal species or a broad suite of wildlife. This assessment focused on a number of specific, site-scale habitat elements relevant to particular species, and on larger scale habitat blocks and the connections between them, which are relevant to a wide range of organisms, large and small. The more specific, site-scale elements included identifying potential black bear feeding resources (mast stands and bear wetlands), vernal pools important for pool-breeding amphibians and invertebrates, and deer wintering areas. These specific habitat elements were then combined with other data on surface waters and wetlands, riparian corridors, rare species and significant natural community occurrences, core/interior forest habitat, and conserved lands to provide a larger analysis of wildlife habitat blocks and connectivity. This analysis seeks to both describe the features of these habitat blocks and compare their relative importance at the town scale. The following discussion first summarizes the specific habitat elements or features and then proceeds to description of the larger habitat blocks. Finally, the connections between these are evaluated.

Description of Wildlife Habitat Elements

Core Habitat

Sometimes known as Interior Forest habitat, core habitat areas are those places that are far enough removed from roads, dwellings, clearings, agricultural areas, and other human landscape features that the prevailing habitat conditions are distinct from the surrounding "edge" areas. Edge areas are known to have altered habitat values due to direct disturbance by people, vehicles, and pets, and due to changes in physical and biological factors, including decreased humidity, increased light levels, and increased predation risks and pressure from exotic species. Many species, especially wide-ranging mammals like bobcats, fishers, moose, and bear, require the secluded conditions of large blocks of

core habitat to meet their needs for mating, denning, feeding, and nesting. While most wildlife sightings may be in edge areas near our homes and roads, it is the core habitat areas that serve as critical habitat for maintaining healthy populations. The core habitat areas depicted in Figure 17 were developed by VT Fish and Wildlife (Sorenson and Osborne, 2014) and are generally about 200 meters or more from forest edges, depending on the adjacent land use type.

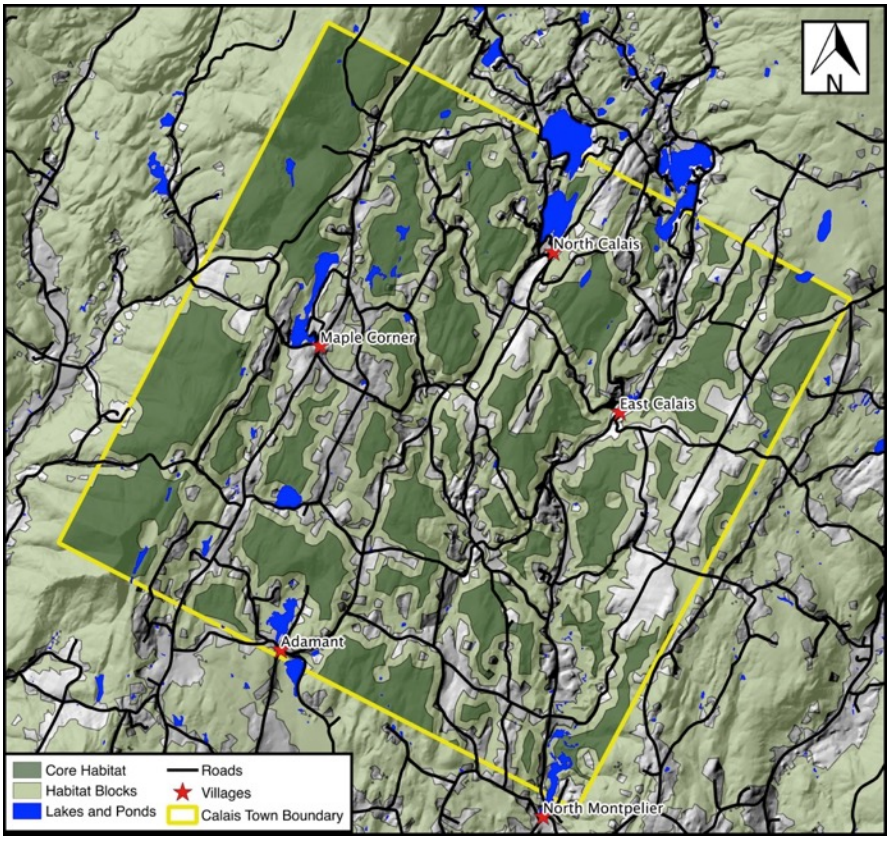


Figure 17. Core Habitat Areas Map

Potential Mast Stands

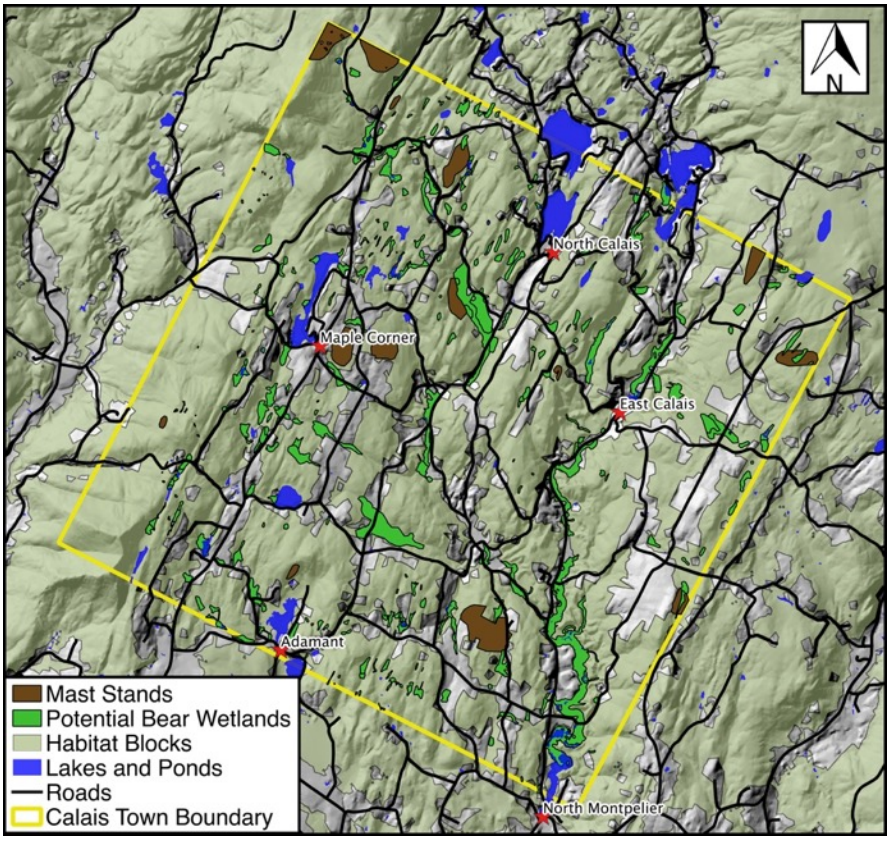


Figure 18. Potential Bear Habitats: Mast stands and bear wetlands

Stands of "hard" mast (nuts) are important fall food resources for black bears stocking up prior to hibernation, and they also provide food for many other species including deer, turkeys and squirrels. In Calais these are primarily beech stands, though the small red oak-northern hardwood forest on Blackberry Hill may also be an important mast stand. Figure 18 presents the potential mast stands, which were largely mapped based on aerial observations of beech bark disease by VT FPR, augmented by limited field observations of bear-scarred beeches during Phase 2 fieldwork. These areas are considered "potential" and

are in need of further field verification to determine actual levels of use; additional unmapped mast stands may also be present. Landowners interested in managing these areas to increase mast production are encouraged to obtain the mast stand management guidelines published by VT Fish and Wildlife (Hamelin, 2011). Of the 14 potential mast stands identified, 5 were visited and 4 were confirmed to have some level of bear use.

Potential Bear Wetlands

As omnivores, bears consume as wide range of foods, including large amounts of plants, and the succulent green growth of spring is a preferred seasonal food resource for freshly awakened bears. Many wetlands, especially seepage wetlands, provide the earliest and most abundant source of these nutritious spring greens and are favored grazing spots. Figure 18 presents the 323 potential bear wetlands, which were identified primarily based on the community types from the wetland assessment. Small forest seeps, larger forested seepage swamps, and floodplain forests are among the many wetland types than can provide this function. Field verification is needed to determine if these potential bear wetlands are actually fulfilling this role.

Potential Deer Wintering Areas

Deer wintering areas (DWAs) are forests whose canopy, slope, aspect, and other physical parameters make them likely to provide important thermal cover and food resources for deer in winter, especially during years with high snowfall amounts and deep cold. These are primarily areas of softwood (evergreen) and mixedwood (>40% softwood cover) forest where conifers trap heat and retain snowfall on their branches, thereby reducing ground snow depths, which makes moving and feeding easier for deer. About 13,300 acres of deer wintering areas are presented in Figure 19. These mapped areas were produced by the VT Fish and Wildlife Department and are a recently updated, unpublished version (Fortin and Haskell, 2009) of the original state DWA maps produced in the 1980s. The mapping is based primarily on remote assessment, thus while they are considered more comprehensive than previous maps, they are still in need of field verification.

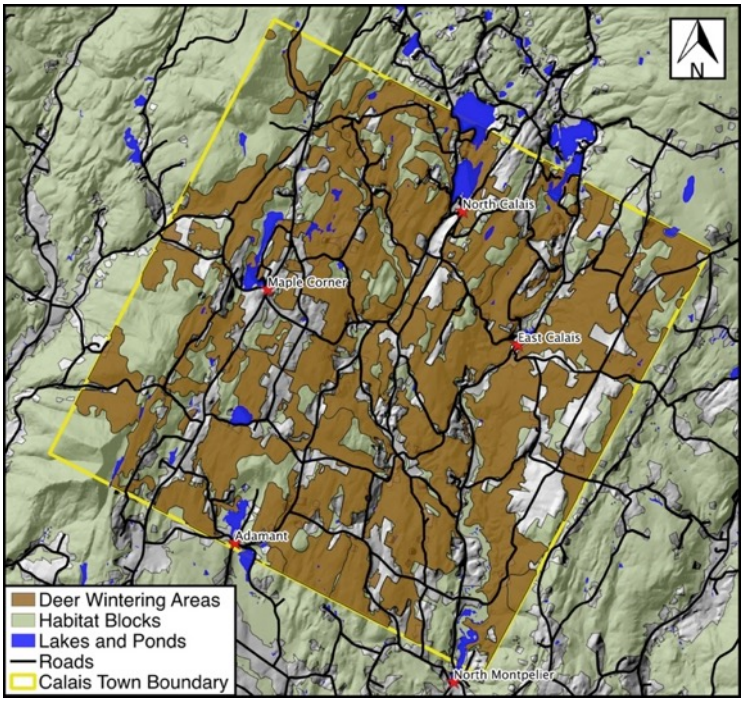


Figure 19. Deer Wintering Areas Map

Vernal Pools

Vernal pools are small, shallow, open-water wetlands that typically undergo a seasonal cycle of filling and drying that prevents populations of fish from developing. These conditions make them ideal breeding habitats for certain amphibians and many invertebrates that would be vulnerable to fish predation in more permanent water bodies. Wood frogs, spotted salamanders, Jefferson salamanders, and blue-spotted salamanders are considered the quintessential and diagnostic pool-breeding amphibians in Vermont. Fairy shrimp, a type of tiny (<1inch long) crustacean, are also

considered an indicator species for vernal pools, meaning that they require these habitats to successfully reproduce and carry out their lifecycles.

Calais' ledge topography is rich in vernal pools with 108 potential pools identified (Figure 20); 34 of these were visited during the inventory or were previously confirmed by residents as functioning pools, and 15 were observed to have high enough levels of amphibian breeding and other conditions to warrant state-significant status. This leaves 74 potential pools in need of field verification, offering an excellent opportunity for ongoing citizen science involvement. Appendix 2 presents a summary of attribute data for the 34 confirmed vernal pools.

To protect the inhabitants of vernal pools and ensure their continued presence on the landscape it is important to consider more than just the pool basin itself, however. Figure 20 displays three concentric areas to consider when planning around vernal pools: the pool basin itself, the 100 ft Vernal Pool Protection Zone around the pool basin, and the 750 ft Amphibian Life Zone, which is considered critical terrestrial habitat. The pool basin itself is the actual aquatic habitat needed by pool-breeding amphibians and other organisms to reproduce. This area should remain free from all human disturbances (apart from curious onlookers that is!). The 100 ft Protection Zone is meant primarily to protect the integrity of the pool itself, including its hydrology (or water supply), its microclimate (temperature and shading), and its leaf litter supply (the basis for the pool's food web), and secondarily to protect the high densities of amphibians that may be in this area during spring migration and summer/fall juvenile dispersal periods. This zone would ideally also receive no human disturbance, especially disturbances such as development, roads, filling, ditching, damming, rutting, and soil compaction that can seriously impact the pool's hydrology, a critical component of its functionality. If necessary, light thinning timber harvests can be compatible in this zone, but should occur on thoroughly frozen ground, under snow-covered conditions, should stay well back from the edge of the pool, and should avoid dropping trees or slash into the pool. The Amphibian Life Zone is a broader buffer intended to protect a core area of upland habitat where pool-breeding amphibians live, feed, and overwinter throughout the bulk of the year. Recommendations for the size (radius) of this Life Zone vary from 400-750 ft or more depending on one's objectives. However, studies of amphibian movements make it clear that even a 750 ft Life Zone does not encompass and protect the entire amphibian population of a pool. The 750 ft Life Zone is recommended based on Calhoun and Klemens (2002) and others. Forestry and other forest-based uses are compatible with the Life Zone. Any timber harvesting should retain at least 60-75% canopy cover of trees over 25 ft tall and should avoid ground disturbances, ideally by occurring during frozen conditions. Throughout all these areas it is important to avoid creating ruts that can fill with water and act as population sinks with marginal conditions for successful breeding, and it is important to maintain high quality upland forest habitat with abundant woody debris, intact leaf litter layers, and non-compacted soils, all of which contribute to quality amphibian habitat. More extensive discussions of management recommendations around vernal pools can be found in *A Landowner's Guide: Wildlife Habitat Management for Lands in Vermont* (Adams et al., 2015) available from the VT Fish and Wildlife Department or the NRCS's *Biological Technical Note 1: Vernal Pools in Conservation Planning* available at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_010203.pdf.

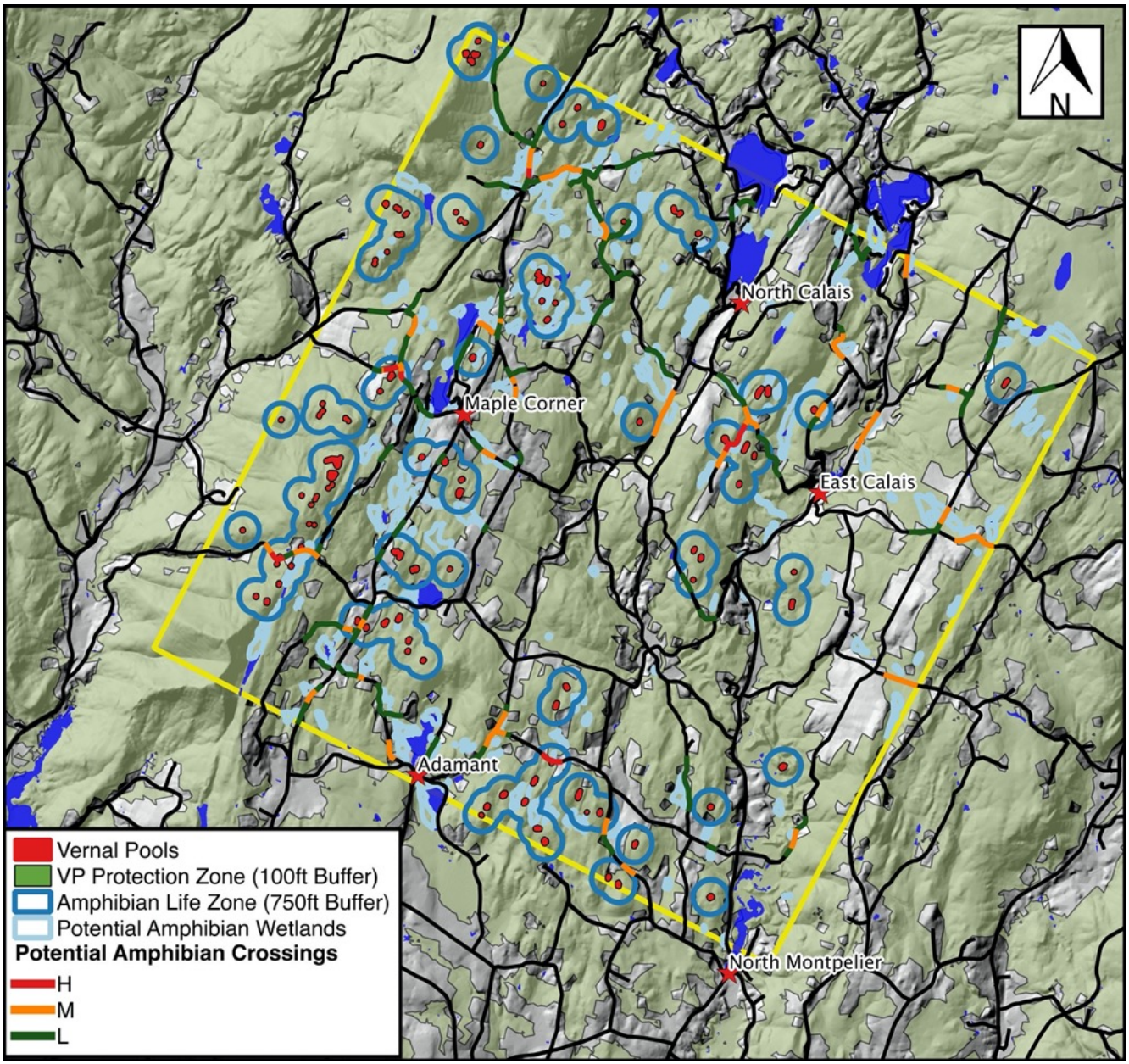


Figure 20. Vernal Pools, their buffers, Amphibian Wetlands, and Potential Amphibian Crossings

Potential Amphibian Road Crossings

Pool-breeding amphibians spend the bulk of their adult lives in the upland habitats, especially forests, surrounding their breeding sites, so when roads separate these areas from breeding pools the results can be very damaging to the populations. Migrations are most concentrated as adults move to the breeding pools, typically on warmer rainy nights in early spring, but the reverse migration of adults, and later new juveniles, back to upland areas can be equally dangerous for these creatures. Identifying likely crossing areas is the first step toward reducing these impacts. Once identified, signage, crossing volunteers and other measures can be used to minimize driver's impacts. Since no crossing data existed for Calais, a map of Potential Amphibian Road Crossings was created based on the known migration distances of the species and the breeding habitat locations. For this analysis breeding habitats included the 108 vernal pools and many additional types of wetlands can sometimes include small, shallow, fishless pools that are functionally similar to vernal pools. These are here referred to as potential amphibian wetlands. It should be noted that other species, such as

leopard frogs, green frogs, bull frogs, spring peepers, American toads, and red-spotted newts can be found in these habitats, but also successfully breed in a much wider range of aquatic habitats which are not included here. Potential amphibian wetlands numbered 227 and represent a subset of the entire wetland map extracted based on community type. No field verification of these occurred.

Figure 20 depicts the breeding habitats, buffers, and potential crossing areas and differentiates the crossings into high, medium, and low likelihood, based on professional judgment. In total 79 discrete road segments were identified as being potential amphibian crossing areas. Collectively these span about 20 miles of roadway including all classes of roads. The bulk of these potential crossing miles (17) are on class 2 and 3 town roads and less than a half mile of Route 14 was identified as a potential crossing. While this is collectively a significant amount of roadway, only 31 discrete segments spanning 7 (~1.2H and 5.9M) miles were identified being high and/or medium likelihood crossing areas. This map is based primarily on remote analysis rather than field observations and provides a starting point for further verification; the actual number of high frequency crossing areas may be much lower.

Given the very large number of vernal pools and potential amphibian breeding habitats and the moderately-high rural road density in Calais, this is perhaps a surprisingly small number of potential crossing areas. Fortunately, a large proportion of the vernal pools are far enough from roads that migrating amphibians do not have to cross them. This is a positive finding and care should be taken in future development and road building to avoid compromising this situation. Unfortunately, for a small subset of the pools nearer to roads, the surrounding upland habitats have been so altered by land clearing, agriculture, and development that they are unlikely to support significant populations of pool breeding amphibians, particularly mole salamanders. Road segments in these areas were generally rated as low likelihood crossings or were ruled out altogether, because populations have likely already been compromised. This situation reflects past and ongoing impacts to local amphibian populations, but could be changed over time through strategic buffering, reforestation, and restoration efforts by interested landowners. The intermediate scenario, where pools still support significant breeding populations, but are in relatively close proximity to roads that separate them from important upland habitat, is of most concern in this analysis. These are the crossings of greatest concern (High and Medium), where vehicular impacts to migrating amphibians may be greatest, but could be mitigated with appropriate protective measures such as signage and volunteer crossing guards. Avoiding creation of additional barriers, such as developments, clearings, and curbs in these areas will also help protect the ability of Calais' amphibians to successfully complete their annual migration cycles.

<u>Streams and Riparian Corridors</u>

Here in hilly New England streams and roads all too frequently find themselves competing for the same space. This creates challenges not just for the streams and the roads, but also for wildlife that often use the areas along streams as travel corridors and feeding areas. Even in densely settled areas the wild scrubby edges along streams can provide important pathways for bobcats and refugia for species not found in adjacent developed lands. In Calais, streams and riparian zones have special importance for the uncommon [redacted] Because of their frequent proximity to roads riparian areas often fall outside of major habitat blocks, but their importance in connecting adjacent patches of habitat, and providing pathways under roads and through developed areas cannot be overestimated. Figure 1 shows Calais' streams as

mapped in the VT Hydrographic Dataset (VHD). For the habitat block analysis 50ft buffers were used to approximate riparian corridors capable of hosting a suite of aquatic and riparian species and fostering the movements of many other species.

Additional Diversity Elements

Data on known biodiversity features such as rare species and significant natural community occurrences provides an added measure of the value of various habitat blocks. These datasets are discussed in previous sections of this report. Wetlands and open water habitats provide additional habitat diversity, food resources, and homes for species particular to these settings. These data are summarized in the Wetlands section of this report.

Wildlife Habitat Blocks

Thirty-three habitat blocks, collectively spanning about 18,000 acres or 78% of the town land base, were mapped in Calais (Figure 21). See Appendix 1 for mapping process details. However, core habitat areas within these blocks total only about 8,400 acres indicating a moderately high level of fragmentation and a need to pay attention to habitat connectivity to maintain healthy wildlife populations. Habitat blocks emphasize the perspective of wide-ranging animals like bear, bobcat, and moose, that are not especially well suited to living in close proximity to people, and for this reason are more vulnerable to human impacts. This perspective is thought to create an umbrella that covers and encompasses the diverse needs of many other species of wildlife, animals, plants, fungi, and more, over short and long time horizons, making them good tools for planning around the needs of wildlife. The 33 habitat blocks vary widely in size and importance, as gauged by the suite of specific habitat elements discussed above and when viewed from the state-level perspective. The following discussion provides the details of these blocks in rough order of their significance, with further data in Table 3.

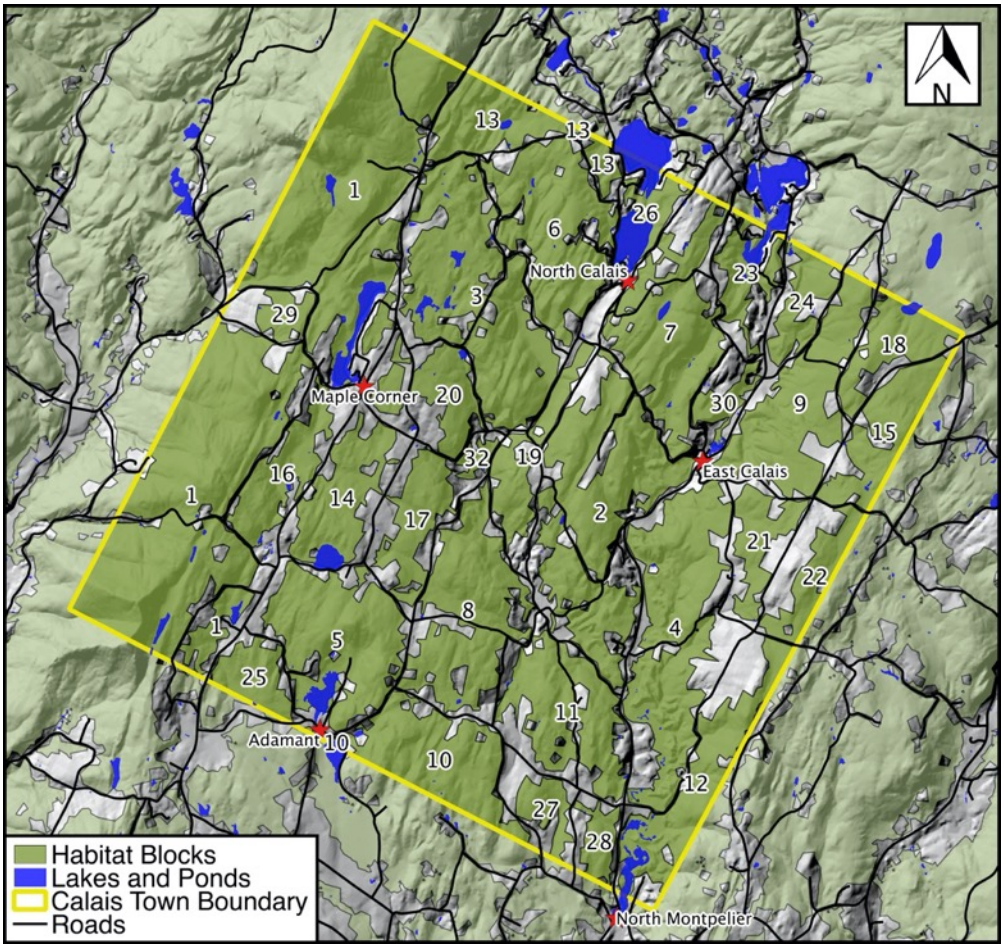


Figure 21. Calais Habitat Blocks, numbered. Repeated numbers represent multi-part blocks that are connected as contiguous units outside of Calais.

Block #1

Block 1 is the single largest and most significant habitat block in Calais, spanning the entire western edge of town west of County Rd, and extending well beyond the town into East Montpelier, Montpelier, Middlesex, Worcester, Elmore, Woodbury, and Hardwick. Collectively covering about 29,800 acres with nearly 4,000 ac in Calais, this block is anchored on Woodbury Mountain to the north and includes all the taller, remote forested hills to the south and west dropping down to the North Branch of the Winooski River and Rte 12. This block is a regional anchor providing the highest levels of core habitat (2,850 ac.) in Calais and facilitating large-scale landscape connectivity. While far removed from the watchful eyes of people, bobcat, bear, and moose have been repeatedly sighted across this block. In Calais, this block contains nearly half (45) of the town's vernal pools, multiple documented mast stands and bear wetlands, 1,500 acres of potential deer wintering area, nearly 100 wetlands of diverse types (though most are relatively small), about 15 miles of headwater streams, and a number of state significant natural communities and rare species. This block includes the Long Meadow Brook (Phase 1), Hersey Hill (Phase 2), and Hawkins Pond (Phase 1 - not visited) Macrosites. About 17% of the block in Calais is conserved, and, though much of the terrain is relatively remote, steep and more difficult to access for development, further conservation is desirable to prevent degradation of this highly state and locally significant block. Several class 4 roads and rights-of-way pass through this block and are not currently considered block fragmenting features; maintaining habitat connectivity across these areas of potential future fragmentation is important to the integrity and continued functioning of this block.

Block #3

Block 3 abuts West County Rd and block 1 for over 1.5 miles between Apple Hill Road and Dugar Brook Road as well as extending across the class 4 section of Apple Hill Road. Dugar and Pekin Brooks roughly form its north and east edges and indicate a major important riparian corridor for traveling wildlife. Totaling about 1200 acres with half that as core habitat, this block is one of several in a second tier of significance for relatively large area, high core levels, and numerous valuable habitat features. Its close association with the large anchor block 1 adds to its importance for connectivity reasons as indicated by its priority ranking in the state level analysis (VCD). This is also one of several blocks of statewide high priority due to their unique physical landscape features, a ranking that, in Calais, is largely tied to their calcareous soils and bedrock. This block includes the Three Ponds Macrosite and parts of the Dugar Brook Swamps Macrosite, both studied during Phase 1. Wetlands abound with 45 units, the second greatest in number and the greatest in area (173 ac. including ponds) of all blocks. Bear mast stands, bear wetlands, vernal pools, and deer wintering areas are present, along with several state significant natural communities and rare species. None of the land base is currently legally conserved. Maintaining habitat connectivity across Apple Hill Road is important to the continued functioning of this block.

Block #13

Block 13 also abuts West County Rd and block 1, extending north from the fragmenting feature of Dugar Brook Road well into Woodbury to the Cranberry Meadow wetland complexes. This block has good connectivity to the anchor block 1 and there have been a number of reported sightings of bears moving between these blocks. Only about 446 acres of the total 957 acres of this block lie within Calais, downplaying its significance if viewed without proper context. Similarly to block 3, its close association with the large anchor block 1 enhances its importance, as indicated by its priority ranking

in the state level analysis (VCD), and it is also of statewide high priority due to its unique physical landscape features of calcareous soils and bedrock. This block also has a relatively high core area, bear wetlands, mast stands, deer wintering area, vernal pools, and a number of enriched wetlands. These are the Bayne Comolli Road Wetlands Macrosite (Phases 1 and 2), which encompasses 5 state-significant wetlands and hosts at least 4 rare species. None of the Calais land base of this block is currently legally conserved.

Block #18

Lying in the northeast corner of Calais, block 18 appears unimpressive until its easterly connections beyond town are recognized. This block provides an important connection through Woodbury, Cabot, and Marshfield, down to the main stem of the Winooski River and across to another regional anchor block, the Groton State Forest block. Just 306 acres of the total 3,933 acre block are in Calais, so the statistics in Table 3 are not particularly noteworthy, but the larger block is significant, as indicated by its state-level (VCD) rankings. In Calais the block includes bear wetland, deer wintering area, a vernal pool, and several other wetlands including the Bliss Road Swamp site (Phase 2) with its state-threatened bog wintergreen, and parts of the Mud Pond complex that has state-significant features. Fortunately, nearly a third of the Calais portion of this block has been conserved.

Block #4

Block 4 is the fourth largest in Calais at 1062 acres, flanking the east slopes of the Kingsbury Branch from Max Gray Road north to East Calais village. This block provides a very significant wildlife travel corridor along over 3 miles of the Kingsbury Branch floodplain, as well as several small tributary streams. While it did not rate highly in the statewide connectivity perspective it appears locally quite significant. The elongate shape of this block reduces its percent core area (37%), but the relatively unfrequented and difficult to access nature of the extensive, shrubby floodplain swamps likely makes the functional core area much greater. These diverse, state-significant swamps, largely encompassed in the Kingsbury Floodplain Swamps Macrosite (Phase 2), provide excellent habitat for a range of riparian and wetland associated species. This is important [redacted] habitat; beaver, otter, mink, waterfowl, and many other aquatic/amphibious species use the area, and bears may graze the lush spring growth in the river bottoms. Several rare and uncommon species find homes here. The adjacent forested slopes include deer wintering areas and a few vernal pools. The Still Brook Road and right-of-way passes through this block and, while it is not presently considered a block-fragmenting feature in this analysis, it does present an area of concern that may be subject to further development pressure. It is important to maintain habitat connectivity across this area.

Block #12

Block 12 is another somewhat linear area extending further downstream along the Kingsbury Branch from block 4, to which it has good connectivity across the narrow separation of Max Gray Road. It extends this important local riparian travel corridor another mile along the Kingsbury. Just 566 of this block's total 1,230 acres are in Calais, but they include North Montpelier Pond and the diverse oxbow ponds, backwater marshes, and shrub swamps at its north end. While many of these wetlands have doubtlessly been altered by historical backwatering from the dam at North Montpelier, they provide high quality natural habitats for a wide range of aquatic and wetland species and offer easy recreational access for wildlife watchers, boaters, and fishermen. The upland portions of this block extend south to the Plainfield town line and north to Sadie Foss Road encompassing 2 potential mast stands, bear wetlands, and deer wintering areas. This block includes the lower reaches of the

Kingsbury Floodplain Swamps Macrosite (Phase 2) and the Max Gray Road Swamp Site (Phase 2 - not visited). Over half of the acreage of this block in Calais has been conserved.

Block #10

Block 10 straddles the southern border of town, with 660 of 1,879 total acres in Calais, reaching from Tucker Road to Adamant village. The relatively round shape gives this block a large amount of core habitat for its size; lands conserved by The Nature Conservancy anchor this core area. This block is particularly noteworthy as the greatest biodiversity hotspot in Calais, which was highlighted as the Chickering Bog Area Macrosite (Phase 1 and 2). Among the fens and high value wetlands there are 12 state-significant natural community features that support at least 22 rare and uncommon species, the greatest concentration of rare species in town, and one that is publically accessible by trail and boardwalk, thanks to TNC and neighboring landowners. Additionally, these wetlands are great places to see moose, otters, and less well-known wildlife such as rare dragonfly species; bobcat tracks have been repeatedly sited in this area. Amphibians abound in the 13 vernal pools, several of them highly productive and significant. The uplands provide abundant deer wintering area.

Block #2

Block 2 is the second largest block by acreage in Calais at 1,216 acres, extending from Pekin Brook Road north to Moscow Woods Road and covering much of the territory between the Kingsbury Branch and Pekin Brook. However, due to its relatively high amount of internal fragmentation from spur roads and scattered homes, the block has a somewhat lower proportion of core habitat, and has a lower state-wide weighted block score. Nevertheless it is provides important habitat with an actively used mast stand, bear wetlands, several highly productive vernal pools, including one of the few observed to host fairy shrimp, and over 1,000 acres of deer wintering area. There are 6 state-significant natural communities and 7 known rare or uncommon species. This block includes the Ledge Hill Road Macrosite (Phase 2) and may serve as an important pathway between the Kingsbury Branch corridor and block 3, with connectivity through to the larger wildlands along the west edge of town. It is considered priority interior forest as well as a high priority physical landscape block in the state-wide analysis. Two sections of class 4 road/right-of-way occur within the block and it will be important to limit further fragmentation along these potential development corridors. None of the land base is reported conserved.

Block #5

At about 822 acres block 5 encompasses Adamant Pond, Blackberry Hill and its surrounding forests (Blackberry Hill/Adamant Pond Area Macrosite - Phase 1). Despite a history of granite quarrying and long-term manipulation of Adamant Pond's water levels, the area can feel wild and pristine. The old granite grout piles and quarry pit pools have become new habitat features, with the latter often hosting salamanders and other vernal pool species. Blackberry Hill hosts the town's only known natural red oak-northern hardwood forest, which provides mast for bears and other wildlife. The hill's steep south slopes also host a small, state-significant talus woodland where widely spaced trees grow among natural granitic boulder rubble, that likely provides denning sites for various small and mid-sized mammals. The open waters and shoreline marshes of Adamant Pond support a wide range of aquatic species and birdlife, as well as a few rare species, as does the state-significant Hemlock-Balsam Fir-Black Ash Seepage Swamp that flanks Quarry Road. None of the land base is reported conserved.

Block #6

Block 6 spreads west from Mirror Lake (No. 10 Pond) between Bayne Comolli Road and Dugar Brook Road. At 814 total acres the block includes significant core area, a mast stand, bear wetlands, deer wintering area, vernal pools, a small state-significant fen, and rare species. Its good connections to both Pekin and Dugar Brooks as well as to the larger blocks 3 and 13 make this area important for wildlife movement, which is supported by several reported bear sightings and road crossings. Doubtless bobcats and other wide-ranging animals use and pass through this area. Part of the Interlacken Fens Macrosite (Phase 2) is in this block as is the No Name Pond Site (Phase 2 – not visited). The area is considered a priority block for connectivity and high priority for physical landscape in the state-wide perspective. None of the land base is reported conserved.

Block #7

Block 7 encompasses nearly 800 acres east of Mirror Lake from the town line south to Moscow Woods Road and east to Batten and Balentine Roads. There is a moderate amount of internal fragmentation along the west side of this block, and the class 4 Hayden Road is an obvious pathway for potential further fragmentation; maintaining connectivity here is important. However, the core of this block includes the remote, undeveloped Little Pond, extensive enriched beaver meadows and swamps along Carr Brook, numerous other wetlands and vernal pools, and remote calcareous outcrops and ledges. In combination, all of this makes for high quality, diverse habitat, and repeated sightings of bear and bobcats crossing Batten Road support the use of this area by wide-ranging mammals. The area is considered a high priority physical landscape block for its calcareous soils and bedrock, which supports an uncommon species along with many plants tied to calcareous conditions. The block includes the Carr Brook Swamps and Rich Woods Macrosite (Phase 2). None of the land base is reported conserved.

Block #9

Block 9 includes the rolling hills and slopes east of Rte 14 and the Kingsbury Branch, from East Calais north to the town line and east to East Hill and Bliss Roads. This 742 acre block is over half core area, and includes over 5 miles of headwater streams, a mast stand, bear wetlands, and deer wintering area. Reports of bear sign at a road crossing along Sand Hill Road illustrate the use of the area and the need to minimize any further fragmentation along the class 4 road/right-of-way that crosses this area. The unit is a priority connectivity block and high priority physical landscape block in the statewide analysis. Its proximity to block 18 provides potential pathways from the Kingsbury Branch to the Winooski mainstem and Groton State Forest block. In the opposite direction, there may be some connectivity to block 7 and beyond across the small block 30 and the Kingsbury floodplain swamps, as indicated by the bear and bobcat sightings to the west. None of the land base is reported conserved.

Block #8

Block 8 reaches from Lightening Ridge Road in the south to the north end of Singleton Road and encompasses nearly 1.5 miles of riparian corridor along the middle reaches of Pekin Brook as well as miles of unnamed tributaries. Through the larger network of riparian corridors this block aids in creating major north-south and east-west connectivity. The block is 789 acres, much of which is deer wintering area with abundant hemlock cover. Bear, otter and other mammals have been repeatedly sighted crossing at the north end of this block, and likely find homes throughout. The tributary streams are associated with the Singleton Road Seepage Forest Site (Phase 2) and Lightening Ridge Road Swamps Macrosite (Phase 1), both of which contain state-significant natural communities.

Several rare and uncommon species are associated with the latter, as well as with Pekin Brook, which is important [redacted] habitat and has also been found to host the seldom seen burbot. The unit is a priority connectivity block and high priority physical landscape block in the statewide analysis. About 13% of the block is presently conserved.

Block #15

This block straddles the northeast town boundary with Marshfield, with 403 of its 1,022 total acres in Calais spanning between Marshfield and East Hill Roads. Despite some internal fragmentation, this block has good connectivity to the larger block 18, with its wide-ranging connections toward Groton State Forest. This area has a significant component of conserved land (25%), a mast stand, several bear wetlands, and deer wintering area. Citizen sightings of many frogs crossing Marshfield road at the south edge of this unit suggest a potentially important amphibian crossing area in need of further verification and highlights the importance of habitat blocks for creatures small and large. The statewide analysis scored this block highly for interior forest, connectivity and its physical landscape.

Other Smaller Habitat Blocks (#11, 14, 16, 17, 19-33)

The remaining 19 habitat blocks collectively cover more than 4,000 acres of Calais and undoubtedly make significant contributions to wildlife habitat; however the shape and size of each block means that all have less than 250 acres of core area. This is considered a cut off below which functional core habitat conditions are not really present or at least are greatly diminished in value to the species that require such undisturbed conditions (Sorenson and Osborne, 2014). Barely a quarter of the collective area is mapped as core, and the smallest five blocks have no mapped core area in Calais (Note that block 33 barely enters Calais but is significant in East Montpelier). This illustrates the problem of fragmentation: with increasing density of roads and dispersed settlements large areas of forest can be broken into many small pieces with reduced ability to provide interior forest conditions, leaving many kinds of wildlife with increased vulnerability to stressors and greater challenges in moving through the landscape.

Nevertheless these areas can still have great value to wildlife. While they are unlikely to support permanent populations of larger, wide-ranging animals, they can provide important specialized food resources, can facilitate travel through the larger landscape, and support a wide range of smaller animals and those more tolerant human disturbance, such as deer, red and gray fox, coyote, raccoon, woodchuck, snowshoe hare, various rodents, amphibians, reptiles and many birds. Smaller blocks that have particular habitat features, such as mast stands, bear wetlands, vernal pools, ledges, rare or significant species and natural communities may have important habitat value that is disproportionate to their size. Blocks 11, 14, 25, 26, especially, as well as 19, 20, 22, 23, and 32 all have species and/or natural communities of special significance. Block 14 stands out for its abundant vernal pools and the significant cedar swamp in the Town Forest; vernal pools are also present in blocks 11, 16, 27, and 28. Blocks 11, 20, and 31 all have potential mast stands and virtually all of these small blocks have potential bear wetlands and deer wintering potential.

Small blocks along larger riparian corridors offer special connectivity values as they facilitate the movement of wildlife through more fragmented conditions. Blocks 11, 32, 19, 30, 24, and 23 provide special value in this sense as they fill the gaps between larger blocks traveling up the Kingsbury Branch, Pekin Brook, and Dugar Brook riparian corridors. Virtually all of the smaller blocks include some riparian zones of smaller headwater streams, which can provide travel corridors, food resources and habitat diversity. Block 29 is the only block that truly lacks riparian zones; however, it

too is worthy of special mention for its roll in providing connectivity between the northern and southern parts of block 1, the most significant habitat block in Calais. Without this small unit the connections among Calais' western hills would be much weaker than at present. Blocks 14, 16, 20, 22, 24, 25, 29, and 33 are all considered priority connectivity blocks in the statewide perspective, underscoring even the large-scale importance of smaller habitat blocks. Blocks 11, 14, 16, 19, 20, 22, 23, 24, 28, 29, 30, and 33 are also considered of statewide high priority physical landscape features due to their calcareous bedrock and soils. As has been discussed elsewhere in this report, this characteristic is fundamental to many of Calais' ecologically significant features and this statewide perspective underscores Calais' special responsibility to steward these landscapes.

Wildlife Road Crossings and Connectivity Analysis

Even many of the larger habitat blocks in Calais may lack the size and diversity of resources needed to support sustainable populations of wide-ranging wildlife species over the long term, and, in this era of changing climate, animals, plants and other creatures of all sizes may need to move to find the

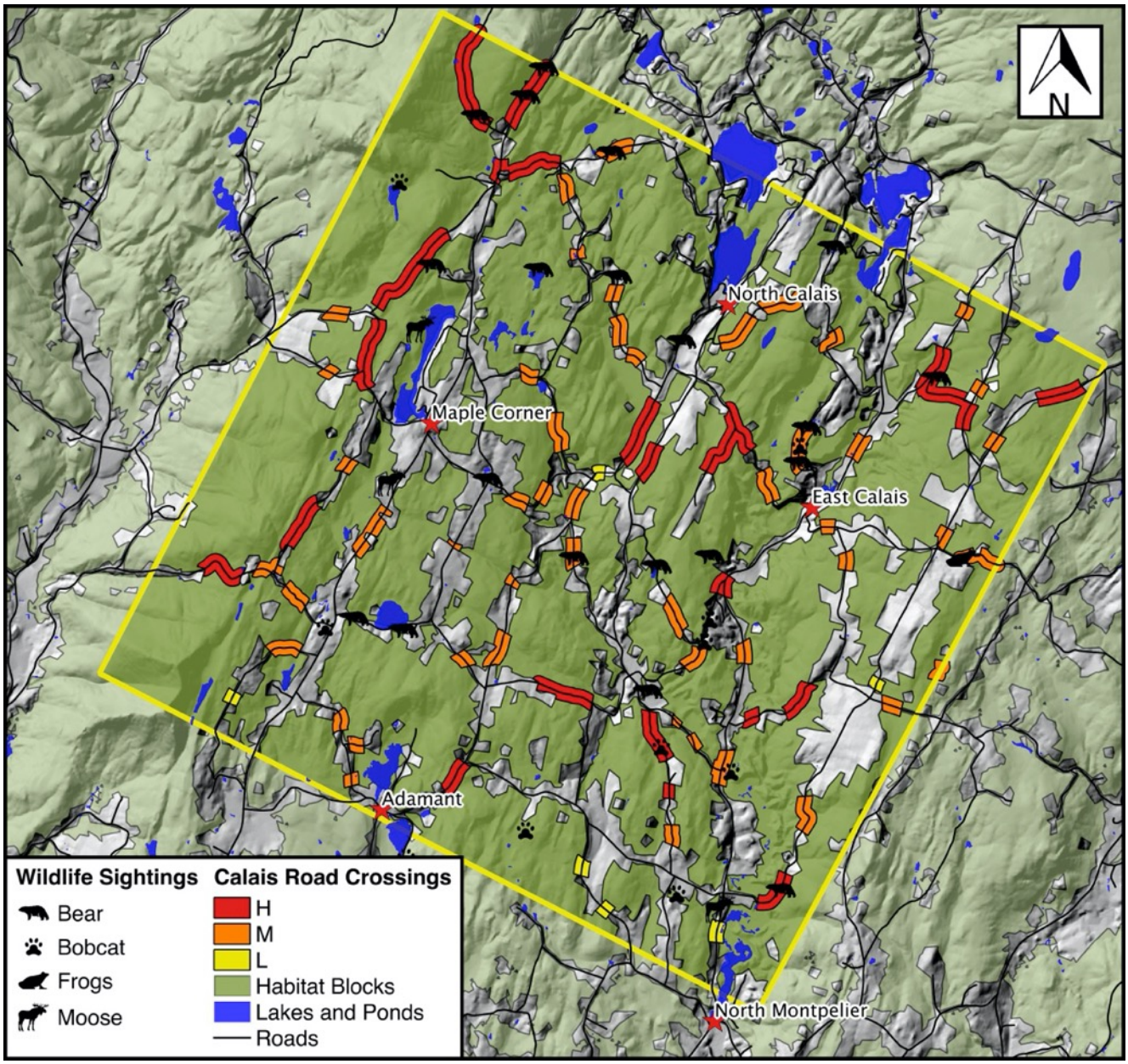


Figure 22. Potential Wildlife Road Crossings and Wildlife Sightings in Calais, VT.

conditions most conducive to their survival. For this reason it is important to consider and protect the pathways most likely to be used by wildlife on the move. In particular, it is important to focus on the pinch-points in the landscape where roads and other human developments limit the options and increase the stress levels of migrating animals. This connectivity analysis therefore focuses on local wildlife road crossings, the areas in Calais' road network most likely to be crossed by wildlife getting from one habitat block to another. In general, the best road crossings are extended road segments with forest on both sides, low traffic volume, and no development nearby. Adjacent corridor-enhancing features such as streams, wetlands, and conifer cover can further increase the utility of crossings and reduce the stress involved for wildlife. For this analysis, habitat blocks, core habitat, state road crossing data, corridor enhancing features, and other data sources were visually examined to map and prioritize the most likely and significant road crossing areas based on professional judgment. This remote analysis was augmented and supported with wildlife sightings data gathered mainly by Calais residents over the last decade.

Figures 22 and 23 depict these 77 potential wildlife road crossing areas, presented here as 100m buffers along segments of roadway; however, in reality these are not precisely bounded features. The mapped areas are meant to represent general areas where it is particularly important to maintain or improve the existing conditions that favor wildlife movement and to avoid the creation of new barriers and unfavorable conditions. The identified areas are roughly prioritized (High, Medium, Low) for their importance and likelihood of being major crossings, based on professional judgment; see the Detailed Methods section (Appendix 1) for more details. Note that many of the high priority crossings are sections of class 4 road or right-of-way that are not currently considered to be habitat block fragmenting features, but that pose natural pathways for future development, which could impair existing connectivity. It is also important to note that, apart from the local wildlife sightings data presented in Figures 22 and 23, these road crossing areas have not been field verified.

Table 3. Summary of Habitat Block Attributes for Calais, VT.

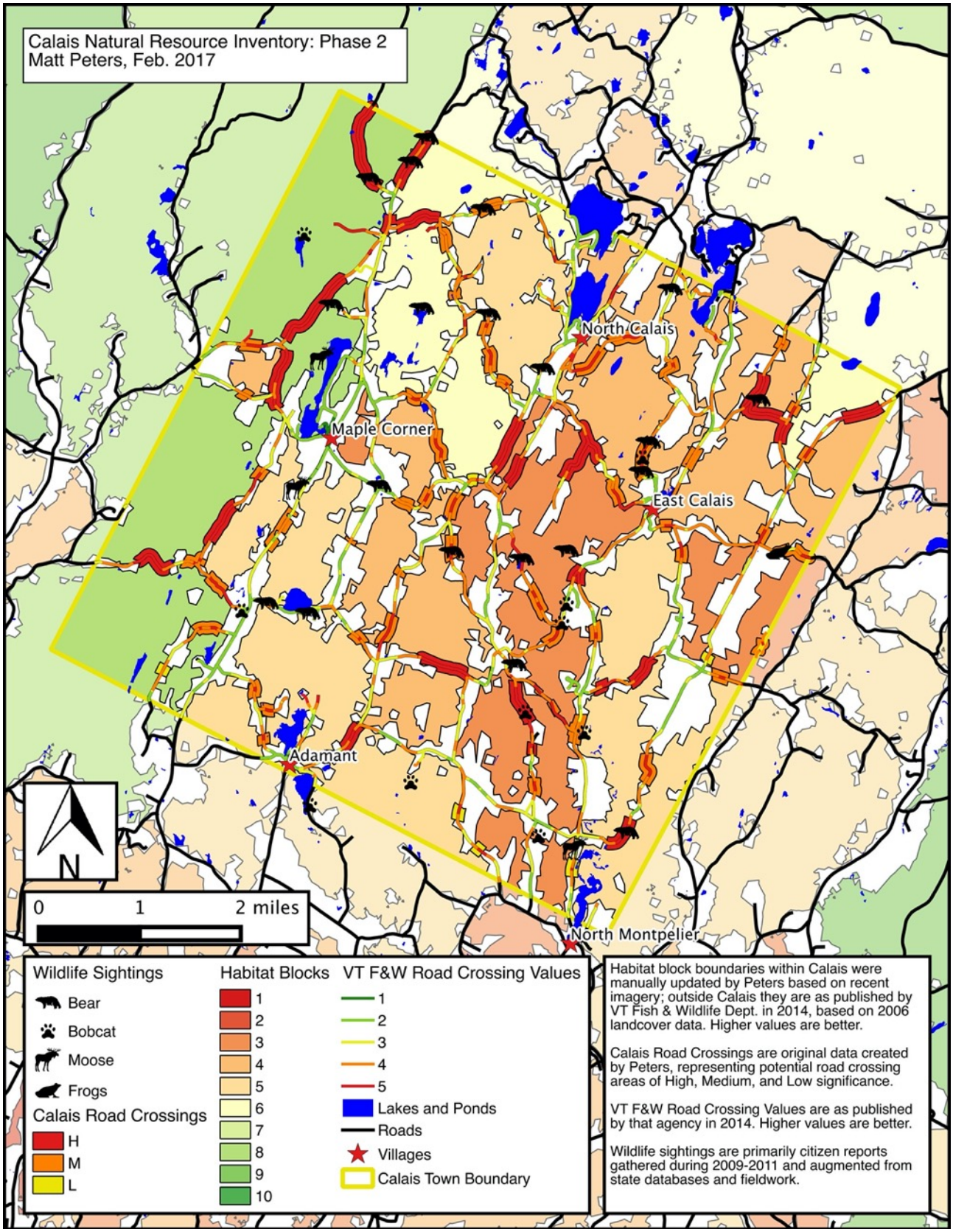
Blocks are ordered by block number and decreasing size*. Figures represent areas, numeric counts, lengths, or percentages contained with each block. Note that Block Size and other attributes are for areas within Calais, though some blocks also extend significantly into adjacent towns.

Block #	Block Size (ac)	Core Habitat Area (ac)	% Core Habitat	Conserved Land Area (ac)	% Conserved Land	Stream Miles	50 Ft Riparian Buffer Area (ac)	# of Bear Mast Stands	Bear Wetland Area (ac)	Deer Wintering Area (ac)	# of Vernal Pools	Open Water Area (ac)	Wetland Area (ac)	# of Wetlands	# of Sig. Natural Community Occurrences	# of Rare and Uncommon Species	VCD Interior Forest Blocks[1]	VCD Connectivity Blocks[1]	VCD Physical Landscape Blocks[1]	VT F&W Weighted Block Score[2]
1	3963*	2850	71.9	679	17.1	15.5	186	2	122.1	1500.2	45	243.2	148.7	99	4	6	High Priority	High Priority		8
2	1216	459	37.7	none	none	4.7	55	1	33.6	1047.9	7	1.6	47.3	32	6	7	Priority		High Priority	3
3	1206	589	48.8	none	none	6.5	76	1	161.1	910.6	8	18.1	173.0	45	4	5	Priority	Priority	High Priority	6
4	1062	395	37.2	none	none	11.3	129		144.6	866.7	3	0.1	153.6	14	1	5	Priority		High Priority	5
5	822	371	45.1	none	none	2.2	26	1	30.3	491.0	5	36.2	57.4	26	2	5		Priority		5
6	814	354	43.5	none	none	3.6	43	1	47.0	596.9	4	0.0	50.4	27	2	3		Priority	High Priority	5
7	797	343	43.1	none	none	3.1	37		49.6	584.8	3	8.1	51.1	16		1			High Priority	4
8	789	284	36	103	13.1	3.8	44		96.4	651.6	2	0.5	106.3	18	4	5		Priority	High Priority	4
9	742	384	51.8	none	none	5.2	63	1	54.6	631.7	0	1.0	54.6	7				Priority	High Priority	4
10	660*	445	67.4	296	44.8	1.8	22		35.1	705.2	13	11.9	147.8	35	12	22	Priority	Priority	High Priority	5
11	604	215	35.7	none	none	2.0	23	1	44.7	513.1	1	2.5	57.7	16	1	8			High Priority	3
12	566*	227	40.2	304	53.6	4.6	54	2	96.6	367.2	0	37.5	96.6	6	1	2	Priority		High Priority	5
13	446*	224	50.3	none	none	1.0	12	1	25.6	236.2	3	8.7	28.5	22	5	4	Priority	Priority	High Priority	6
14	442	167	37.8	48	10.9	1.5	17		49.8	263.6	8	28.1	54.4	19	3	5		Priority	High Priority	5
15	403*	221	54.8	101	25.1	0.9	11	1	34.0	304.8	0	0.4	34.0	8			Priority	Priority	High Priority	4
16	345	110	31.9	58	16.7	2.3	27		48.7	213.4	1	8.1	50.9	13				Priority	High Priority	5
17	313	82	26.2	130	41.5	2.1	25		30.7	251.0	0	0.0	31.7	4	1					4
18	306*	144	47	96	31.4	0.2	3		9.8	225.8	1	8.6	10.2	6		2	Priority	High Priority		6
19	272	46	16.7	none	none	1.0	11		17.3	194.4	0	0.0	17.3	3		2			High Priority	3
20	245	86	35	none	none	1.5	18	1	0.3	206.2	0	4.1	0.3	1		1		Priority	High Priority	4
21	242	49	20.2	none	none	0.9	10		4.8	186.3	0	0.4	4.8	1						3
22	235	81	34.2	none	none	0.1	1		13.7	139.3	0	3.1	17.4	6	1	1		Priority	High Priority	3
23	221	39	17.7	none	none	1.9	22		14.8	155.5	0	21.7	16.9	9	1	1			High Priority	4

Block #	Block Size (ac)	Core Habitat Area (ac)	% Core Habitat	Conserved Land Area (ac)	% Conserved Land	Stream Miles	50 Ft Riparian Buffer Area (ac)	# of Bear Mast Stands	Bear Wetland Area (ac)	Deer Wintering Area (ac)	# of Vernal Pools	Open Water Area (ac)	Wetland Area (ac)	# of Wetlands	# of Sig. Natural Community Occurrences	# of Rare and Uncommon Species	VCD Interior Forest Blocks[1]	VCD Connectivity Blocks[1]	VCD Physical Landscape Blocks[1]	VT F&W Weighted Block Score[2]
24	216*	73	33.7	none	none	1.7	19		5.0	124.2	0	2.4	5.1	2				Priority	High Priority	4
25	214	100	46.9	none	none	0.9	10		15.7	184.2	0	0.2	34.6	6	1	9		Priority		5
26	204	58	28.5	none	none	1.2	14		2.2	154.6	0	131.1	2.2	4	1	11				4
27	136	24	17.9	none	none	0.7	8		3.2	127.0	1	0.0	5.3	4						3
28	121	21	17.5	none	none	0.6	7		5.2	0.0	1	1.3	6.6	6					High Priority	3
29	115	none	none	none	none	0.0	0		2.3	58.2	0	0.7	3.4	3				Priority	High Priority	4
30	107	none	none	none	none	0.8	9		22.5	80.2	0	1.4	22.5	1					High Priority	4
31	78	none	none	none	none	0.2	2	1	5.2	65.8	0	0.0	5.3	3						3
32	50	none	none	none	none	0.5	5		12.1	24.7	0	0.2	12.1	1	1	1				4
33	2.7*	none	none	none	none	0.0	0		0.0	0.3	0	0.0	0.0	0				Priority	High Priority	5
Total	**17954**	**8442**	**47%**	**1815**	**10%**	**84**	**989**	**14**	**1238**	**12063**	**106**	**581**	**1508**	**463**	**51**	**106**				

* Does not include acreage that extends significantly beyond Calais boundaries. 1. VCD High Priority and Priority blocks are as identified in the Vermont Conservation Design (Sorenson et al., 2015). 2. Weighted Block Scores from Sorenson and Osborne (2014), statewide range is 0.8 - 8.3, higher being better. Both 1. and 2. provide statewide perspective on block values.

Figure 23. Wildlife Sightings, Habitat Blocks, and Road Crossings Map



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Appendix 1: Detailed Methods

Wetland Mapping

Wetland mapping during Phase 2 was limited in scope, with the bulk of the wetland mapping having been produced during Phase 1. At the time of the Phase 1 wetland mapping high resolution leaf-off color infrared imagery was not available for the eastern 1/4-1/3 of Calais, potentially reducing the accuracy and completeness of the wetland mapping in this area relative to the rest of the town. Subsequent to completion of the Phase 1 mapping this imagery became available for the area, so a brief review of the Phase 1 mapping was conducted to bring this mapping to the same standard as the rest of the town. Full methods are provided in the Phase 1 report. New fieldwork during Phase 2 also resulted in identification of additional wetlands in other areas. The resulting wetland boundaries are suitable for planning purposes, including the development of wetland overlays, but are advisory in nature and are not a replacement for onsite field investigations or formal wetland delineations.

Field Inventory of Ecologically Significant Natural Features

Fieldwork during both phases of this inventory focused primarily on finding and documenting new state and locally significant features, with a particular emphasis on natural communities. Detailed methods are provided in the Phase 1 report, and the materials in Appendix 3, produced by the Vermont Natural Heritage Inventory (VNHI), provide further information relating to state-significance determinations and rarity ranks.

Following completion of Phase 1, over 60 high and medium priority sites that were identified during landscape analysis remained unvisited, so Phase 2 fieldwork focused on visiting as many of these as possible. Twenty-two macrosites were identified as the top priority for Phase 2, encompassing many of these remaining sites. Landowner information for the relevant properties was assembled from the Grand List, and Conservation Commission members conducted most of the work of contacting owners for permission to access their properties. In a few instances, significant community occurrences that cross parcel boundaries were mapped onto parcels where permission was not obtained; however, such mapping was based strictly on orthophoto interpretation and views obtained from adjacent public areas such as roads, or areas where permission had been granted. In no case was a property accessed without permission.

In total, parts or all of 15 of these top priority macrosites were visited. For the remaining 7, permission was denied or the owners could not be reached. (Note that two of the visited sites, the Bliss Pond Town Forest and the Chickering Bog Area were visited during Phase 2 only to assess vernal pools and are not given separate site descriptions herein, hence 13 sites are described at length here.) Fieldwork at these sites was conducted throughout the season from May to September of 2016. Site visits consisted of walking the survey area, recording data on the type, quality, and spatial extent of natural community occurrences, important habitat features, vegetation, and wildlife, as well as documentation of any rare species present. Natural community classification and rankings follow established protocols of the VNHI and *Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont* (Thompson and Sorenson, 2005). With one exception, all landowners who granted permission for access also granted permission to share any findings with the VNHI (a state entity), so, in addition to the reporting provided herein,

technical descriptions of each state-significant natural community occurrence and rare/uncommon species sighting were prepared and submitted to the VNHI for inclusion in the state natural heritage database.

Wildlife Habitat and Connectivity Analyses

Several components of Phase 2 work focus on wildlife habitats and the importance of connectivity among patches of habitat at small and large scales. These components include identification of important features for pool-breeding amphibians, including vernal pools and other wetlands, and areas of potential amphibian road crossings, identification of potential bear habitats, including mast stands and wetland feeding areas, an assessment of the major habitat blocks in Calais and the most important wildlife road crossings that connect these blocks. These components are primarily the result of GIS analysis of underlying data generated by landscape analysis and field work during this project and of external data sources (mainly from VT Fish and Wildlife). Brief summaries of each component follow.

Vernal Pools and Amphibian Crossings

Vernal pool locations were extracted from the full Calais wetland dataset (generated during this project) and include both potential and field-verified pools. Pool verification efforts incorporated some of the information previously gathered by Calais residents on a number of pools, though some of the documentation from this prior effort was missing at the time of this project. Other potential amphibian wetlands were extracted from the wetland dataset by selection of community types considered likely to contain small pool areas that are functionally similar to vernal pools. Together, the vernal pool and potential amphibian wetlands data were used to evaluate potential amphibian road crossings.

The amphibian road crossing analysis consists of identifying and reviewing all road segments close enough to potential breeding habitats to be potential crossing locations between upland overwintering areas and spring breeding habitats. Published migration distances for pool breeding amphibians form the basis for identifying the road segments for further review. For example, blue spotted and four toed salamanders travel up to 650 ft, spotted salamanders travel about 422 ft on average, but up to 817 ft, wood frogs travel up to about 1550 ft, and Jefferson salamanders travel an average of about 650 ft, but up to an impressive 2051 ft (Calhoun and deMaynadier, 2004). Clearly there is a fair amount of variability in published migration distances, but 800 ft was used as a practical cutoff for reviewing road segments. This distance encompasses the majority of mole salamander movements and a significant portion of wood frog migration. Actual migration distances can vary greatly depending on the topography and density of potential breeding habitats. The relatively high density of potential breeding habitats in Calais (108 vernal pools plus many wetlands) may mean the average migration distance is somewhat lower locally relative to other regions. Professional judgment was used to further refine and narrow the potential road crossing to produce the final map. Crossings were assigned a rough likelihood rating (high, medium, low) based on consideration of the particular setting (nature of the breeding and upland habitats, topography, orientation of roads, aspect).

Mast Stands and Bear Wetlands

Two types of areas of potential value as black bear feeding habitats were identified: Potential Mast Stands and Potential Bear Wetlands. Mast stands refer to areas of concentrated “hard” mast (i.e.

nuts). In Calais, this primarily means beech stands that produce crops of beechnuts, a favored fall food of black bears; it also includes oak stands (1 in Calais). The VT Fish and Wildlife Black Bear Database contained no mast stand data for Calais, so potential mast stands were inferred from areas of beech bark disease mapped annually through aerial sketchmapping by VT Forests, Parks and Recreation as part of their forest health monitoring. These areas were augmented and refined with limited field data where bear-scarred beech were incidentally encountered or where sketchmapped areas were found to lack beech altogether. Mapped wetland areas were also removed since they do not support beech or oak in Calais. The resulting map is preliminary and is not a comprehensive assessment of all potential mast (beech) stands.

Bear wetlands are wetlands that produce some of the earliest lush green vegetation in spring and are favored by bears for spring grazing. The Potential Bear Wetlands dataset is a subset of all wetlands extracted based on their community type and its likelihood of producing this type of vegetative growth. Wetland types considered likely to be bear wetlands include forested wetlands, seeps and seepage wetlands, riparian wetlands, and marshes. Both of these types of bear habitat data are "potential" and require further field verification.

Habitat Blocks and Wildlife Road Crossings

The VT Fish and Wildlife Department, in collaboration with the Vermont Land Trust, developed a statewide analysis of wildlife habitat blocks that incorporates many factors from landscape scale habitat connectivity considerations to detailed habitat features such as the presence of wetlands, water bodies, and specific biodiversity elements (Sorenson and Osborne, 2014). The habitat blocks exclude class 1, 2, and 3 roads, developed areas, agricultural lands, and isolated fragments of habitat less than 20 acres in size. While very small habitat fragments and agricultural lands have some value to wildlife it is limited compared with the importance of larger habitat blocks. This state analysis provides an excellent starting point for further local level refinement and interpretation. It was built on 2006 land cover data, thus at the town level, visual interpretation of more current orthophotos allowed refinement of the habitat block boundaries. While the overall effect of this refinement on the block areas and shapes was relatively minor, it is more accurate and incorporates nearly an additional decade of land use change in Calais. The resulting revised habitat block boundaries were used, through a GIS analysis, to summarize a variety of other types of geographic data by habitat block, allowing a description of each block and a comparison of their relative merits to emerge.

The revised habitat blocks were then used in combination with state Wildlife Road Crossings data (from VT F&W) to identify important road crossings and connectivity areas for wildlife from a local perspective. In brief, the habitat blocks and road crossing values (a measure of the ease of movement across an area for a large animal) were visually examined in the context of data on core habitat areas, special habitat features (including streams and riparian corridors, potential bear mast and wetland areas), and previously mapped connectivity areas (Sorenson, pers. comm.) to identify the areas thought to have the highest value for wildlife moving between habitat blocks.

These areas were augmented and to some degree verified by wildlife sighting data from several sources. From about 2009-2011 citizen science efforts led by then-resident Candace Shaffer and others documented about 170 wildlife sightings around Calais. The most relevant subset of these, relating to the wide-ranging species bear, moose, and bobcat, were combined with a few

datapoints from state bear and roadkill databases, and field observations to create a local wildlife sightings dataset. Many additional sightings of other important species are present in the citizen-gathered data and could be of further use in verifying potential wildlife road crossings, but the data exists solely in paper maps and documents and time was not available to fully digitize it for use in this analysis. Finally, data on priority interior forest, connectivity, and physical landscape blocks from the VT Conservation Design project (Sorenson et al., 2015) was examined for further state and regional perspective on connectivity. The resulting set of identified road crossing areas were further prioritized based on professional judgment using the following guidelines:

High priority indicates crossings that appear important in one or more of the following ways:

1) they are internal to core habitat areas (class 4 roads) or provide particularly close connections between core areas, especially large core areas,
2) they are larger/longer segments of relatively intact forested connections,
3) they appear to provide a critical link, or the best link across a larger fragmenting/barrier feature, e.g. Rte 14, and/or
4) they provide connection along a larger scale zone of connectivity, e.g. a link along a major riparian corridor that is otherwise fairly intact.

Low priority indicates crossings that are typically small/narrow, and/or marginal in their degree of cover/ habitat, and/or that connect smaller, mostly non-core habitat areas presumed to be of lower overall habitat value.

Medium priority includes everything else, crossings of more moderate size and quality of connection, or that connect habitat patches of more moderate size and value, and that do not appear involved in critical connections between high value features.

Appendix 2: Vernal Pool Data

This table presents a summary of attribute data on the 34 confirmed vernal pools identified during this inventory. The remaining 74 potential pools that have yet to be visited and confirmed are not included here. See the vernal pool shapefile/kml file for additional information.

Pool ID #	Visited?	Confirmed?*	Size (ft x ft)	Area (ft^2)	Depth in feet	Hydroperiod	Wood Frog presence	Spotted Salamander presence	Fairy Shrimp?	Other animals observed	Pool Vegetation	State Significant?	Locally Significant?
1	Y	Y	20 x 50	1000	<1	likely sufficient	6 egg masses	36 egg masses	N	fingernail clams, caddisfly larvae	very sparse grasses and herbs, abundant moss	Y	Y
2	Y	Y	90 x 100	9000	2-3	semi-permanent	2 egg masses, abundant tadpoles	37+ egg masses	N	caddisfly larvae	extensive sedges and grasses, transitional to intermediate fen or marsh (Carex lasiocarpa, C. pseudocyperus, Scirpus atrocinctus, etc.) scattered willow shrubs at edge	Y	Y
7	Y	Y	60 x 80	4800	1-2	likely insufficient	none	1 dead egg mass	U	fingernail clams, caddisfly larvae, helical snails	40% cover of basin, sensitive fern, sedges, grasses, marsh fern, bulrush	Y	Y
10	Y	Y	70 x 100	7000	1-2	likely insufficient	1 juvenile	5 dead egg masses	U	unconfirmed report of Jefferson Salamander egg masses and "dozens" of salamander egg masses reported from 2006 citizen inventory efforts, probably this pool, caddisfly larvae, 4 red efts	extensive Sphagnum squarrosum moss lawn with Torreyechloa grass colony, fern hummocks, a few spiraea shrubs, a few tree saplings on hummocks	Y	Y
26	Y	Y	30 x 40	1200	1-2	likely sufficient	unknown	unknown	U	unknown	duckweed	U	U
27	Y	Y	60 x 50	3000	2-3	likely sufficient	unknown	unknown	U	unknown	sedges (Carex tuckermanii), royal fern	U	U
34	Y	Y	60 x 420	25200	>3	semi-permanent	abundant tadpoles	115+ egg masses	N	raccoon, spring peepers chorusing, adult red spotted newt, fingernail clams, caddisfly larvae, ostracods	abundant sensitive and royal ferns, sedge and bulrush tussocks, Sium suave abundant, a little duckweed, bur-reed, a few stunted trees and other forbs	Y	Y
38	N	Y				unknown	unknown	unknown	Y	fingernail clams, fishfly larvae, nematodes, waterfleas, mosquito larvae	pondweed	U	U
45	N	Y			<1	likely sufficient	unknown	~35 egg masses total	U		sensitive fern, buttercups, mosses	U	U
46	N	Y			<1	likely sufficient	unknown	~35 egg masses total	U		sensitive fern, buttercups, mosses	U	U
47	Y	Y	20 x 30	600	<1	clearly insufficient	none	none	N	fingernail clams	sparse sensitive fern	N	N
48	Y	Y	20 x 20	400	<1	clearly insufficient	none	none	N	fingernail clams	sparse ostrich and sensitive ferns	N	N
49	Y	Y	20 x 50	1000	<1	clearly insufficient	none	none	N	red-backed salamander adult under moist litter in pool	sparse sensitive fern and Juncus effusus	N	N

Pool ID #	Visited?	Confirmed?*	Size (ft x ft)	Area (ft^2)	Depth in feet	Hydroperiod	Wood Frog presence	Spotted Salamander presence	Fairy Shrimp?	Other animals observed	Pool Vegetation	State Significant?	Locally Significant?
50	Y	Y	35 x 80	2800	<1	clearly insufficient	none	none	N	red eft, fingernail clams	lush sensitive and cinnamon fern, Impatiens, and other seep species	N	N
62	Y	Y	100 x 150	15000	2-3	clearly sufficient	12+ egg masses	none	N	spring peepers, caddisfly larvae	extensive sedges, duckweed, algae, mosses; scattered small willows, black ash, yellow birch	Y	Y
63	Y	Y	20 x 30	600	1-2	clearly insufficient	none	none	N	none	sparse, grasses, sedges, sensitive fern, violets	N	N
64	N	Y											
65	Y	Y	30 x 100	3000	1-2	likely sufficient	20 egg masses	12 egg masses	N	abundant mayfly larvae, caddisfly larvae	grasses (Glyceria striata), golden spleenwort (Chrysosplenium americanum), forget-me-not (Myosotis sp.), bittersweet nightshade (Solanum dulcamara), a couple small black ash	Y	Y
66	Y	Y	60 x100	6000	>3	clearly sufficient	tadpoles	152 egg masses	Y	wood ducks (3), green frog (1 adult), fingernail clams, caddisfly larvae, ostracods, collembola	sedges (Carex tuckermannii), scattered black ash, sensitive fern, grasses (Glyceria striata), red twig dogwood	Y	Y
68	Y	Y	40 x 90	3600	>3	semi-permanent	tadpoles	1 egg mass hatched	U	fingernail clams	80% cover of lush sensitive fern, spiraea, willows, arrowhead, other herbs	U	U
69	Y	Y	30 x 40	1200	1-2	clearly insufficient	none	5 egg masses drying	N	caddisfly larval cases abundant	30% cover of sensitive fern and Juncus effusus	N	N
73	Y	Y	30 x 150	4500	>3	permanent	tadpoles	unknown	U	fingernail clams	abundant duckweed, sensitive fern, Glyceria melicaria, Spiraea, other herbs	U	Y
89	Y	Y	50 x 150	7500	2-3	semi-permanent	tadpoles abundant	40 egg masses	N	fingernail clams, caddisfly larvae	extensive sedges (incl. Carex pseudocyperus), patchy willow and dogwood shrubs, mossy edges	Y	Y
90	Y	Y	60 x 220	13200	>3	permanent	tadpoles	55+ egg masses	N	spring peepers chorusing, wood ducks, fingernail clams, caddisfly larvae, leeches	diverse, deepest part with water lilies, elsewhere extensive willow shrubs, sedges (incl. Carex pseudocyperus, C. utriculata), Bidens, duckweed, sensitive and cinnamon ferns, stunted red maple and red spruce on sphagnum hummocks	Y	Y
91	Y	Y	40 x 120	4800	1-2	likely sufficient	tadpoles	25 egg masses	N	caddisfly larvae	grasses, small elms	Y	Y

Pool ID #	Visited?	Confirmed?*	Size (ft x ft)	Area (ft^2)	Depth in feet	Hydroperiod	Wood Frog presence	Spotted Salamander presence	Fairy Shrimp?	Other animals observed	Pool Vegetation	State Significant?	Locally Significant?
93	Y	Y	80 x 100	8000	2-3	semi-permanent	abundant tadpoles	26+ egg masses	N	fingernail clams, caddisfly larvae, aquatic snails	extensive duckweed, abundant grasses (Glyceria borealis, G, striata), sedges, Bidens, jewelweed, extensive mosses, occasional dogwood shrubs, sensitive fern, bur-reed (Sparganium)	Y	Y
96	Y	Y	180 x 290	52200	3+	semi-permanent	abundant tadpoles	121+ egg masses	Y	spring peepers chorusing, green frog adult, fingernail clams, predaceous diving beetles, caddisfly larvae, ostracods, collembola, aquatic snails, water striders	diverse, extensive winterberry shrubs in center, bulrush, sedge, and manna grasses abundant in patches, other areas very open, many small forest islands near edges	Y	Y
97	Y	Y	20 x 30	400	1-2	likely sufficient	none	12+ egg masses	N	unknown	unknown	N	N
98	Y	Y	40 x 70	2800	U	likely sufficient	unknown	unknown	U	unknown	unknown	U	U
99	Y	Y	40 x 100	4000	1-2	likely sufficient	unknown	unknown	U	fingernail clams	sedges (Carex retrorsa)	U	U
100	N	Y										N	N
103	Y	Y	60 x 150	9000	<1	clearly sufficient	150+ egg masses	13 egg masses + 1 dead adult	N	mosquito larvae	abundant mossy logs and hummocks with scattered hemlock, black ash, red spruce saplings	Y	Y
105	Y	Y	50 x 50	2500	1-2	likely sufficient	tadpoles	tadpoles + 63 egg masses	N	fingernail clams, ostracods, predaceous diving beetle larvae, caddisfly larvae	sparse sensitive fern, manna grass	Y	Y
108	Y	Y	80 x 150	10000	<1	likely sufficient	tadpoles (2009)	lots of egg masses (2009)	N	adult red-spotted newt, fingernail clams, ostracods, caddisfly larvae, dragonfly larvae, phantom midge larvae, water striders, mosquito larvae	extensive 90% herb cover, Boehmeria, Torreyechloa pallida (a grass), sedges (2016)	U	Y

* Confirmed pools that were not visited during this inventory were confirmed by citizens during prior work; these need revisitation for full assessment of potential significance.

Appendix 3: Natural Heritage Inventory Protocols

Explanation of Legal Status and Information Ranks[1]

State Rank and Global Rank - Value that best characterizes the relative rarity (abundance) or endangerment of a native taxon within Vermont's geographic boundary or throughout its range, respectively. Ranks are as follows:

1 - 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

2 - 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

3 - 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

4 - General, regular, and apparently secure: May be locally uncommon or widely scattered but not uncommon on a statewide basis

5 - Common (Secure): widespread and abundant

H - Possibly extinct/extirpated: Missing; only historical occurrences but potential for rediscovery

X - Presumed extinct/extirpated: Not located despite intensive searches and little likelihood of rediscovery

U - Unrankable: Currently unrankable due to lack of information or due to substantially conflicting information about status or Trends

NR - Not ranked: Not yet assessed

NA - Not applicable. Element is not a suitable target for conservation for one of the following reasons: Hybrid, Exotic Origin, Accidental/Nonregular, Not Confidently Present, No Definable Occurrences

An indicator of uncertainty about the rank, either in the form of a range rank (e.g. S1S3) or a ? qualifier, may follow a numeric rank. For global ranks only, an appended T-rank indicates an infraspecies, and a qualifier after the rank in the form of a Q indicates questionable taxonomy.

State Status - Legal protection under Vermont Endangered Species Law (10 V.S.A. Chap. 123)
E = Endangered: in immediate danger of becoming extirpated in the state
T = Threatened: with high possibility of becoming endangered in the near future
PDL = Proposed for Delisting
PE = Proposed for Endangered Status (not legally protected by 10 V.S.A. Chap. 123)
PT = Proposed for Threatened Status (not legally protected by 10 V.S.A. Chap. 123)
RE = Recommended (by the Endangered Species Committee) for Endangered Status (not legally protected)
RT = Recommended (by the Endangered Species Committee) for Threatened Status (not legally protected)
RDL = Recommended (by the Endangered Species Committee) for Delisting

Federal Status - Legal protection under the federal Endangered Species Act, U.S. Fish & Wildlife Service
LE = Listed Endangered
LT = Listed Threatened
PDL = Proposed for Delisting
C = Candidate for Listing (not legally protected under ESA)

[1] Excerpted from *Rare and Uncommon Native Vascular Plants of Vermont* web-published by the Vermont Natural Heritage Inventory, Vermont Fish & Wildlife Department 15 September 2014.

Guidelines for State-significance
Natural Heritage Inventory
Vermont Fish & Wildlife Department

Initially drafted November 5, 1996, latest revision July 25, 2013

The following guidelines are for determining whether a particular area will be entered into the Vermont Fish & Wildlife Department's Natural Heritage Database as a species or natural community occurrence of statewide conservation significance. They are used in conjunction with the Natural Heritage Network's Element Occurrence Data Standard and Element Occurrence Specifications. These guidelines are primarily intended for staff and others providing Natural Heritage data to the Vermont Natural Heritage Inventory (VNHI)

These guidelines represent VNHI's default position on determining state-significance for a species or natural community Element Occurrence (EO). Any deviation from the guidelines needs to be clearly justified and documented either in these guidelines (see Exceptions Section) or in the Natural Heritage Database.

The terms state-significant and exemplary have been used synonymously in the past to describe important Natural Heritage Element Occurrences. The term exemplary is currently used in the Vermont Wetland Rules (Exemplary Wetland Natural Community, section 5.5) and includes all wetland natural community occurrences that VNHI determines to be state-significant.
Meeting any of the following criteria would constitute state-significance for the purpose of entering an Element Occurrence into the Natural Heritage Database.

PLANT SPECIES

- Presence of any S1, S2, or state-listed (Threatened or Endangered) species;
- Presence of any G3/S3 species (e.g. Ginseng, Hill's Pondweed).

  Note that split-rank species default to the lower ranking, e.g. an S2S3 species is treated as S2 and mapped and tracked as an EO.

  S3 (but not S3S4) plant species are documented in the Natural Heritage Database with limited observational information but are not considered as state-significant.

ANIMAL SPECIES

- Known or suspected occupied breeding-season habitat for any S1, S2, or state-listed species;
- Known or suspected occupied breeding-season habitat for a G3/S3 species (e.g. West Virginia White);
- Known overwintering concentrations of S1, S2, or state-listed species;
- Known overwintering concentrations of G3/S3 species.

  Note that split rank species default to the lower ranking, e.g. an S2S3 species is treated as S2 and mapped and tracked as an EO.

  S3 and S3S4 animal species are documented in the Natural Heritage Database with limited observational information but are not considered as state-significant.

NATURAL COMMUNITIES

- Presence of an S1 or S2 natural community type with an EO Rank of A, B, or C;
- Presence of an S3 or S4 natural community type with an EO Rank of A or B;
- Presence of an S5 natural community type with an EO Rank of A.

  Note that D-ranked S1 and S2 natural communities, C-ranked S3 and S4 natural communities, and B-ranked S5 natural communities may be tracked in the Natural Heritage Database, and may be considered state-significant, if their EO Rank has been downgraded due to a temporary lowering of their condition for which recovery is expected. Justification must be provided. C-ranked Vernal Pools are tracked regardless of whether their condition is downgraded and expected to recover because the primary basis for ranking vernal pools is amphibian breeding.

ASSOCIATIONS OF NATURAL COMMUNITIES

A site may be considered state-significant if it contains an association of natural communities for which ecologically intact examples are rare or declining in the state. There are typically strong ecological connections between the natural communities in these associations that relate to specific site characteristics, such as topography, soils, hydrology, or natural disturbance. In these cases, the association of natural communities is the state-significant feature, not necessarily all of the individual natural communities that are components of the association, although at least one component natural community should be state-significant. Examples include the following: Lake Champlain associations of Deep Rush Marsh, Lakeshore Grassland, Lakeside Floodplain Forests, Sand Beach, and Sand Dune, all closely tied to the ecological processes of flooding, wave action, wind, and sand deposition; and associations on calcareous hills of the Champlain Valley, including Mesic Maple-Ash-Hickory-Oak Forest, Dry Oak-Hickory-Hophornbeam Forest, and Temperate Calcareous Outcrop and Cliff, all tied to the warm, dry to mesic calcareous substrate of these hills.

EXCEPTIONS TO THE GUIDELINES

Great Blue Heron: While this species is ranked S3S4B, because of their concentrated nesting and vulnerability to human disturbance, VNHI does track Great Blue Heron rookeries.

Double-crested Cormorant: While this species meets the criteria for S2B it currently is not of conservation concern and is not tracked by VNHI. The species is considered a nuisance and its population in Vermont is being actively controlled. Under current conditions it is expected the population size would return to at least S4 levels if active control activities ceased.

American Eel: Though rare and of conservation concern, there are no definable occurrences to track due to their dispersed distribution while in their juvenile stage here. VNHI tracks observations as Independent Source Features.

Bryophytes: Most bryophyte S-ranks are provisional. VNHI will not track S3 bryophyte species, even as Independent Source Features, until further notice.