

Limestone Bluff Cedar-Pine Forests of Vermont: A Statewide Inventory

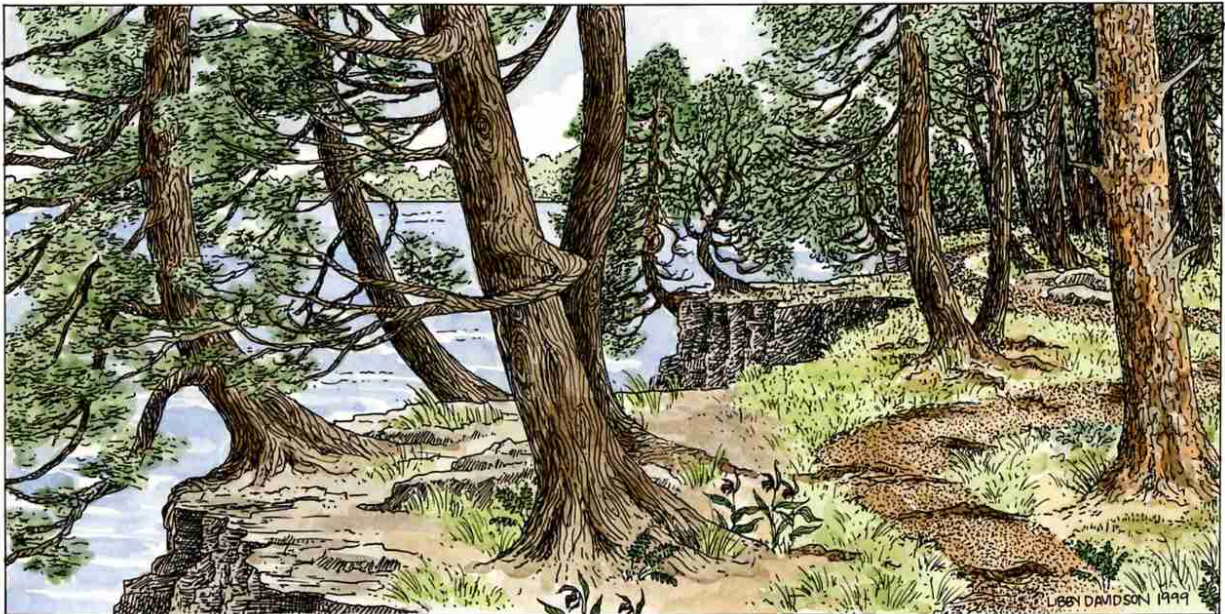


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Background

The Vermont Fish and Wildlife Department is committed to the conservation of all species of fish, wildlife and plants and their habitats for the people of Vermont. In order to be successful, this broad mission requires conservation attention at multiple scales. At the small scale, we need to plan for the health of populations of some especially rare or sensitive species. At the large scale, we need to conserve large tracts of forests, wetlands, and the landscape connections between these areas in order to protect the needs of wildlife species with large home ranges and allow for continued movement and migration of plant and animal species, as well as to maintain landscape level ecological processes. At the intermediate scale, we need to conserve the specific habitats and natural communities of plants and animals. Successful conservation of all species at these multiple scales will continue to require the cooperation and sound management by landowners.

The Vermont Fish and Wildlife Department has recently completed a Wildlife Action Plan (Kart et al. 2005). This plan identifies 331 animal "Species of Greatest Conservation Need" on which we need to focus attention because they are rare, threatened, or declining. One of the goals of this plan is also to keep common species from becoming rare. The plan reemphasizes the need for conservation to occur at multiple scales: species, natural communities/habitats, and landscapes. Although this Limestone Bluff Cedar-Pine Forest inventory was funded under the federal Wildlife Conservation and Restoration Program, a precursor to the State Wildlife Grants, the inventory project was conducted as much as possible according to the developing guidelines from Vermont's Wildlife Action Plan.

Natural communities and habitats are two terms that are generally used to describe the intermediate scale of conservation needs. A habitat is a place where an individual species lives and that provides that species with the food, water, shelter, and space it needs to survive. We can describe the habitat needs for individual species like bobcat, spotted salamander, or calypso orchid. In contrast, a natural community type is an assemblage of plants and animals that is found recurring across the landscape in similar environmental settings. Examples include Hemlock Forests, Dwarf Shrub Bogs, and Limestone Bluff Cedar-Pine Forests. For some species, habitat needs can be described in terms of natural community types, such as for spotted salamanders and their reliance on vernal pools for breeding. For other species, habitat needs may be smaller than a natural community (invertebrates in a rotting log) or much larger or more general than a natural community (black bear may use seeps for spring feeding, but otherwise range over diverse forested landscapes).

Limestone Bluff Cedar-Pine Forest is a rare upland natural community type in Vermont. It occurs on the limestone and dolomite bluffs and outcrops found primarily along the shore of Lake Champlain and is dominated by northern white cedar (*Thuja occidentalis*). This rare community type is also known from New York, Quebec, and Ontario, and similar communities are described from limestone escarpments in the Great Lakes region. Limestone Bluff Cedar-Pine Forest is one of 80 natural community types recognized in Vermont. Descriptions of all the community types are provided in the book *Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont* (Thompson and Sorenson, 2005) which can be purchased at

bookstores and can also be viewed at the Vermont Fish and Wildlife Department's web site (<http://www.vtfishandwildlife.com/>).

The wildlife habitat values of these lakeshore communities have not been well documented. There are numerous rare plant species associated with this community, including the state-threatened ram's head lady's-slipper (*Cypripedium arietinum*).

Remaining Limestone Bluff Cedar-Pine Forests are highly threatened. Lake Champlain shoreline property is highly desirable for development and these dry cedar-dominated bluffs are especially favored for their commanding views over the lake. As in much of the warm Champlain Valley, invasive exotic species are a considerable threat to the integrity of natural communities. Limestone Bluff Cedar-Pine Forests are especially sensitive to invasion by these exotic species after disturbance due to the calcium-rich bedrock on which the community occurs. These threats affect the natural community, the populations of rare species present, and the value of the area as wildlife habitat. Given their rarity, concentration of rare species, and known threats, Limestone Bluff Cedar-Pine Forests are a conservation priority in the state.

Purpose

Given the rarity of Limestone Bluff Cedar-Pine Forests in Vermont and the threat to this community type and the habitat it provides, this project was undertaken with several specific objectives.

- Map the locations of this community type in Vermont in order to better understand its distribution and threats.
- Collect information on wildlife species using this community type and ascertain if more detailed wildlife surveys are needed.
- Collect ecological information on the composition and structure of examples of this community type in order to better understand its variability and to revise the community classification if necessary.
- Inventory and provide management guidance for the rare plants associated with this community type (this objective was funded by the Nongame Fund, not by WCRP).
- Develop specifications for ranking the conservation significance of individual examples of the community type based on three factors: size of the community, condition of the community, and condition of the surrounding landscape.
- Identify the best remaining examples of this community type through inventory and ranking in order that appropriate conservation actions can be taken.
- Provide information to landowners on the ecological significance of Limestone Bluff Cedar-Pine Forests and offer management recommendations for maintaining the integrity of the communities and associated wildlife.
- Inform the public, as well as government and non-profit organizations of the significance of Limestone Bluff Cedar-Pine Forests and provide conservation recommendations.

Methods

The Vermont Fish and Wildlife Department's Nongame and Natural Heritage Program (NNHP) is responsible for tracking the location of rare species of animals and plants and exemplary natural communities. NNHP has been conducting animal, plant, and community inventories since 1989. Although this inventory of Limestone Bluff Cedar-Pine Forests has more emphasis on wildlife than some past projects, it generally follows a similar protocol. The inventory is divided into four stages: landscape analysis, landowner identification and contact, field inventory, and data compilation and reporting.

Landscape Analysis

The purpose of landscape analysis for this project was to identify the extent of Limestone Bluff Cedar-Pine Forests in the Champlain Valley of Vermont. The initial list of sites was identified from the NNHP Biotics database, which included the eight locations of this community type that had been documented prior to 2002. Potential locations for additional sites were identified through review of field notes and reports in NNHP's manual files and through conversations with knowledgeable ecologists, foresters, and biologists. A systematic mapping of potential Limestone Bluff Cedar-Pine Forests was done on the computer by on-screen digitizing using several layers of information. This digital information included topographic maps, bedrock type, soil type from the Natural Resources Conservation Service, satellite images depicting evergreen forest cover, and house and road locations. Color-infrared photos (scale of 1:40,000) that were taken in the early spring of 1992, 1993, and 1994 were viewed through a stereoscope as a primary basis for identifying Limestone Bluff Cedar-Pine Forests. These photos provide a three-dimensional view of the landscape and it is also possible to distinguish stands of northern white cedar from other evergreen species of trees. On-screen mapping of the Limestone Bluff Cedar-Pine Forests was done using the 1:5,000 scale black and white orthophotos as the base map. Individual polygons identified through this process were assigned site names, site codes based on the town in which it occurs and a sequential number, and a subjective prioritization for later field investigation based on the size and expected condition of the forest and surrounding habitats and natural communities.

Landowner Identification and Contact

It is the policy of Vermont Fish and Wildlife Department and the Nongame and Natural Heritage Program that privately owned sites will be visited only if specific permission from landowners has been obtained. The Lake Champlain Land Trust provided invaluable assistance in identifying landowners for all the high and medium priority sites identified for this project. These landowners were then contacted by telephone, the purpose of the project was explained, and permission was requested for NNHP staff to visit their property. Letters were sent to some landowners who could not be reached by telephone. Forms documenting the responses of all landowners were kept in each site file.

Field Inventory

Fieldwork for the project was conducted in 2002. Field methods consisted of general observation of the community, breeding bird census, observation of wildlife sign and habitat, and limited quantitative vegetation sampling. General site observations entailed walking the full extent of the Limestone Bluff Cedar-Pine Forest and developing a list of plant species present,

describing forest structure, signs of human or natural disturbance (primarily wind and ice storms), soil depth and pH, type of bedrock and the extent of outcrops, the overall age and condition of the forest, and the presence and condition of adjacent community types and habitats. A part of general site observation is to review and revise the mapping of the Limestone Bluff Cedar-Pine Forest that was done in the office and to add the location of other significant communities/habitats. This general site observation process provides very useful information that can be used to describe, compare, and rank individual sites. Given the small size of all Limestone Bluff Cedar-Pine Forests, it was possible to thoroughly cover most of each community during the general survey.

Breeding Bird Census: A breeding bird census was conducted in three of the Limestone Bluff Cedar-Pine Forests in June 2002. The sampling protocol followed that used by the Vermont Institute of Natural Science in their Forest Bird Monitoring Program. Two to five listening stations were established at each of the three sites. The first station was established 100 meters into the community, and subsequent stations were located at 200-meter intervals. Care was taken that no station was less than 100 meters from the edge of the community type. Because of the small size of the community that were sampled and concern about including birds from adjacent communities, there were only two listening stations at Mallet's Head. The other two sites, Kingsland Bay and The Head, both had the full five listening stations.

Each site was sampled twice during the breeding season, once during the first ten days of June and again seven to ten days later. In all cases both samples at a site were conducted by the same individual. All individuals conducting the sampling were skilled in identifying birds by song. The census began at dawn or very soon thereafter and entailed an observer listening at each station for a total of ten minutes before proceeding to the next station.

The data were evaluated to estimate the number of breeding individuals for each species at each site on a per listening station basis. For each listening station the number of breeding individuals was based on the type of observation. The following observations were tallied as two individuals: a singing male and any observation of a pair, family group, or nest. Alternatively, a calling individual and any observation (male or female) were tallied as a single individual. The number of breeding individuals attributed to each listening station was the higher of the two sampling times for each species. Once the number of individuals of every species was determined for all listening stations at the site, this total was divided by the number of listening stations. This provides a measure of the average number of individuals per listening station and allows direct comparison among the three sites. It also results in estimates of fractional birds at most sites.

General Wildlife Observations: During the visit to each site, notes were taken on all wildlife observations. Sightings of all species of birds, mammals, reptiles, and amphibians were recorded, and more general notes and occasional photographs were taken of invertebrates encountered during the surveys. In addition, notes were taken on the presence of den trees, tree nesting cavities, bird nests, caves used for denning, abundance of dead standing and downed coarse woody material, lakeside basking or resting sites, evidence of browse, and scat. Wildlife observations were also discussed with landowners, when possible.

Quantitative Vegetation Sampling and Other Plot Data: Vegetation sampling followed standard methodology used by NNHP. Most plots were 400 square meters (20m x 20m). Plots were located in area of mature, representative vegetation. Both vegetative and biophysical data were collected. For each plot, vegetation cover was estimated by species by stratum for the following layers: emergent trees (T1), tree canopy (T2), small trees (T3), tall shrubs (S1), short shrubs (S2), herbaceous (H), and non-vascular (N). Species lists were constructed by stratum and percent cover was estimated for each species. Additionally for trees, diameters at breast height for stems greater than 3.9 inches (10cm) were recorded. Two or more average-sized trees were cored to estimate stand age; most cores were read in the field and a sub-sample of the cores were further prepared and read again under a microscope. Biophysical data included soil profile description, percent exposed bedrock or rock, description of microtopography, and measurement of mineral soil pH with a Cornell Soil Kit.

Taxonomy and nomenclature for vascular plants follows *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* (Gleason and Cronquist, 1991). Bryophyte taxonomy follows Anderson, Crum, and Buck (1990) for mosses.

Data Compilation and Reporting

Information from the field inventory was compiled in site reports (see site reports organized by county and town in Appendix A) and in the manual (Geographic Manual File) and computerized (Biotics) databases of the Nongame and Natural Heritage Program. This information includes rank of the quality or ecological integrity of each site (A through D) compared to others in the state, observations of wildlife use, information on any rare plants present, and brief management guidelines to conserve the natural community and species.

A map of Limestone Bluff Cedar-Pine Forest and associated state-significant natural communities was made for each site that was visited during this inventory and also for those sites that were visited by NNHP staff prior to this inventory and included in the NNHP database. Natural community maps were made using ArcView GIS based on information in ecologists' field notes and field maps, digital topographic maps, and digital orthophotos. Attributes included for each polygon in this ArcView theme included site name and code, natural community type, acreage, priority ranking, whether a site visit was conducted, general comments, and field ecologist's name. A separate point theme was developed based on this Limestone Bluff Cedar-Pine Forest polygon theme. In this theme, a point was created at the centroid of each polygon that represented a Limestone Bluff Cedar-Pine Forest.

Copies of this report and appropriate individual site reports are provided to landowners whose property was visited and contained a Limestone Bluff Cedar-Pine Forest of state or local significance. Copies of the full report with all site reports are also provided to the appropriate regional planning commissions (Rutland, Addison, Chittenden, and Franklin Counties), the District Offices of the Agency of Natural Resources, the Vermont Chapter of The Nature Conservancy, the Lake Champlain Land Trust, and the Vermont Land Trust.

Results and Discussion

Distribution of Limestone Bluff Cedar-Pine Forests and Study Sites

Limestone Bluff Cedar-Pine Forest was identified at 97 locations during the landscape analysis and mapping phase of this project. Most of these 97 mapped polygons are adjacent to the shoreline of Lake Champlain, although two polygons were within three miles of the lake and five others were within one half mile of the lake. The 97 mapped polygons were condensed into 75 named sites, based on combining those that occur within close proximity of one another and can be considered functionally as one site. In Figure 1, each asterisk represents one of the 97 mapped locations of Limestone Bluff Cedar-Pine Forest.

The 97 mapped polygons of Limestone Bluff Cedar-Pine Forest are not the full extent of this community type in Vermont. Very small examples of this forest type were difficult to map at the 1:5,000 scale used for this project. Therefore, most examples less than one half acre have not been identified. Also, some larger examples of the community type were not mapped if they were so fragmented and altered by shoreline development that it was unclear whether the Limestone Bluff Cedar-Pine Forest still persisted at the site. These highly disturbed sites are unlikely to be very significant examples of the community type and are unlikely to provide high quality wildlife habitat.

Site visits were conducted at 27 of the 75 Limestone Bluff Cedar-Pine Forest sites. These 27 sites were selected for on-the-ground evaluation based on being initially ranked as high or medium priority sites and because landowners had given permission for Vermont Fish and Wildlife Department staff to visit their properties. High and medium priority sites are generally those that are larger and in landscapes least fragmented by development. In addition, sites were also selected for field inventory to ensure that examples were visited throughout the range of the community type in the Champlain Valley. It should be noted that there are some very significant examples of Limestone Bluff Cedar-Pine Forest that were not visited as landowner permission was not obtained.

Site reports are provided in Appendix A for all the sites that were visited during this project and that were considered to be of state significance. There are 21 site reports. Each site report provides a summary of the significant natural communities and species at the site, a general description of the Limestone Bluff Cedar-Pine Forest and associated communities, wildlife habitat values of the sites, management guidelines, and a map showing the location of the site and the significant communities present. The management guidelines are Nongame and Natural Heritage Program recommendations for landowners on protecting or enhancing the quality of the natural community, habitat, or associated rare species. Many of the maps show the location of significant communities occurring on private property. Permission of the landowners should be obtained before visiting these properties.

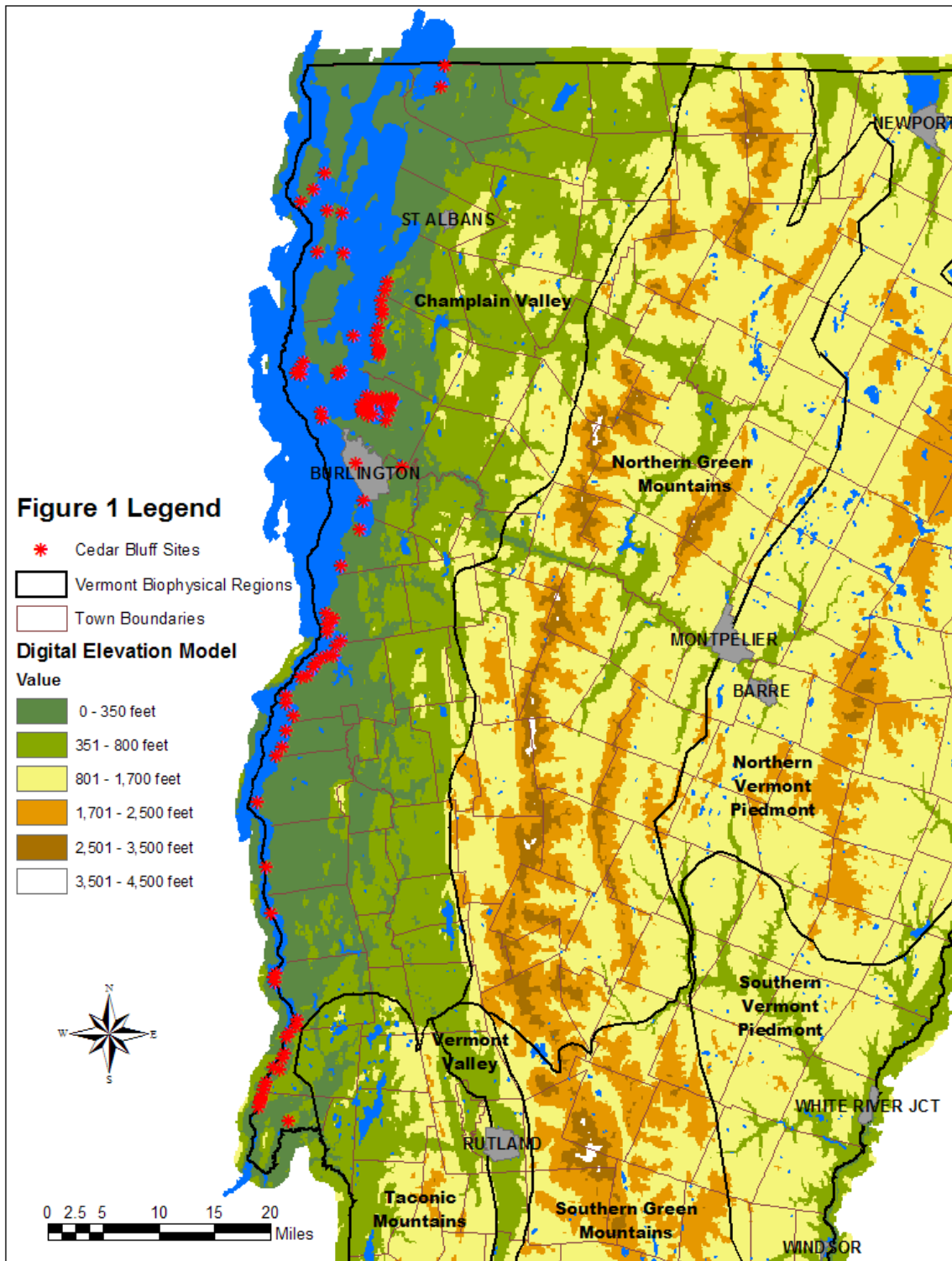


Figure 1. The location of the 97 examples of Limestone Bluff Cedar-Pine Forest mapped for this project. The locations of visited sites are provided in the individual site reports in Appendix 1.

Description of the Limestone Bluff Cedar-Pine Forest Community Type

The following description is based on the information collected during field visits for this project, as well as earlier descriptions of Limestone Bluff Cedar-Pine Forests by ecologists. The description is also based on the community profile in *Wetland, Woodland, Wildland* (Thompson and Sorenson, 2005). Vegetation plots from six of the visited sites also added to the description.

Ecology and Physical Setting: Limestone Bluff Cedar-Pine Forests occur on limestone, dolomite, and calcareous shale bluffs and outcrops along the rocky headlands of Lake Champlain. In these settings, these dark, coniferous forests typically occupy a narrow band along the top of the bluff or cliff and may extend inland several hundred feet. Soils are very shallow and bedrock is commonly exposed or just below the soil surface. These forests also occur occasionally on steep, rocky slopes adjacent to the lake and on calcareous cliff tops and ridges farther from the lake. Cedar bluff forests are small, with 70 of the 97 mapped forest patches (72%) under 10 acres. Only 13 of the 97 mapped forest patches (13%) are over 20 acres, with 65 acres as the largest documented example (The Head). The thin soils over calcareous bedrock, the warm and droughty summer conditions, and the exposure to winds off the lake are key environmental factors influencing these forests. Natural disturbance may be infrequent small fires, individual tree blow-down, and infrequent ice storm or high winds that can flatten several acres of forest or knock down single trees. The community appears to be stable over long time periods.



Vegetation: These forests are slow growing and northern white cedar, the dominant tree, is typically stunted, twisted, and wind-swept. Cedars of over 300 years have been documented on the headlands of Mallets Bay and several other locations. It is not uncommon to find stunted trees less than 15 feet tall, over 200 years old, with hollow centers clinging to the cliff tops. In most sites studied, hemlock (*Tsuga canadensis*) is a co-dominant tree in small areas of the bluff forest, but the conditions that favor this species are unclear. Tree species present in most bluff forests in low to moderate abundance include white pine (*Pinus strobus*), red pine (*Pinus resinosa*), hophornbeam (*Ostrya virginiana*), eastern red cedar (*Juniperus virginiana*), red oak (*Quercus rubra*), basswood (*Tilia americana*), and sugar maple (*Acer saccharum*). The taller white pine and red pine typically stand out above the lower closed canopy of northern white cedar. Less common tree species include white ash (*Fraxinus americana*), shagbark hickory (*Carya ovata*), and yellow oak (*Quercus muehlenbergii*). The shrub layer cover is typically low, but species richness can be high, including snowberry (*Symphoricarpos albus*), buffalo-berry (*Shepherdia canadensis*), bush honeysuckle (*Diervilla lonicera*), Canada yew (*Taxus canadensis*), poison ivy (*Toxicodendron radicans*), purple-flowering raspberry (*Rubus odoratus*), common bittersweet (*Celastrus scandens*), and limber honeysuckle (*Lonicera dioica*). Non-native invasive shrubs are present in many of the more disturbed sites and include Morrow's

honeysuckle (*Lonicera morrowii*), Japanese barberry (*Berberis thunbergii*), and common buckthorn (*Rhamnus cathartica*). A groundcover of ebony sedge (*Carex eburnea*) is characteristic, but typically patchy in distribution. Ebony sedge may form a low, fine lawn in some areas. Many other herbaceous species may be present, including wild columbine (*Aquilegia canadensis*), Virginia polypody (*Polypodium virginianum*), marginal wood fern (*Dryopteris marginalis*), bulblet fern (*Cystopteris bulbifera*), wild sarsaparilla (*Aralia*



nudicaulis), herb Robert (*Geranium robertianum*), blue-stemmed goldenrod (*Solidago caesia*), peduncled sedge (*Carex pedunculata*), and roseate sedge (*Carex rosea*). The rare to uncommon, state-threatened ram's-head lady's slipper (*Cypripedium arietinum*) grows in several examples of this community type. Many species of mosses thrive on the shady calcareous rock and include *Anomodon rostratus*, *Anomodon attenuatus*, *Thuidium delicatulum*, *Brachythecium digastrum*, *Abietinella abietina*, and *Rhytidium rugosum*.

State Rarity Rank: At this time only 21 examples of Limestone Bluff Cedar-Pine Forest in Vermont are considered state-significant based on the ranking factors of size of the community, current condition of the community, and the quality of the surrounding landscape. These 21 sites together only occupy 360 acres. Based on the small number of state-significant sites, the small total area occupied by this community type, and the high level of threat to this shoreline community from development, Limestone Bluff Cedar-Pine Forest is ranked as Rare or S2 (see description of state rarity rank in Table 5).

Regional Distribution: In Vermont, Limestone Bluff Cedar-Pine Forest is known only from the shores of Lake Champlain and nearby limestone and dolomite hills, although some cedar-dominated cliff tops in northeastern Vermont are very similar. Similar natural communities are described as Limestone Woodland in New York (Edinger et al. 2002) and Fresh-Moist White Cedar Coniferous Forest in Ontario (Lee et al. 1998). Similar communities are also known in Michigan and Wisconsin where descriptions are being developed. In the National Vegetation Classification maintained by NatureServe, Vermont's Limestone Bluff Cedar-Pine Forest is considered part of *Thuja occidentalis* / *Carex eburnea* Forest (CEGL006021) (NatureServe 2004).

Commonly Associated Natural Communities

All documented examples of Limestone Bluff Cedar-Pine Forests are small. In their typical setting along Lake Champlain they occur with a variety of other community and habitat types. Table 1 shows the 21 state significant examples of the community type that are described in the site reports (Appendix A) and lists the natural community types associated with each example. The associated communities listed are those found adjacent to or in very close proximity to the cedar bluff forest.

Table 1. Natural community types associated with the Limestone Bluff Cedar-Pine Forests at the 21 state significant sites that were surveyed.

Cedar Bluff Site Name	Town	Associated Natural Community Type					Other Community Types
		Temperate Calcareous Cliff	Transition Hardwood Limestone Forest	Lake Shale or Cobble Beach	Transition Hardwood Talus Woodland	Dry Oak-Hickory-Hophornbeam Forest	
Blue Ledge	Orwell	X	X	X			
Button Point	Ferrisburgh	X	X				Temperate Calcareous Outcrop
Camp Everest to Sandbar Bluffs	Milton	X	X	X			Lakeside Floodplain Forest
Coates Island	Colchester	X	X				
Eagle Mountain	Milton	X	X	X	X	X	
Garden Island	Charlotte	X	X	X			
Georgia Heights	Georgia	X	X				
Grosse Point	Ferrisburgh	X	X	X			
Highgate State Park	Highgate	X		X	X		Rich Northern Hardwood Forest
Kingsland Bay State Park	Ferrisburgh	X	X	X			
Lone Rock Point	Burlington	X	X		X		Temperate Calcareous Outcrop
Malletts Head	Colchester	X	X	X			
Mount Independence	Orwell	X	X	X	X		Deep Bulrush Marsh
Niquette Bay State Park	Colchester	X	X	X	X	X	Red Pine Forest; Lake Sand Beach
Providence Island	South Hero	X		X			Hemlock Forest
Red Rocks Park	South Burlington	X	X	X	X		
Robinson Point	South Hero	X		X			
The Head	Isle La Motte	X	X	X			Alvar
The Narrows WMA	West Haven	X	X		X	X	
Thorp Brook Hills	Charlotte	X	X				Deep Bulrush Marsh
Thujaland	Milton	X	X			X	
Frequency of community association		21	18	14	7	4	

Temperate Calcareous Cliffs are associated with all of the cedar bluff forests that were visited. These nearly vertical, warm, sparsely vegetated cliffs of limestone, dolomite, and shale have a strong influence of the development of the cliff-top cedar forests. Perched on the level, rocky ground above the cliff, northern white cedar is well adapted to the droughty, calcium-rich soils and the persistent winds which stunt the trees' growth. The exposed nature of this cliff-top setting also makes these forests susceptible to lightning strikes. The presence of red pine and fire scarred tree trunks indicate that fires are a periodic event in these forests.

Transition Hardwood Limestone Forests occurred at 18 of the 21 cedar bluff sites. These dry, rich, hardwood forests of sugar maple, shagbark hickory, basswood, white ash, white oak (*Quercus alba*), yellow oak, and red oak, with many rich woods spring wildflowers typically border the cedar bluff community farther back from the cliff top.

Lake Shale or Cobble Beaches are associated with 14 of the cedar bluff forests. These sparsely vegetated beaches typically are kept open by lake flooding, wave action, and winter ice, all factors that shift the rocky substrate and prevent woody plants from surviving. The substrate in these beaches varies from fine pieces of broken shale, to rounded cobbles, to flat surfaces of limestone or dolomite (sometimes called "limestone pavement lakeshore").

Several other community types that occur less frequently in association with Limestone Bluff Cedar-Pine Forests are also listed. The Transition Hardwood Talus Woodland has an open canopy and typically occurs on the jumble of large rocks that accumulate at the base of cliffs. Dry Oak-Hickory-Hophornbeam Forests are hardwood forests with a sedge-dominated, open groundcover that typically occur on the dry, warm hilltops. Although Temperate Calcareous Outcrop is only listed as being associated with two cedar bluffs, it is likely that it occurs more frequently. It is common to find rocky outcrops within the cedar bluff forest and at cliff tops that are droughty enough to prevent tree growth, but that are generally too small to map as a separate community type. Alvar is a globally uncommon community type found regionally in New York, Ontario, Michigan, and Wisconsin. The example at The Head needs more inventory attention.

Although it is not included in Table 1, Lake Champlain is itself a very important aquatic community that is closely associated with all cedar bluff forests except those two that are set back from the lake (Georgia Heights and Thujaland). Ecological effects on the cedar bluff forests due to close proximity to the lake include frequent winds and moderated summer and winter temperatures.

Breeding Bird Census

Breeding bird surveys were conducted in June 2002 at The Head, Malletts Head, and Kingsland Bay State Park. In total, 29 bird species were observed, and presumed to be nesting or at least utilizing the habitat at the three cedar bluff forests that were surveyed (Table 2). Of this total, nearly two-thirds (18 species) were observed at only one of the three sites. Four of the species were observed at two of the sites, while approximately one-quarter (seven species) occurred at all three sites. No bird species considered to be rare or uncommon in the state were noted during the inventory. However, three species are considered Species of Greatest Conservation Need in Vermont's Wildlife Action Plan (Kart et al. 2005): Black-throated Blue Warbler, Coopers Hawk, and Wood Thrush.

The eleven species that occurred at two or three cedar bluff sites are not truly indicators of this community type; all of them are generalists with greater fidelity to woodlands and forests, in general, rather than to cedar bluff forests specifically. Because cedar bluff forests are rare in Vermont, and since they are distributed as small patches on the landscape, it is not surprising that no suite of birds is specifically associated with them. It is expected that their primary utilization would be by generalists. In addition, since they typically occur as narrow swaths along the shore of Lake Champlain, the species that were most commonly observed are most often associated with open woodlands, edges, and hedgerows.

Since the three cedar bluffs that were sampled are considered to be of reference quality, many of the nesting species encountered in this survey would therefore be expected to occur in other

examples of this community type. The absence of more than a few of these species and their replacement by species more typically associated with suburbs, gardens, and disturbed areas would likely indicate some level of impairment in the bluff or the surrounding landscape. Caution should be exercised, however, in relying on the presence of certain of the more common species as indicators of pristine conditions, especially in this case where they are all habitat generalists.

The more common bird species encountered in limestone cedar bluff forests are each discussed below in order of their frequency and abundance at the three sampled sites. The first seven species were present at all three sites while the latter four occurred at only two of the sites.

- Black-capped Chickadee: typically nests in mature forest, hedgerows, and edges with a preference for hardwoods, but utilizes most forest types.
- American Robin: nests in various openings, utilizing most forest types.
- Eastern Wood Pewee: typically nests in clearings and woodland edges of most forest types except spruce-fir.
- Blue Jay: associated with woodlands and suburbs, utilizing most forest types.
- Yellow-rumped Warbler: typically nests in open woods and edges, preferring hardwoods and spruce-fir.
- Red-eyed Vireo: associated with deciduous forest, but utilizes most forest types.
- Mourning Dove: fairly ubiquitous except for dense forest; prefers pines for nesting.
- American Crow: associated with landscapes with a combination of woods and fields; will utilize nearly every forest type, but prefers to nest in pines.
- Black-throated Green Warbler: typically nests in mixed woodlands with a preference for hardwoods and hemlock.
- House Wren: associated with hedgerows, but will utilize most hardwoods or pine.
- Great-crested Flycatcher: associated with open woods and edges, utilizing most forest types.

Table 2. Average number of birds per species per listening station for three Limestone Bluff Cedar-Pine Forests. Species are ordered by their frequency of occurrence and by the average number of individuals observed per listening station. Species of Greatest Conservation Need are listed in bold (Kart et al. 2005).

Site	Kingsland Bay	Mallet's Head	The Head	Ave. # of Inds. per Listening Station	Frequency
Number of Listening Stations	5	2	5		
Species					
Black-capped Chickadee	2.8	3	1	2.08	3
American Robin	1.6	1.5	1	1.33	3
Eastern Wood Pewee	1.6	1	0.8	1.17	3
Blue Jay	1.6	1.5	0.6	1.17	3
Yellow-rumped Warbler	1.6	1	0.4	1.0	3
Red-eyed Vireo	1.2	1	0.4	0.83	3
Mourning Dove	0.2	0.5	0.2	0.25	3
American Crow	2	0	0.6	1.08	2
Black-throated Green Warbler	0.4	0	1.2	0.67	2
House Wren	0	3	0.4	0.67	2
Great Crested Flycatcher	0.8	1	0	0.5	2
Eastern Phoebe	1.2	0	0	0.5	1
Black and White Warbler	0	3	0	0.5	1
Golden-crowned Kinglet	0.8	0	0	0.33	1
Brown-headed Cowbird	0.8	0	0	0.33	1
Black-throated Blue Warbler	0	0	0.8	0.33	1
White-throated Sparrow	0	0	0.8	0.33	1
Ovenbird	0	0	0.8	0.33	1
Northern Oriole	0	2	0	0.33	1
Tree Swallow	0.6	0	0	0.25	1
American Goldfinch	0	0	0.6	0.25	1
Northern Cardinal	0.4	0	0	0.17	1
White-breasted Nuthatch	0.4	0	0	0.17	1
Wood Thrush	0.4	0	0	0.17	1
Brown Creeper	0	0	0.4	0.17	1
Belted Kingfisher	0	1	0	0.17	1
Common Yellowthroat	0	1	0	0.17	1
Cooper's Hawk	0.2	0	0	0.08	1
Hairy Woodpecker	0	0.5	0	0.08	1
Avg. Number of Individuals per Listening Station	18.6	21	10	13.33	
Total Number of Bird Species	18	14	15	29	

Other Wildlife Habitat Values of Limestone Bluff Cedar-Pine Forests

In addition to the breeding bird census, there are several other ways of assessing the wildlife habitat values of cedar bluff forests and associated natural communities. These include direct observation of species in cedar bluffs and associated communities during this study, NNHP records of rare species, and the size of the forest blocks in which the cedar bluffs occur.

General Wildlife Observations: During each site visit to a Limestone Bluff Cedar-Pine Forest, notes were taken of all wildlife species and their sign that were observed. This process gives a good understanding of the more common species found in these forests. Since the cedar bluff forests are small this survey technique allowed good coverage of the entire community. However, since the field visits occurred in varying weather from June through September there are clearly differences in species abundance and visibility, especially for migratory birds. For this reason, birds are discussed primarily in the breeding bird census section and Table 3 shows only those species of birds that were not encountered in the three breeding bird census sites. Table 3 also shows the mammal and the one snake species encountered. As with the breeding bird census, most of the wildlife species observed are common species and are generalists.

Table 3. Birds, mammals, and reptile species observed in the 21 Limestone Bluff Cedar-Pine Forests. The numbers in parentheses indicate the number of sites at which each species was observed. Species of Greatest Conservation Need are listed in bold (Kart et al. 2005).

Birds	Mammals
Pileated Woodpecker (2)	White-tailed Deer (17)
Canada Warbler (1)	Red Fox (5)
Common Grackle (1)	Porcupine (3)
Common Raven (1)	Coyote (3)
Downy Woodpecker (1)	Red Squirrel (3)
Nashville Warbler (1)	Gray Squirrel (2)
Osprey (1)	Flying Squirrel (2)
Red-breasted Nuthatch (1)	Bobcat (1)
Rose-breasted Grosbeak (1)	Eastern Chipmunk (1)
Ruby-crowned Kinglet (1)	Eastern Cottontail (1)
Ruffed Grouse (1)	Raccoon (1)
Song Sparrow (1)	
Winter Wren (1)	
	Reptiles
	Garter Snake (3)

Osprey is the only uncommon nesting species on this list. An Osprey was observed perching on a tall tree in the cedar bluff forest at Kingsland Bay State Park and the species is known to nest nearby. Canada Warbler, a species that is declining across its range, was observed in the spring and presumed to be nesting in the cedar bluff forest at Thujaland in Milton. Ruffed Grouse is declining in New England, presumably as a result of declining early-successional habitat. This species was observed at Georgia Heights, where the mature cedar bluff forest abuts a large area of young, early-successional forest.

White-tailed deer and their sign were observed in 17 of the 21 cedar bluff forests visited – by far the most ubiquitous species. The only cedar bluff sites in which no deer or sign were observed were Lone Rock Point (Burlington), Red Rocks Park (South Burlington), Robinson Point (South Hero), and Mount Independence (Orwell). The first two of these are small parks surrounded by urban development. The latter two are small forests surrounded by agricultural land – it is expected that deer do occur at these sites. Four of the cedar bluff sites are part of deer wintering areas mapped by the Fish and Wildlife Department (The Narrows WMA, The Head, Niquette Bay State Park, and Blue Ledge).

There are two species of flying squirrel in Vermont, the Northern and Southern. The species are difficult to identify without close inspection. Positive identification was not made for the individuals observed for this project. However, both species of flying squirrel are considered Species of Greatest Conservation Need, primarily because so little is known of their abundance and distribution in Vermont. These shy, nocturnal squirrels were only observed at two sites, Camp Everest and Kingsland Bay State Park. Flying squirrel tends to favor mature forests with nesting cavities near water. Both of these sites have mature forests with many nesting cavities. It is expected that flying squirrel occurs in many more cedar bluff forests, as many have an abundance of old trees with nesting cavities, are adjacent to water, and have an abundance of invertebrates that provide food for the squirrels.

Bobcat sign was only observed at The Head in Isle La Motte. Likely denning sites were observed in the ledges and small caves on the southeast side of this large cedar bluff. The Head is included in a contiguous forest block of over 400 acres, which includes swamps and dense early successional forest, both habitat conditions favored by bobcat.

The natural community types most commonly associated with cedar bluff forests are listed in Table 1. These communities and their juxtaposition with cedar bluffs and Lake Champlain provide habitat for other wildlife species. Temperate Calcareous Cliffs are associated with all of the cedar bluff forests visited. Turkey Vultures were observed or known to nest on three of these cliffs (Eagle Mountain, Highgate State Park, and Thujaland) and Common Raven was known to nest on the cliffs of Eagle Mountain. Lake Shale or Cobble Beaches are common below the cliffs associated with cedar bluff forests. Spotted Sandpipers were observed on many of these beaches and are presumed to use this habitat for nesting and feeding. Map turtles were observed basking on flat, shoreline rocks at The Head and Thorp Brook Hills and it is expected that they use similar habitats at many more sites. Although not observed, it is likely that spiny softshell turtles use some of the extensive shale beaches associated with the more northern cedar bluff forests. For these and other species not documented, the intact cedar bluff forests enhance the habitat value of the cliffs and beaches by providing additional buffer from human disturbance.

Rare Species Records: The Nongame and Natural Heritage Program of Vermont Fish and Wildlife Department maintains a database on the locations of all rare, threatened, and endangered species and state significant natural communities in Vermont. There are several notable records for rare animal species associated with cedar bluff forests.

The five-lined skink is Vermont's only lizard and is considered very rare and listed as state-endangered. Five-lined skink has been observed at the cedar bluff forest, temperate cliffs, and

talus of The Narrows Wildlife Management Area by David Cunningham (Andrews 2003). Eastern ratsnake, a rare, state-threatened species, is known from The Narrows Wildlife Management Area and a nearby cedar bluff that was not visited for this study (Andrews 2003).

Forest Block Size: Limestone Bluff Cedar-Pine Forest is one of the small patch community types (generally occurring in small patches under 50 acres) found within the Oak-Pine-Northern Hardwood Forest formation of the Champlain Valley. There are many species of wildlife that occur within the Champlain Valley that require or benefit from larger tracts of forest and wetland with forested or riparian connections to other large forest blocks. Some of these species are listed as Species of Greatest Conservation Need in Vermont's Wildlife Action Plan (Kart et al. 2005) and are described in more detail in New England Wildlife (DeGraaf and Yamasaki 2001).

Conducting on-the-ground surveys of forested blocks associated with each of the cedar bluff forests visited was beyond the scope of this project. However, the size of contiguous forest blocks in which each cedar bluff forest occurs was easily measured using geographic information systems (GIS) and available digital coverages, especially roads, house locations (e911), and 2003 color orthophotography of Vermont. With these layers, forested and wetland areas contiguous to cedar bluff forests could be quickly measured, although this provides no assessment of forest or wetland type or condition. Table 4 provides the acreage of contiguous forest and wetland measured for each cedar bluff site.

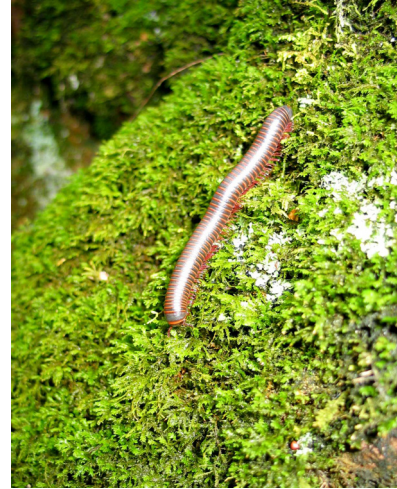
Cedar Bluff Site Name	Acreage of Contiguous Forest and Wetland
Georgia Heights	1,065
The Narrows WMA	995
Camp Everest to Sandbar Bluffs	959
Eagle Mountain	827
Thujaland	827
Mount Independence	755
Niquette Bay State Park	735
Blue Ledge	418
The Head	407
Thorp Brook Hills	240
Grosse Point	157
Providence Island	126
Kingsland Bay State Park	120
Highgate State Park	87
Lone Rock Point	85
Red Rocks Park	85
Malletts Head	60
Button Point	26
Robinson Point	26
Garden Island	23
Coates Island	16

Table 4. The 21 Limestone Bluff Cedar-Pine Forests and the acreage of the associated contiguous forest and wetland in which they occur. Note that Eagle Mountain and Thujaland occur within the same contiguous forest block.

In general, the larger blocks of contiguous forest are more likely to include a greater variety of interconnecting natural communities and habitats than the smaller blocks. The larger forested

blocks are also likely to provide habitat for more species of wildlife and to be more likely to sustain these species over time, especially if the forested blocks are connected to other similar blocks by forested or riparian movement corridors. Long-term conservation of these forested and wetland blocks that protects against additional fragmentation of the block by roads and development should be a priority.

Future Wildlife Study Needs: During field surveys of Limestone Bluff Cedar-Pine Forests both investigators saw many invertebrates, primarily land snails and millipedes (photo at right). No collections were made and no species have been identified, given the scope of this project and our lack of knowledge of these and related taxa. Similar calcareous cliff and bluff forest communities occurring on the Niagara Escarpment in Wisconsin have been found to harbor many species of rare land snails (Anderson et al. 2002). It is recommended that a study of land snails and other invertebrates be done in cedar bluffs and associated cliffs if funding becomes available.



Small-footed bat is considered very rare and is listed as state-threatened in Vermont. It is known to roost on rock faces and cliffs that are warmed by the sun. There is some indication that the temperate cliffs along the Lake Champlain shoreline may be used by this species (Scott Darling, Vermont Fish and Wildlife Department, personal communication). If this habitat proves to be important for roosting, it will be important to maintain contiguous forest blocks of cedar bluff forests and other communities. The Fish and Wildlife Department is conducting additional surveys.

Rare and Uncommon Plant Species

Limestone Bluff Cedar-Pine Forests have long been known as hotspots for rare and uncommon plant species. Although the focus of this project was not to survey rare plant species, any rare plants encountered during a site survey were recorded.¹ Many rare plants from cedar bluffs are known from earlier surveys by botanists.

Table 5 lists all the rare species currently known to occur in the 21 surveyed Limestone Bluff Cedar-Pine Forests. This is a truly impressive list of rare species, especially given that the total area occupied by all 21 cedar bluff forests is only 360 acres. Thirteen of the 33 species on the list are considered Species of Greatest Conservation Need in Vermont's Wildlife Action Plan (Kart et al. 2005). A few of the rare species are discussed below.

¹ Plant surveys are not eligible for funding under Wildlife Conservation and Restoration Program grants and were therefore not paid for by this source for this project. However, since rare plants are such an important component of Limestone Bluff Cedar-Pine Forests and the Vermont Department of Fish and Wildlife mission, time spent on rare plant surveys for this project by the two investigators was paid for by the Nongame Fund, a state fund. This funding for plant work was above and beyond the 25 percent state match requirement that was also paid from the Nongame Fund.

Table 5. Rare and uncommon plants of Vermont's Limestone Bluff Cedar-Pine Forests, with their global and state rarity ranks, their state legal status, and the number of sites at which each species occurred. Species of Greatest Conservation Need are listed in bold (Kart et al. 2005).

Scientific Name	Common Name	Global Rarity Rank	State Rarity Rank	State Status	Number of Sites
<i>Adlumia fungosa</i>	Climbing Fumitory	G4	S3		8
<i>Agropyron trachycaulum</i>	Slender Wheatgrass	G5	S3		1
<i>Arabis divaricarpa</i>	Limestone Rock-cress	G5	S2S3		4
<i>Asclepias quadrifolia</i>	Four-leaved Milkweed	G5	S3S4		6
<i>Asplenium ruta-muraria</i>	Wall Rue	G5	S3S4		6
<i>Aster laevis</i>	Smooth Blue Aster	G5	S3		1
<i>Bromus kalmii</i>	Wild Chess	G5	S2S3		3
<i>Carex backii</i>	Back's Sedge	G4	S3		1
<i>Clematis occidentalis</i>	Purple Clematis	G5	S3		6
<i>Corydalis aurea</i>	Golden Corydalis	G5	S2	T	6
<i>Cynoglossum virginianum var. boreale</i>	Northern Wild Comfrey	G5	S1	T	1
<i>Cypripedium arietinum</i>	Ram's Head Lady's-slipper	G3	S2S3	T	5
<i>Draba arabisans</i>	Rock-cress	G4	S2S3		4
<i>Draba glabella</i>	Smooth Draba	G4G5	S1	T	1
<i>Gentianella quinquefolia</i>	Stiff Gentian	G5	S1	T	1
<i>Hackelia deflexa var. americana</i>	Nodding Stickseed	G5T5	S2S3	T	5
<i>Lathyrus ochroleucus</i>	Pale Vetchling	G4G5	S2		1
<i>Pellaea atropurpurea</i>	Purple-stem Cliff-brake	G5	S3		2
<i>Pellaea glabella</i>	Smooth Cliff-brake	G5	S3		3
<i>Penstemon hirsutus</i>	Hairy Beardstongue	G4	S3		1
<i>Poa nemoralis</i>	Woods Bluegrass	G5	S2		2
<i>Polygala senega</i>	Seneca Snakeroot	G4G5	S2S3		7
<i>Potentilla arguta</i>	Tall Cinquefoil	G5	S3		1
<i>Quercus muehlenbergii</i>	Yellow Oak	G5	S3		9
<i>Rhus aromatica</i>	Fragrant Sumac	G5	S3		6
<i>Sanicula canadensis</i>	Short-styled Snakeroot	G5	S2	T	3
<i>Sanicula trifoliata</i>	Long-fruited Snakeroot	G4	S3		1
<i>Scutellaria parvula</i>	Small Skullcap	G4	S2		2
<i>Shepherdia canadensis</i>	Canada Buffaloberry	G5	S3		8
<i>Symphoricarpos albus</i>	Snowberry	G5	S3S4		15
<i>Taenidia integerrima</i>	Yellow Pimpernel	G5	S2	T	4
<i>Ulmus thomasi</i>	Cork Elm	G5	S1		1
<i>Woodsia obtusa</i>	Blunt-leaved Woodsia	G5	S3		1

State (S) Rarity Rank - Value that best characterizes the relative rarity (abundance) or endangerment of a native taxon within Vermont's geographic boundary.

Global (G) Rarity Rank - Value that best characterizes the relative rarity (abundance) or endangerment of a native taxon throughout its range.

1 - Critically imperiled (very rare): 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 - Imperiled (rare): 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 - Vulnerable (uncommon to rare): At moderate risk of extinction or extirpation due to restricted range, relatively few populations or occurrences (often 80 or fewer), recent and widespread declines, or other factors

4 - Apparently secure (common to uncommon): locally common or widely scattered to uncommon, but not rare; some cause for long-term concern due to declines or other factors; or stable over many decades and not threatened but of restricted distribution or other factors

5 - Secure (common): widespread and abundant

State Status - As per the 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

Ram's head lady's-slipper (*Cypripedium arietinum*) is the only plant that is considered globally uncommon (G3), with a limited distribution in the northern United States and southern Canada. Five of the 30 known Vermont populations of this orchid occur in Limestone Bluff Cedar-Pine Forests, while many of the remaining populations are in northern white cedar swamps. This species is listed as Threatened under Vermont's Endangered Species Law.

Wild comfrey (*Cynoglossum virginianum* var. *boreale*) is a very rare species in Vermont. Two of the three known populations occur in cedar bluff forests, one on Providence Island and the other at Cedar Mountain in Benson, a very important site that was not visited for this project.

Smooth draba (*Draba glabella*) is a very rare, state-threatened plant. Although only one of the state-significant cedar bluffs studied for this project includes this species, the other four populations in the state also occur in small openings in cedar bluffs on Lake Champlain Islands.

Golden corydalis (*Corydalis aurea*), a beautiful plant of mossy, calcareous rocks and boulders, is a rare, state-threatened species with only 12 known populations in Vermont. Six of these populations occur in cedar bluff forests.

Northern stickseed (*Hackelia deflexa* var. *americana*) is also a state-threatened species. Eight of the 19 statewide populations are associated with cedar bluff forests; some of these forests are small or degraded and were not visited for this project.

Yellow pimpernel (*Taenidia integerrima*) is a rare, state-threatened species. There are currently 11 populations of this species statewide, with nine of these associated with cedar bluff forests. Four of these sites are cedar bluff forests of state-significance.

There are several uncommon plant species that are closely associated with Limestone Bluff Cedar-Pine Forests. These include snowberry (*Symphoricarpos albus*), buffalo-berry (*Shepherdia canadensis*), fragrant sumac (*Rhus aromatica*), yellow oak (*Quercus muehlenbergii*), and climbing fumitory (*Adlumia fungosa*). Long-term conservation of multiple examples of cedar bluff forests will go a long way to conserving these uncommon species.

Exotic Plant Species

A total of 31 exotic plant species was observed at the 21 Limestone Bluff Cedar-Pine Forests that were visited during the inventory (Table 6). Of these 31, the following five species are included as Class B noxious weeds on the state's Noxious Weed List: common buckthorn, European bush honeysuckle, European buckthorn, oriental bittersweet, and garlic mustard. Inclusion on the list legally prohibits the sale and/or distribution of these species, which have all been documented to invade natural communities and displace native vegetation. In addition, the following five species are included on the Invasive Species Watch List: common barberry, Norway maple, Japanese barberry, autumn olive, and spotted knapweed. Inclusion on the watch list indicates species that may become invasive in Vermont or that may already be but are insufficiently documented to include on the Noxious Weed List. Most of the remaining species have either become naturalized or are mostly restricted to agricultural lands or disturbed habitats

Table 6. Exotic plant species observed at the 21 Limestone Bluff Cedar-Pine Forests. Species are ordered by their frequency percentage.

Nonnative Species		Site Name																			Frequency percentage		
Common name	Scientific name	Blue Ledge	Button Point	Camp Everest to Sandbar Bluffs	Coates Island	Eagle Mountain	Garden Island	Georgia Heights	Grosse Point	Highgate State Park	Kingsland Bay	Lone Rock Point	Mount Independence	Niquette Bay State Park	Providence Island	Red Rocks	Robinson Point	Summer Point	The Head	The Narrows		Thorp Brook Hills	Thujaland
common buckthorn	<i>Rhamnus cathartica</i>	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	90
European bush honeysuckle	<i>Lonicera morowii</i>	X	X	X	X		X			X	X	X	X		X	X	X	X	X		X		71
herb Robert	<i>Geranium robertianum</i>	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X		X	X	71
helleborine	<i>Epipactis helleborine</i>		X	X	X		X	X	X	X	X	X		X	X	X		X		X			62
Canadian bluegrass	<i>Poa compressa</i>	X	X			X	X		X	X			X	X	X	X	X			X			57
common barberry **	<i>Berberis vulgaris</i>		X	X	X	X	X	X				X	X	X	X	X					X		57
self-heal	<i>Prunella vulgaris</i>		X		X		X								X			X		X			29
common mullein	<i>Verbascum thapsus</i>							X					X		X	X						X	24
common nightshade	<i>Solanum dulcamera</i>			X	X		X							X				X					24
motherwort	<i>Leonurus cardiaca</i>			X			X		X						X								19
yellow toadflax	<i>Linaria vulgaris</i>				X		X									X							14
catnip	<i>Nepeta cataria</i>																		X			X	10
common dandelion	<i>Taraxacum officinale</i>										X								X				10
European buckthorn	<i>Rhamnus frangula</i>											X				X							10
Japanese barberry **	<i>Berberis thunbergii</i>												X					X					10
Norway maple **	<i>Acer platanoides</i>									X		X											10
timothy	<i>Phleum pratense</i>															X	X						10
autumn olive **	<i>Eleagnus umbellata</i>												X										5
black nightshade	<i>Solanum nigrum</i>																					X	5
celandine poppy	<i>Chelidonium majus</i>									X													5
common mouse-eared chickweed	<i>Cerastium fontanum</i>														X								5
common sow-thistle	<i>Sonchus oleraceus</i>																		X				5
garlic mustard	<i>Alliaria petiolata</i>		X																				5
Jerusalem artichoke	<i>Helianthus tuberosus</i>			X																			5
large-flowered yellow foxglove	<i>Digitalis grandiflora</i>														X								5
oriental bittersweet	<i>Celastrus orbiculatus</i>									X													5
ox-eye daisy	<i>Chrysanthemum leucanthemum</i>																			X			5
Scots pine	<i>Pinus sylvestris</i>											X											5
smooth brome	<i>Bromus inermis</i>																X						5
spotted knapweed **	<i>Centaurea maculosa</i>											X											5
wayfaring tree	<i>Viburnum lantana</i>								X														5
Number of nonnative species per site		4	8	8	8	4	7	7	3	8	4	9	8	5	11	10	5	6	7	3	4	5	
Number of noxious weed and watch list species		2	4	3	3	2	3	2	1	3	2	6	5	2	3	4	2	3	2	0	3	1	

Bold type indicates inclusion on the Vermont Noxious Weed List

** indicates inclusion on the Invasive Species Watch List

such as roadsides. Inclusion in this report, however, indicates that they do occasionally spread into natural communities.

No clear trend emerges in analyzing the number of exotic species occurring at each site. The site with the greatest number of exotics, Providence Island, may harbor more due in part to its larger size. But the island also has open fields and trails and the cedar bluff community is fragmented by homes, all of which serve to promote the spread of exotics. Typically, those cedar bluffs with the highest number of exotics tend to occur either as narrow fringes that are subject to invasion from adjacent areas, such as Button Point and Highgate State Park, or in more developed settings where exotics are more abundant, such as Lone Rock Point and Red Rocks. Conversely, larger and more isolated parcels, such as Blue Ledge, Eagle Mountain, Grosse Point, Kingsland Bay, and The Narrows tend to have fewer exotic species.

Perhaps more compelling is the number of species at each site that are included on the Vermont Noxious Weed List or Watch List. By looking only at this subset, the naturalized and less invasive species are removed from the mix, retaining only those exotics considered to be of major concern. The only cedar bluff with 6 of these noxious species is the urban Lone Rock Point where they are a serious problem, especially in areas of younger or more disturbed forest. Three other sites had four or five of these exotics: Red Rocks, Button Point, and Mount Independence, which occur in developed settings or as a narrow strip of forest. Conversely, the only cedar bluffs with no noxious weeds, The Narrows, or only a single species, Grosse Point and Thujaland, are all fairly isolated and are buffered from areas with a lot of development or disturbance. Seven sites have two noxious weed species, and most of these are rather isolated or at least well buffered by surrounding forested natural communities.

Of the 31 exotic species found in the cedar bluff communities, nearly half (14) occur only at a single site. Only seven species occur at approximately one-third or more of the sites. Four of these: herb Robert, helleborine, Canadian bluegrass, and self heal are considered to be naturalized and not invasive. The remaining three: common buckthorn, European bush honeysuckle, and common barberry are considered to be highly invasive or potentially so in the case of the barberry. Unfortunately, the buckthorn is present at 19 of the 21 sites and the honeysuckle at 15 sites. Both of these are highly invasive and have the potential to displace native species of trees, shrubs, and herbs by forming dense, impenetrable thickets where few other species can survive. This alteration of the structure and species composition has been shown to have detrimental effects on wildlife as well. At least one study documented an increase in nest predation of robin nests located in common buckthorn and European bush honeysuckle compared with nests situated in native shrubs (Schmidt and Whelan 1999).

It is recommended that owners and managers of any of these Limestone Bluff Cedar-Pine Forests sites be vigilant to places where common buckthorn and European bush honeysuckle are invading the community and attempt to control the infestation at an early stage before it becomes well established. Alternatively, where the infestation is already too advance for eradication, management practices can be adopted to prevent its further spread by not creating any large openings. Any naturally occurring openings should be monitored and any invasive exotics, especially buckthorn or honeysuckle, removed before they can spread into the opening.

Conclusions

Limestone Bluff Cedar-Pine Forest is a rare community type in Vermont. There are currently only 21 state-significant examples known, together occupying only 360 acres. Cedar bluff forests are highly threatened by development as they occur on low cliff tops with commanding views of Lake Champlain. These forests occur on limestone and dolomite bedrock and are therefore especially susceptible to invasion by exotic plants, especially common buckthorn and European bush honeysuckle.

Limestone Bluff Cedar-Pine Forests provide important general wildlife habitat in the highly developed and agricultural Champlain Valley. The cedar bluff forests and associated communities support many common species of birds and mammals, as well as several Species of Greatest Conservation Need. Five-line skink (very rare, state-endangered) and eastern ratsnake (rare, state-threatened) have both been identified in cedar bluff forests and associated communities. Many of the best remaining examples of cedar bluff forests are also part of some of the larger blocks of contiguous forest remaining along the Lake Champlain shoreline. These contiguous forest blocks, the included mix of natural communities and habitats, and the riparian and forested connections between blocks are of critical conservation concern for maintaining wildlife populations and functioning landscapes.

Limestone Bluff Cedar-Pine Forests harbor an unusually high concentration of rare, threatened, and endangered plant species, including Ram's head lady's-slipper that is globally uncommon to rare and state-threatened.

Recommendations for Conservation

The long-term conservation of Limestone Bluff Cedar-Pine Forests and their associated species of animals and plants will depend primarily on the continued good stewardship provided by many private landowners. By continuing to learn about the ecology, plants, and animals of their cedar bluffs, landowners can be better equipped to make land management decisions.

The burden for the successful conservation of Limestone Bluff Cedar-Pine Forests cannot be placed entirely on private landowners, however. As shoreline development pressures and shoreline property taxes both increase, it will become more difficult for many landowners to maintain the remaining unfragmented cedar bluff forests. Many properties will be sold and developed under these pressures and financial incentives that run counter to shoreline conservation.

Several high quality examples of Limestone Bluff Cedar-Pine Forest are already conserved as public land or with conservation easements on private land. These include all or part of Button Point, Eagle Mountain, Mount Independence, Highgate State Park, Kingsland Bay State Park, Niquette Bay State Park, Red Rock, Sandbar Wildlife Management Area, The Narrows, and Grosse Point. The following sites may be considered high priority for long-term conservation, if landowners are interested and willing.

A-Ranked Examples

The Head, Isle La Motte
Malletts Head, Colchester
Cedar Mountain, Benson (tentative rank)

B-Ranked Examples

Georgia Heights, Georgia
Thujaland, Milton
Providence Island, South Hero
Camp Everest to Sandbar Bluffs, Milton (private lands)

Along with Kingsland Bay State Park, Malletts Head and The Head are the top examples of Limestone Bluff Cedar Pine Forest in Vermont. They are large examples in good to excellent condition and in relatively intact landscapes. Cedar Mountain in Benson, was not visited for this project, but based on remote-sensed mapping and a short site visit in 1990, this also appears to be a top quality site. There are from 50 to 90 acres of cedar bluff forest set in a contiguous forest block of approximately 2,000 acres at this lakeshore site.

In comparing the relative significance of the B-ranked examples of Limestone Bluff Cedar-Pine Forest, it is important to review the associated community types and habitats, the associated rare species, and sizes of the contiguous forest blocks in which they occur (Table 4). Other factors, such as the number of landowners and the size of their parcels or the ease with which the area can be developed may influence prioritization for conservation action at these sites. The final decisions on what happens with these important natural areas clearly rests with the landowners.

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