Ecological Conservation Analysis of the Lewis Creek Watershed, Addison and Chittenden Counties, Vermont

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The Landscape and Ecosystems of the Watershed

The Lewis Creek watershed contains lands and waters within the Champlain Valley and Northern Green Mountains biophysical regions (Thompson and Sorenson 2000) (Figure 1). The biophysical regions, although adjacent, are characterized by different bedrock types, different topographic relief, and different climate. Thus, the natural and human-imposed patterns on the land are strikingly different in these juxtaposed landforms, and therefore conservation strategies will likely differ also.

In order to understand more about the landscape of the watershed, it is useful to develop a hierarchical classification. As Noss (Noss 1996) points out, “To be useful to conservationists, defined ecosystems must be discrete enough to be mapped. They must also be describable by adjectives denoting quality, such as, undammed, old-growth or ungrazed.” Naveh (1994) argues that the first step required for restraining the degradation and impoverishment of biodiversity is to develop and apply a comprehensive method for assessing the biodiversity on a landscape scale plus the relationship of species diversity to site (or natural community) diversity and heterogeneity. Toward those ends, we have 1) defined, classified and mapped landform-level ecosystems within the two biophysical regions (Map 1), 2) listed the predicted dominant natural communities within each ecosystem (Table 1), and 3) compiled a preliminary catalog and map of known rare and uncommon species (Table 2, Map 2).

In the landscape classification of the watershed, the biophysical regions are seen as the highest-level ecosystems, and within each there are various ecosystems at a lower level. We call the highest-level ecosystems “***major landforms***,” and thus the watershed is composed of a ***mountain landform*** and a ***broad valley landform***.

Within each major landform are numerous “***minor landforms***”; the minor landforms are classified and described on the basis of important ecological factors to which biota (plants, animals, microorganisms) respond. The following factors are those we utilized: bedrock type, surficial geologic deposit (based on ecological soils groups developed from our knowledge and county soil survey information (Griggs 1971, Allen 1989)), slope, aspect, elevation (which reliably depicts climatic variation), and physiography (landforms such as ridge, high flat, bottom of valley, and draw).

The purpose of delineating minor landforms on the basis of various combinations of physical characteristics was to describe the ecological variation, or heterogeneity, of the watershed. The same classification can be applied to any part of western Vermont, but different areas, based on the physical landscape, will require the addition or deletion of some minor landforms. The theory and system used to develop the classification are highly transferable to other landscapes and are in use in many places around the world.

Ecological Description and Context of the Lewis Creek Watershed

SUMMARY OF MINOR LANDFORM ECOLOGICAL CHARACTERISTICS

BROAD VALLEY OF LAKE CHAMPLAIN

Cheshire Quartzite Hills – Cheshire quartzite is an acidic (non-calcareous), erosion-resistant bedrock that occurs at the westernmost edge of the Green Mountains. It is the rock of the steep, western mountain escarpment where the terrain is extremely rugged. This landform is usually very strongly dominated by forest, and both road and building construction are minimal. The natural communities that predominate are a mix of those that show some warm-climate influence (due to the valley and the western slope locations) – mesic red oak-northern hardwood forest and white pine-red oak forest – and those that are more characteristic of our mountain forests – northern hardwood and hemlock-northern hardwood forest. Acidic cliff and outcrop natural communities are common on this landform. Cheshire Quartzite Hills feature the largest blocks of forest in the valley. Hogback Mountain and the hill terrain west of Bristol Pond that is also called Hogback represent the bulk of the landform.

Dolomite Hills – A special feature of the Champlain Valley is its calcium-rich, or calcareous, bedrock types; these are limestone, dolomite, and marble. Dunham and Winooski dolomites are the predominant calcareous rocks in the watershed. Mountain-building processes (orogenies) and geologic faulting caused formation of the dolomite hills, which are scattered throughout the generally more undulating valley-floor terrain. Soils on the hills tend to be shallow to extremely shallow, and thus they are not productive for agriculture. Most of the dolomite hill terrain, however, was cleared of forest and used as pasture for sheep and cattle. After the sheep boom of the 1850s, forest was allowed to reclaim many hills. The topography of the hills is generally smooth, although areas of exposed ledge are very frequent. Natural community types on these hills all reflect the abundance of calcium and other nutrients in the soil. Transition hardwood limestone forest appears to be the most widespread natural community on the rich hills, while dry oak-hickory-hophornbeam forest occurs on moisture limited areas such as steeper slopes and shallow soil hilltops. Other, less extensive, calcareous outcrop and cliff natural communities also occur on the hills. Forest patches on the hills tend to be “heavily worked” and degraded; and they are usually small, somewhat isolated, and are often infested with invasive exotic shrubs.

Dolomite Valley – Like the dolomite hills, the dolomite valley is a landform that typifies the Champlain Valley. This valley landform on calcium-rich bedrock, however, tends to have a deep soil and thus tends to be good agricultural land. The dolomite valley is, therefore, largely deforested. Forest patches are probably restricted to wet or rocky parts of the landscape, and agricultural and residential land-uses predominate. Wetland complexes are a substantial component of the dolomite valley natural-community mosaic. Aside from the wetlands, there has been very little ecological inventory or research conducted in the dolomite valley, and less is known about the upland natural communities of the valley-floor terrain than perhaps any of the other minor landforms. Although they are likely similar to natural communities on the dolomite hills, there are bound to be differences due to deeper soils and greater available moisture. Exotic species tend to be prevalent in these forest patches, many of which succeeded from or, at the least, are surrounded by, agricultural fields. Numerous small and medium streams flow through the valley floor, and conservation in the landform is important for providing riparian corridors as well as for protecting water quality.

Monkton Quartzite Hills – The Monkton quartzite, or redstone, of the Champlain Valley is strikingly beautiful and renowned as a building stone. It is a somewhat-calcium-rich bedrock and thus has ecological similarities with the dolomite hills. The natural communities include a mix of those that show calcium-enrichment – transition hardwood limestone and dry oak-hickory-hophornbeam forest – and those that do not – mesic red oak-northern hardwood and hemlock-northern hardwood forest. Although much of this landform supports forest patches, there is a substantial amount of cleared land and relatively high housing density in the Monkton Pond area. The Monkton quartzite hills potentially have an important role for maintaining both forest cover and connectivity in the valley. Small-patch natural communities, particularly outcrop types and vernal pools, are scattered throughout the landform.

Lacustrine Plain – Now commonly referred to as the clay plain, the lacustrine plain is that portion of the valley that is mantled in deep clay or sand-over-clay deposits from post-glacial Lake Vermont and the Champlain Sea. The Lewis Creek watershed has a relatively small proportion of clay plain. Adjacent areas near Lake Champlain that are drained by smaller streams or Little Otter Creek have more clay plain and should perhaps be seen as part of the watershed for conservation planning purposes. Valley clayplain forest is the predominant natural community of the lacustrine plain; lakeside and riverine floodplain forest occupies the area at the mouth of the creek. Agriculture reigns dominant on the clay soils and clayplain forest patches in the watershed proper are very small and degraded.

WESTERN GREEN MOUNTAINS

Ablation Till Flats, deep soil – The Green Mountains have two general soils types, those derived from materials that were somewhat washed as the glaciers melted and those derived from materials laid down beneath the glaciers. Ablation till is the former type of material, while basal till is the latter. Deep-soil, ablation-till flats and gentle slopes are prime northern hardwood forestlands. Growing conditions are good, and stresses on plants are likely fewer than on most other mountain landforms. Seepage zones likely support rich northern hardwood forest, and hemlock-northern hardwood forest may occur in small to medium-sized patches. Although forest is by far the predominant land cover, this landform provides some of the most arable soils in the mountains, and most of the fields that have been maintained tend to be on deep-soil, ablation-till flats or on the hollows landforms.

Ablation Till Flats, shallow soil – Knolls are frequently areas of very rocky and shallow-soils. Such places are characterized by less moisture (and perhaps nutrient) availability than the deeper-soil flat to moderately sloping terrain. In these areas, red spruce tends to occur with northern hardwood species, with paper birch, or occasionally in purer stands. This landform occurs in small to medium, scattered patches.

Basal Till Flats – The basal-till lands have soils that are substantially moister and less well drained than the ablation-till lands. Some of this area is forest or shrub swamp and some of it is moist or very moist northern hardwood or red spruce-hardwood forest. Seepage areas and other areas with mineral enrichment but not overly wet soils are likely to be sugar maple-white ash-jack in the pulpit northern hardwood forest.

Hollows – Stream-valleys and large concavities in the landscape have different climate and moisture regimes than do the general terrain. In addition to a variety of northern hardwood forest types, hollows contain shrub, forest, and graminoid wetlands. Little is known about the ecological diversity of this landform, but the lands likely have greater importance for water-quality protection and also likely support high species diversity. Roads tend to have been constructed in the hollows, and thus houses and farmsteads also. These lands are largely deforested and are mountain areas where people have tended to maintain agricultural fields.

Steep North- and East-facing Slopes – Steep north and east mountain slopes generally have a cooler, moister climate and more persistent snow mass than the other parts of the landscape. Hence they are very unlikely to contain any "warm-climate" species or natural communities. Hemlock and red spruce are often common partners with the northern hardwood species. Since the steepness of the terrain usually precludes construction projects and use as productive agricultural fields, the lands are heavily forested.

Steep South- and West-facing Slopes – These slopes are usually strikingly different from the other mountain landforms, in part because they have higher temperatures and greater moisture stress and in part because the western Green Mountains feature some exceptionally steep western slopes. Natural communities of the landform are characterized by species that respond well to the warmth and are able to withstand great moisture stress – hemlock, pine and red oak, among the trees. Red oak-northern hardwood forest, white pine-northern hardwood forest, and red pine forest or woodland are among the forest natural communities found on these slopes. Temperate acidic outcrop and cliff natural communities are also common. Forest, with lesser areas of outcrop, cliff, and talus, is the dominant land cover.

LANDSCAPE COMPARISON BY BEDROCK-TYPE

Comparison of some of the watershed's physical characteristics with those of entire biophysical regions and the entire state is useful for understanding what is special, common, different, or well represented within the watershed, in contrast to the larger landscape areas. Percent of area by bedrock type is a relatively quick and easy way to make comparisons based on an available and ecologically meaningful factor (Table 3). Comparison of bedrock types in the valley portion of the watershed versus the entire Champlain Valley biophysical region shows that the watershed has relatively high percentage of carbonate-rich bedrock and quartzites, both calcareous and non-calcareous, and a relatively low percentage of somewhat-carbonate rich rocks (shales). The mountain landform in comparison with the Northern Green Mountain biophysical region shows a higher percentage of non-calcareous slate/greywacke/conglomerate rocks and a smaller proportion of schist/phyllite types. Separating the Pinnacle formation (schistose greywacke) and the Underhill formation (schist) into two different "ecological" bedrock groups, however, may not be appropriate from the perspectives of differences in species, natural communities, or ecological processes.

Forest-cover Analysis

The ecological classification and map depict the natural landscape, yet they offer no information on the condition of the ecosystems or natural communities on the landscape. A land-cover map, such as that prepared by the UVM Spatial Analysis Laboratory, is an excellent tool for characterizing the patterns on the human-modified landscape. To gain a more powerful conservation analysis from the land-cover data, we compared and contrasted the forest cover of the two major landforms and the eleven minor landforms (Table 4, Map 3). Forest cover in the valley portion of the watershed (50%) is greater than the forest cover percent of the entire southern Champlain Valley (33%) (Lapin 2003). Furthermore, even the agriculturally productive minor landforms (lacustrine plain and dolomite valley), which have had the largest amount of forest cleared, retain a much greater proportion of forest (28% and 31%, respectively) than the lacustrine plain of the entire southern Champlain Valley, which Lapin found to be only 12% forested. The valley portion of the Lewis Creek watershed thus has greater forest cover than the average for the entire southern Champlain Valley, and it also is likely to feature larger forest patches and greater clustering and connectivity; the abundance of forest is clearly due in part to the high proportions of Cheshire and Monkton quartzite hills in the watershed. The forest-cover analysis indicates rather good potential for nature conservation in the watershed's valley landscape as a whole, and in each of the minor landforms.

All mountain landforms, except for hollows, are heavily forested. Overall, forest covers 90% of the mountain landscape. The figures are likely comparable with other portions of the Green Mountains.

Forest-cover analysis can be based simply on the proportions of the landscape in the different cover classes, or one can go further and describe the patterns of the classes. Fragstats (McGarigal et al. 2002) is a very useful spatial analysis program that describes patch structure on the landscape that can generate information on patch sizes, patch shape complexity, core areas, isolation, and patch type diversity. Fragmentation analysis has not been conducted as part of this phase of the work, but would be a useful tool to aid in systematic prioritization of forest patches.

Aquatic Ecosystems

Lewis Creek appears to be one of the most significant streams in Vermont based on classification work accomplished by the Aquatic Classification Workgroup (Langdon et al. 1998). The creek is probably the most frequently cited "best example" of stream/aquatic community types based on macroinvertebrate and fish assemblages (Langdon et al. 1998), and it requires a conservation strategy that differs from but is coordinated with upland and wetland conservation. The same is true for the ponds. Cohesive conservation will to some degree require coordinating terrestrial conservation actions with conservation of priority stream reaches.

Conservation Goals

> *"Thus, trying to incorporate the concepts of landscape heterogeneity into conservation programs requires setting specific conservation objectives and then determining the landscape pattern to aim for...Where the objective is to manage landscapes or regions to retain biotic diversity, the retention of as many areas as*

> *possible of each of the ecological types present in the region is essential." (Arnold 1995 p. 331)*

Even with the ecological framework and the human footprint described for a landscape, it is not easy to prioritize conservation focus. Fragmentation of the watershed's ecosystems, however, is a major landscape-level conservation concern. Ecosystems "cannot be expected to retain their ecological identity as the land around them is subject to ever-intensified human use" (Friesen et al. 1995), for the biota and processes behave in new and different ways as the landscape is fragmented into smaller and smaller pieces. As Arnold indicates in the above quote, setting specific conservation objectives is a fundamental step. Because the valley and mountain landforms have such different land-use histories and current patterns, the objectives for these two areas should be separately detailed.

We have identified three basic conservation goals that are widely accepted as worthwhile approaches to conservation:

- Representative, proportional ecosystem conservation,
- Conservation of rare and unique species and communities, and
- Cohesiveness at the landscape level.

The three goals are not mutually exclusive and could all be acted upon simultaneously, yet site-specific priorities might differ significantly depending upon which goal was seen as most important. Furthermore, the third goal or approach is a much more elusive and less well-defined one than the former two. Although it is, of course, highly desirable to develop a cohesive network, such cohesion is difficult to define, particularly in a fragmented landscape, like the valley portion of the Lewis Creek Watershed.

The perception of a cohesive, connected landscape or conservation system will differ depending upon the species or process under consideration, for "[e]ach species views landscape differently, and what appears as homogeneous patch to one species may comprise a very heterogeneous patchy environment to another" *(Risser et al. 1984 cited in (Risser 1987).* Although each species and process does have unique ecological requirements, there are some well-founded general guidelines that appear to satisfy the needs of most forest species and meet general objectives of cohesion.

The following four general statements can lay the foundation for developing a comprehensive conservation network:

- Larger areas of natural vegetation are preferred over smaller areas,
- Clusters of natural vegetation patches are preferred over isolated patches,
- Connections between patches enhance interchange of individuals and genes, and
- Riparian corridors are used by many animal species.

The guidelines for cohesion, applied in conjunction with guidelines for meeting conservation goals of a representative and proportional mix of ecosystems and conservation of rare/unique elements, can be used to develop a comprehensive conservation plan. Without striving to meet such guidelines, conservation lands will at best be developed into an *ad hoc* network, and at worst will be scattered isolates.

Threats to Conservation by Minor Landform

BROAD VALLEY OF LAKE CHAMPLAIN

Cheshire Quartzite Hills – Because these hills are very non-productive for agriculture and are generally not conducive to construction, threat of conversion to uses other than forestry, and therefore threat of fragmentation, is relatively low. Although the current status of forest management and forestry operations has not been evaluated, and because the principal human activity on this landform is logging, the major conservation threat to Cheshire Quartzite Hills is unsustainable forestry practices.

Dolomite Hills – Dolomite hills are well suited to construction of houses and roads and are more and more becoming favored for house sites because they often afford beautiful views as well as proximity to wooded lands. Residential development and further fragmentation of the already fragmented forest are serious threats to dolomite hills natural communities. Existing populations of invasive exotic shrubs and the high potential for additional infestations is also a threat; invasive exotic plant species tend to populate calcium-rich areas more rapidly and to a greater extent than other upland areas.

Dolomite Valley – Dolomite valley is premier farmland with a abundance of prime and statewide agricultural soils. The landform supports a fairly high density of residences. Patches of "nature" are thus limited and there is a relatively high threat of further degradation. Residential development and further fragmentation of the already fragmented native forest are threats to the natural communities of the dolomite valley.

Monkton Quartzite Hills – Forest fragmentation is a major threat on the Monkton quartzite hills. As with the dolomite hills, these lands are increasingly favored for house sites. The Monkton quartzite hills tend to be larger than the dolomite hills, and consequently forest patches are larger also. Further fragmentation of the larger forest patches, which may be some of the most intact upland forest areas in the valley, aside from forest on the rugged Cheshire quartzite hills, is likely to decrease habitat for area-sensitive organisms that require larger forest patches for high-quality habitat. As with the dolomite landforms, exotic species infestations are also a threat.

Lacustrine Plain – Since nearly all of the landform in the watershed has been converted to agriculture, the greatest threat in the landform may be in riparian areas. Therefore, conservation importance for the lacustrine plain may primarily lie in continuing to protect, and to redevelop forested buffer protection in, riparian areas. There is also threat of residential development and, perhaps, agricultural field expansion in the few clayplain forest patches within the watershed. Management of the Little Otter Wildlife Management Area, where a variety of upland and wetland natural community types are protected from development, has great potential for natural community conservation at the mouth of the creek.

WESTERN GREEN MOUNTAINS

Ablation Till Flats, deep soil – Among the mountain landforms, these areas are likely the most conducive to construction, and thus may be more prone to future forest fragmentation. Thus, the landform would appear to have the greatest threat of human development and forest fragmentation.

Ablation Till Flats, shallow soil – Due to the limitations of shallow soils, these lands are less suited to residential construction than are the deep-soil flats. The greatest conservation threats may therefore be those related to road construction and logging – fragmentation by roads, severe erosion of the soil,.

Basal Till Flats – Since these lands are limited for residential development and agricultural activity due to drainage constraints, conservation threats to the basal till flats are likely similar to those for shallow-soil ablation-till flats – fragmentation by roads and unsustainable forestry practices. Degradation of the many wetlands in the basal till landform may also be of concern, although legal wetlands protection mechanisms do exist.

Hollows – Threats of further forest fragmentation and erosion are relatively high in the hollows landform, since these are lands where road construction (and thus house-sites near to roads) tends to be concentrated. Impacts to wetlands and aquatic ecosystems related to development activities are potentially high in the hollows.

Steep North- and East-facing Slopes – Threats on steep-terrain landforms, as with the shallow-soil areas are likely related to logging and to a lesser extent to road construction. Unsustainable forestry practices and the potential for severe soil erosion of conservation concern.

Steep South- and West-facing Slopes – The steepness and extreme ruggedness of the terrain preclude most construction projects, and the logging potential is lesser on these slopes due to both access difficulty and lower tree productivity. Conservation threats, as with other steep mountain slopes, are related to forestry practices.

Conservation Prioritization

Prioritizing to meet a goal of a <u>cohesive conservation system</u> should be based on:

- Amount of conservation lands within some defined geographic area,
- Size of patch of natural vegetation,
- Isolation of patch from other patches of natural vegetation,
- Condition of (e.g., naturalness, ecological integrity) ecosystems,
- Presence or probability of connections to other large patches, and
- Vulnerability/threat of near-future degradation of ecosystem type.

Prioritizing to meet a goal of <u>representative/proportional ecosystem conservation</u> should be based on the following parameters:

- Proportion of ecosystem presently “secure” as conservation lands,
- Vulnerability/threat of near-future further degradation of ecosystem type,
- Size, isolation and condition of ecosystem, and
- Ability to conserve high-quality examples in the near-future.

Prioritizing to meet a goal of <u>conservation of rare/unique species/ecosystems</u> should be based on:

- Proportion of occurrences presently “secure” within conservation lands,
- Vulnerability/threat of near-future degradation of habitat or ecosystem,
- Regional conservation status (e.g., rare or uncommon regionally), and
- Population size or ecosystem condition.

Some of the parameters, such as size, isolation, proportion presently conserved, can be quantitatively rated quite easily, whereas others, such as condition and vulnerability/threat, must be rated in a more subjective fashion.

Condition should be evaluated on the ground by an experienced conservation professional, but a preliminary assessment could possibly be accomplished by trained community citizens, with the help of a standardized reporting form.

Rating vulnerability/threat of one type of ecosystem compared to another is not easily accomplished and is probably best achieved by a combination of quantitative measures of human population and development trends, land capability classes, and expert knowledge (see, for example, (Noss et al. 2002). We propose that population growth rates, road density, and NRCS land capability classes be utilized to quantify vulnerability/threat and that the quantified ratings be reviewed by local citizens and natural resource/planning professionals, who can propose modifications as they deem appropriate.

The Lewis Creek Association can outline a multi-pronged approach to help guide conservation action in the watershed by the striving to achieve the above three goals and by applying the various ratings in order to plan and prioritize actions. Although Champlain Valley (because of the condition of the landscape, the relative lack of conservation lands, and the generally greater vulnerability to further degradation) may receive higher priority scores than the mountain lands, it may be desirable to assess the two major landforms separately, so that conservation planning and action continues in both parts of the watershed.

The work that can be accomplished in the mountain area differs from what can be done in much of the valley, although the Cheshire Quartzite Hills may offer opportunities more similar to those in the mountain landform. In general, in the valley one might aim for protection of some of the larger and more intact forest fragments, improvement of degraded fragments, buffering of ‘important’ fragments by creation of ‘softer’ edge, and restoration of connectivity. In the mountain, on the other hand, one might aim for conservation of relatively large and diverse areas of natural vegetation and maintenance of connections.

Based on the preliminary analysis of threats presented above, the following conservation priorities at the minor landform level are suggested for the Lewis Creek Watershed:

- Valley
  - Dolomite Hills
  - Dolomite Valley
  - Monkton Quartzite Hills

- Mountain
  - Ablation-till flats
  - Hollows

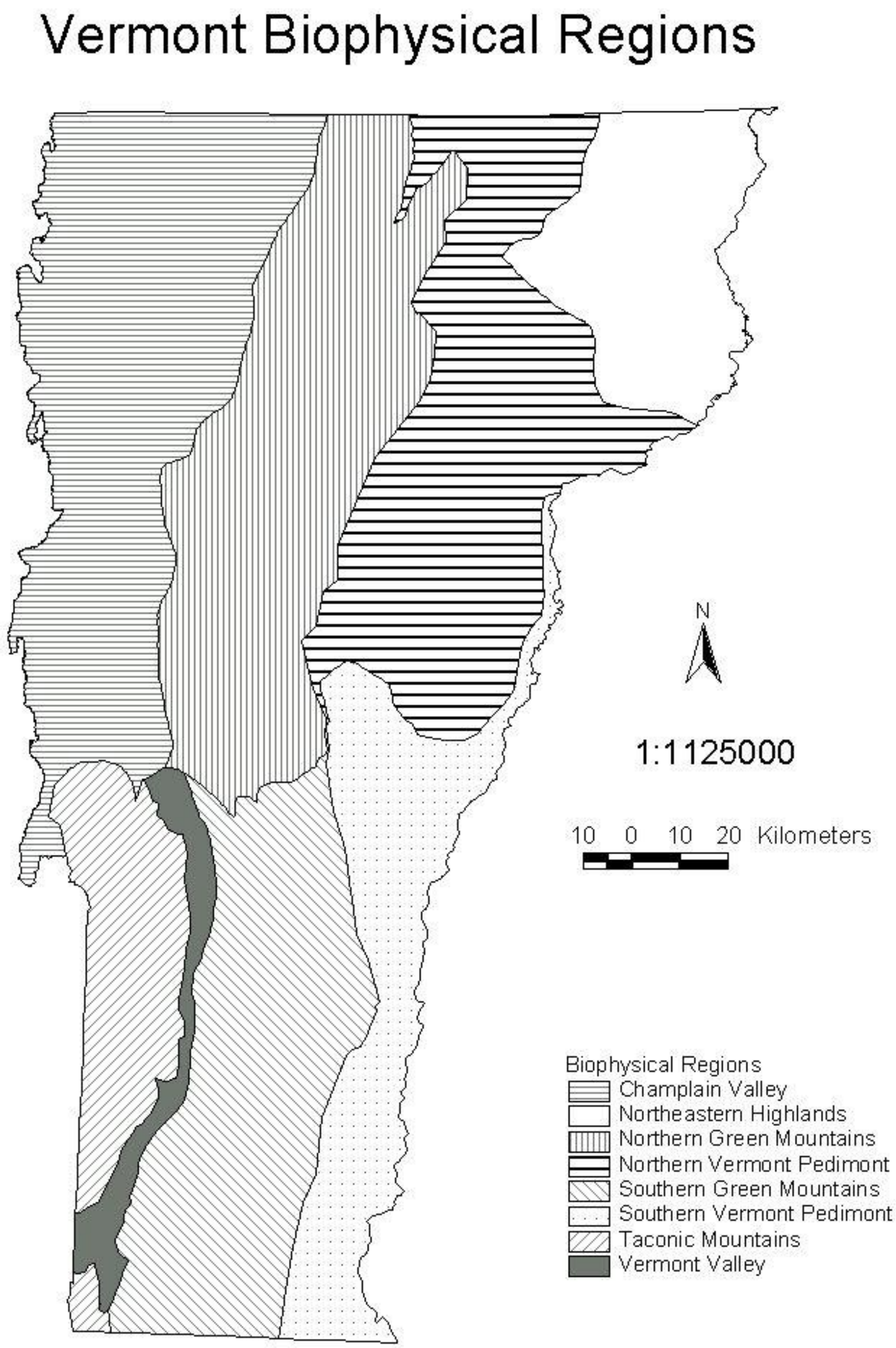

Figure 1. Biophysical Regions of Vermont.

Table 1. Lewis Creek Watershed Landform-Level Ecosystem Classification

Indentations refer to the following levels of ecological hierarchy:
Major Landform
- *Minor Landform*
  - *Predicted Dominant Natural Communities (names generally follow (Thompson and Sorenson 2000)*

Broad Valley of Lake Champlain
- Cheshire Quartzite (non-calcareous) Hills
  - Mesic Red Oak-Northern Hardwood Forest
  - Northern Hardwood Forest
  - Hemlock-Northern Hardwood Forest
  - White Pine-Red Oak-Black Oak Forest (*Black oak not present*)
- Dolomite Hills
  - Transition Hardwood Limestone Forest
  - Dry Oak-Hickory-Hophornbeam Forest
  - Mesic Maple-Ash-Hickory-Oak Forest
- Dolomite Valley
  - Transition Hardwood Limestone Forest
  - Mesic Maple-Ash-Hickory-Oak Forest
  - Rich Northern Hardwood Forest
  - Wetland Complexes including Red Maple-Northern White Cedar Swamp, Northern White Cedar Swamp, Poor/Intermediate Fen Complex, and Shallow Emergent Marsh ("beaver wetlands")
- Lacustrine Plain
  - Valley Clayplain Forest
  - Floodplain Forest
- Monkton Quartzite (somewhat calcareous) Hills
  - Mesic Red Oak-Northern Hardwood Forest
  - Transition Hardwood Limestone Forest
  - Mesic Maple-Ash-Hickory-Oak Forest
  - Hemlock-Northern Hardwood Forest
  - Dry Oak-Hickory-Hophornbeam Forest

Western Green Mountains
- Ablation Till Flats to Moderate Slopes, Deep Soil
  - Northern Hardwood Forest
  - Hemlock-Northern Hardwood Forest
  - Rich Northern Hardwood Forest

Table 1. (Continued)

Ablation Till Flats to Moderate Slopes, Shallow Soil
- Red Spruce-Northern Hardwood (Ledge) Forest
- Hemlock-Northern Hardwood Forest
- Northern Hardwood Forest

Basal Till Flats to Moderate Slopes
- Red Spruce-Northern Hardwood (Wet-Mesic) Forest
- Northern Hardwood Forest
- Sugar Maple-White Ash-Jack in the pulpit Northern Hardwood Forest
- Red Spruce-Hardwood Swamp

Hollows (Deep Mountain Valleys)
- Northern Hardwood Forest
- Sugar Maple-White Ash-Jack in the pulpit Northern Hardwood Forest
- Northern Hardwood Seepage Forest
- Shrub Swamp
- Shallow Emergent Marsh (“beaver wetlands”)

Steep North- and East-facing Slopes
- Hemlock-Northern Hardwood Forest
- Red Spruce-Northern Hardwood Forest
- Northern Hardwood Forest
- Rich Northern Hardwood Forest

Steep South- and West-facing Slopes
- Mesic Red Oak-Northern Hardwood Forest
- White Pine-Northern Hardwood Forest
- Hemlock-Northern Hardwood Forest
- Hemlock Forest