The Soils of Vermont and their associated Natural Communities

based on the book, *Wetland, Woodland, Wildland – A Guide to the Natural Communities of Vermont,* by Elizabeth H. Thompson and Eric R. Sorenson

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The purpose of this report is to provide information on the soils in Vermont in relation to their associated natural community types, as identified and described in the book, ***Wetland, Woodland, Wildland – A Guide to the Natural Communities of Vermont***, by Elizabeth H. Thompson and Eric R. Sorenson (Thompson and Sorenson, 2000). It provides a link between the soil series mapped in the state by the USDA Natural Resources Conservation Service (NRCS) and natural communities. It also provides a list of characteristic trees, species that are abundant or occasional to locally abundant in the canopy layer, associated with each soil series, based on those identified with each natural community in the book.

This report is a supplement to the *Woodland Management and Productivity* tables found in Vermont soil survey reports. Foresters can use this information in managing woodlands more effectively. Botanists, naturalists, conservationists, landowners, planners and others can use the information to gain a better understanding of the natural landscape and use it as a tool in conservation and land use planning efforts. *This report should be considered a work-in-progress. Comments and suggestions for refinements are solicited and welcomed, especially on the basis of further field-testing.*

While the names of Vermont's natural communities are based on the dominant trees in the canopy, each natural community reflects "an interacting assemblage of organisms, their physical environment, and the natural processes that affect them." (Thompson and Sorenson, p 2.) Although general soil conditions are described as part of the "physical environment" in the narratives of the different natural communities, the book does not specifically mention any of Vermont's 175 or so soil series by name. NRCS has primary responsibility for classifying and mapping the soils in Vermont, along with providing general information on the behavior of the soils for various uses. With the full support and cooperation of the authors of ***Wetland, Woodland, Wildland***, this report provides more specific information on how the natural communities of Vermont are related to its soil series.

What is a soil series?
A soil series consists of soils that have a similar sequence of horizons, or layers, that are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. Each soil series has a defined range in characteristics that differentiates it from other soil series. Along with the range in characteristics, each soil series has a specific climatic setting, parent material, and topographic position, and is commonly associated with other specific soils on the landscape. The Official State Soil of Vermont is the Tunbridge soil series. It is a loamy, acidic soil formed in glacial till, and has non-calcareous bedrock between a depth of 20 and 40 inches below the surface. NRCS maintains a database of official descriptions for all the soil series currently established. For more information on the Official Series Descriptions (OSD) for the soils in Vermont, refer to the NRCS website: http://soils.usda.gov/technical/classification/osd/index.html.

To get information on a specific soil series, enter the soil series name using the "View OSD by Series Name" function. See Appendix 1 for a list of the soil series currently recognized in Vermont and their taxonomic classification. A brief description of the USDA soil taxonomic system is in the Glossary.

Factors affecting soil formation and their distribution

Soils form through the interaction of five major factors: climate, parent material, relief, vegetation and biological activity, and time (Jenny, 1941). The relative influence of each of the factors determines the kind of soil in an area. If all the factors are the same from place to place, then the soils in those places will be the same. If any of the factors are different, then the soil will be different. For example, many of the soil series found in Vermont can be found in other northern New England states and upstate New York, but none of them are found in Florida or Arizona.

Climate

Temperature and precipitation vary considerably within the state and are closely related to elevation. Three soil temperature regimes, or zones, are recognized in Vermont: *mesic*, *frigid* and *cryic*, based on criteria set forth in Soil Taxonomy (Soil Survey Staff, 1999). The *mesic* soil temperature zone includes warmer, lower elevation areas such as the Champlain Valley and Vermont Valley biophysical regions and the Connecticut River Valley in the Southern Vermont Piedmont biophysical region. The extensive area included in the *frigid* soil temperature zone covers almost all of the remaining biophysical regions of the state below elevations of about 2500 feet. Climate changes gradually as one moves higher in elevation. The *cryic* soil temperature zone is located on the upper slopes and summits of the Green Mountains, Taconic Mountains, and the Northeast Highlands at elevations above about 2500 feet. Each soil series is assigned to only one soil temperature regime - even if they shared many physical characteristics, a soil series mapped in the Champlain Valley would not be mapped on top of Mount Mansfield because of the difference in soil temperature regimes.

Annual precipitation varies from about 32 inches in some parts of the Champlain Valley to over 70 inches in the upper elevations of the Green Mountains.

Parent Material

The soils in Vermont formed in several kinds of parent material. Many of the soils formed in glacial till, but others formed in alluvium, glacial outwash, lacustrine sediments, and thick organic deposits. Grouping soils by type of parent material and natural soil drainage class provides a convenient method of understanding soil-landscape relationships. For example, Marlow, Peru, and Cabot soils formed in similar parent material, but Marlow soils are on higher or steeper positions, Peru soils are on intermediate positions, and Cabot soils are on lower-lying footslopes and in depressions. The Key to the Soil Series of Vermont (see appendix 2) portrays the relationship between the soils and their parent material and natural soil drainage class. A brief description of the seven natural soil drainage classes is in the Glossary.

Relief

Relief, or the topographic position of a soil on the landscape, along with soil permeability, affects the movement of water in the soil. Soils on steep slopes have a rapid runoff rate and are generally well drained. Soils in depressions have a slow runoff rate, accumulate water from upslope areas, and are typically poorly drained, being saturated and anaerobic for long periods. Soil erosion rates are also affected by relief, with steeper areas being much more susceptible to significant soil loss from water erosion.

Biological Activity
Biological activity, such as vegetation, microorganisms in the soil, and animals and humans, is an important soil forming factor. While changes in soil characteristics can change the type of natural community, likewise, changes in natural communities can affect soil formation and characteristics. Consider, for example, how a soil formed under a tall-grass prairie would differ from a soil formed under a spruce-fir forest.

Time
Soil formation is affected by the length of time other factors such as climate and biological activity have had to alter the parent material. In most places in Vermont, the age of the parent material is about the same. The exception is recently deposited sediment on flood plains - alluvial soils, such as the Hadley, Winooski, and Limerick soils, are younger and show less development than other soils on uplands.

The Soils of Vermont and their associated Natural Communities

Appendix 3 lists the soil series of Vermont and their associated natural communities. Up to 8 natural communities are listed for each soil series. A total of 62 natural communities and their variants are linked to soil series in this report. Natural communities were assigned to soil series based primarily on the following factors:

- soil temperature class
- soil drainage class
- depth to bedrock and type of bedrock for soils less than 60 inches to bedrock
- soil textural class
- parent material
- other soil characteristics such as pH range and presence of a spodic horizon
- observations made in the field during NRCS soil mapping activities throughout the state
- and consultation with other ecologists, foresters, and soil scientists.

The NRCS Soil Resource Specialist also served on a workgroup that assisted the ***Wetland, Woodland, Wildland*** authors in detailing the physical setting for each natural community.

Soil series may be associated with more than one natural community for several reasons. One reason is that the range in characteristics of the soil series may be sufficiently broad as to include several natural community types. Past land use history may also account for variations in natural communities in different areas of the same soil series. Site-specific factors like aspect can also affect the natural community present at a given location.

As a cross-reference, Appendix 4 lists Vermont natural communities and the soil series that are associated with them. It also lists the characteristic tree species associated with each natural community.

Appendix 5 lists the Vermont natural communities that are not currently linked to a soil series. Some natural communities are not linked to specific soil series because of either their small size or because of their rarity. Examples of small natural communities not linked to particular soil series include “Seeps” and “Vernal Pools.” While these communities are quite common, they are generally too small in size to be linked to a soil series that can be mapped as a unique soil delineation at the scale of NRCS soil mapping. The scale used for soil mapping by NRCS in Vermont is approximately 1:20,000. (The soil maps in some counties may have a slightly different scale.) At 1:20,000 scale, the minimum size of a soil delineation is about three acres. The soil series

in a half-acre vernal pool would be too small to map. It is possible, however, that vernal pools and other small wet areas may be distinguished by a "wet spot" symbol on the soil maps.

Examples of rare natural communities not linked to specific soil series include "Red Maple-Black Gum Swamp," "Serpentine Outcrop," and "Alpine Peatland."

Other natural communities are not linked to soil series because they have been mapped as a "miscellaneous area" on the soil maps. Miscellaneous areas mapped in various counties include Alluvial land, Beaches, Beach and dune sand, Blown-out land, Cobbly alluvial land, Fresh water marsh, Marsh, Riverwash, and Rock Land. Natural communities are not linked to specific miscellaneous areas in this report.

Limitations of this Guide based on soil mapping in specific counties
As mentioned above, the scale of the soil maps limit the practicality of mapping soils associated with natural communities that are generally small in size. Other limitations to this guide are more county-specific.

In **Addison County**, the soil mapping was conducted between 1941 and 1964. The soil survey has some of the oldest mapping in the state. The following limitations are recognized:

- *Muck and Peat* are mapped in the large swamps of Addison county. Soil series are not identified. Natural communities in these areas are not linked to any soil series in the county.
- *Rock Land* is mapped extensively in the Green Mountains, rather than specific soil series. Talus slopes, outcrops, cliffs, and other mountain landforms and communities are not linked to any soil series in the county.
- There is no delineation or distinction of areas in the cryic soil temperature zone above approximately 2500 feet elevation in the county. Because of this, high elevation natural communities are not associated with any soil series in the county. These areas are included with soil series mapped in the frigid soil temperature zone below 2500 feet.
- The natural soil drainage classes of soil series mapped in the clayey glaciolacustrine areas of Addison county are somewhat generalized in the soil survey. Newer soil surveys, such as Rutland County, make more distinct separations of the natural soil drainage classes of clayey soil series.
- There is no distinction or delineation of soils formed over limestone bedrock in the frigid soil temperature zone. Because of this, boreal calcareous natural communities have been included with the mesic Farmington and Farmington Variant soils.

In **Bennington County**, there is no distinction or delineation of soils formed over limestone bedrock in the frigid soil temperature zone. Because of this, boreal calcareous natural communities have been included with the mesic Farmington and Galway soils.

The soil mapping in **Caledonia and Essex Counties** is currently on-going. Consult the soils staff at the St. Johnsbury Field Office for specific information about the soil surveys of those counties.

In **Chittenden County**, the soil mapping was conducted between 1940 and 1967. Like other soil surveys in the Champlain Valley, the soil survey has some of the oldest mapping in the state. The following limitations are recognized:

- The map units of *Adams and Windsor loamy sands* covers a broad range of natural communities. Adams and Windsor soils are mapped together in the county, even though the

Windsor soils are in the mesic soil temperature zone and Adams soils are in the frigid soil temperature zone. Windsor soils are at lower elevations near Lake Champlain and favor natural communities that thrive on dry, warm soils. Adams soils are at higher elevations in eastern Chittenden County and favor natural communities that prefer cooler sites.

- *Muck and Peat* are mapped in the swamps with organic soils. Soil series are not identified. Natural communities in these areas are not linked to a soil series in the county.
- *Rock Land* is mapped extensively in the Green Mountains rather than specific soil series. Talus slopes, outcrops, cliffs and other mountain landforms and communities are not linked to any soil series in the county.
- There is no delineation or distinction of areas in the cryic soil temperature zone above approximately 2500 feet elevation in the county, even on Mount Mansfield and Camel's Hump. Because of this, high elevation natural communities are not associated with any soil series in the county. These areas are included with soil series mapped in the frigid soil temperature zone below 2500 feet.
- The natural soil drainage classes of soil series mapped in the clayey glaciolacustrine areas of the county are somewhat generalized in the soil survey. Newer soil surveys, such as Rutland County, make more distinct separations of the natural soil drainage classes of clayey soil series.
- *Terrace Escarpments, silty and clayey*, are mapped in areas of clayey and silty lacustrine soils like Vergennes and Hartland, but soil series are not identified for this unit. Natural communities in these areas are not linked to a soil series in the county.

In **Franklin County**, *Terric Medisaprists* are mapped in some bogs with organic soils. Soil series are not identified. Natural communities in these areas are not linked to a soil series in the county.

In **Grand Isle County**, the soil mapping was completed in 1953. Like the Addison and Chittenden county soil surveys in the Champlain Valley, the soil survey has some of the oldest mapping in the state. The following limitations are recognized:

- The natural soil drainage classes of soil series mapped in the clayey glaciolacustrine areas of the county are somewhat generalized in the soil survey. Newer soil surveys, such as Rutland County, make more distinct separations of the natural soil drainage classes of clayey soil series.
- The Benson soil map units appear to include areas with soils now recognized as Farmington, Galoo, and Galway soil series.

In **Lamoille County**, several soil map units are named using terms from Soil Taxonomy rather than soil series names. These map units are not linked to natural communities. They generally represent soils on wetter sites and floodplains. They include:

- *Borohemists, deep*
- *Borohemists, moderately deep over loamy substratum*
- *Fragiaquepts and Haplaquepts, 0 to 8 percent slopes*
- *Histic Fluvaquents, frequently flooded*
- *Udifluvents, frequently flooded*

In **Orange County**, the following limitations are recognized:

- *Muck* is mapped in the swamps with organic soils. Soil series are not identified. Natural communities in these areas are not linked to a soil series in the county.

- *Rock outcrop* is mapped extensively, rather than specific soil series with shallow bedrock. Natural communities in these areas are not linked to a soil series in the county.
- Soils on floodplains and stream terraces extend from the Connecticut River up to the headwaters of the White River. These soil series include the Agawam, Belgrade, Hadley, Hartland, Limerick, Merrimac, Ninigret, Raynham variant, Saco, Walpole, Windsor, and Winooski soils. All of these soils are considered to be in the relatively warm mesic soil temperature zone. But in the western part of the county, some of these soils are mapped in the frigid soil temperature zone. However, natural communities that occur only in the frigid soil temperature zone are not linked to these mesic soils.

In **Rutland County**, the following limitations are recognized:

- There is no distinction or delineation of soils formed over limestone bedrock in the frigid soil temperature zone. Because of this, boreal calcareous natural communities have been included with the mesic Farmington, Galoo, and Galway soils.
- Organic soils in bogs and swamps are found throughout the county, from warm areas in the valleys up to cooler areas in the Green Mountains. The soil series include the Adrian, Linwood, and Pinnebog soils. All of these soils are considered to be in the warmer mesic soil temperature zone. But in the Green Mountains, these soils are mapped in the frigid soil temperature zone. However, natural communities that occur only in the frigid soil temperature zone are not linked to these mesic soils.
- The map unit, *Histosols and Aquents, ponded*, is named using terms from Soil Taxonomy rather than soil series names. Although it is mapped solely in areas of fresh water marsh along Lake Champlain, it is not linked to any specific natural communities.

In **Windham County**, some soils mapped on floodplains extend from the Connecticut River up to the headwaters of the West River. These soil series include the Ondawa, Podunk, and Rumney soils. All of these soils are considered to be in the relatively cool frigid soil temperature zone. But along the Connecticut River in the eastern part of the county, these soils are mapped in the warmer mesic soil temperature zone. However, natural communities that occur only in the mesic soil temperature zone are not linked to these frigid soils.

In **Windsor County**, the Glover and Vershire soils are mapped in areas of the Waits River bedrock formation. This formation consists of intricately layered calcareous and non-calcareous schist and impure limestone beds. In areas with abundant limestone, temperate calcareous communities may be present. In areas with little or no limestone, temperate acidic communities may be present.

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Glossary

Natural Soil Drainage Class. Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized: **excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,** and **very poorly drained**. The definitions that follow are from the Soil Survey Manual (Soil Survey Staff, USDA, 1993).

Excessively drained. Water is removed very rapidly. The occurrence of internal free water commonly is very rare or very deep. The soils are commonly coarse-textured and have very high hydraulic conductivity or are very shallow to bedrock.

Somewhat excessively drained. Water is removed from the soil rapidly. Internal free water occurrence commonly is very rare or very deep. The soils are commonly coarse-textured and have high saturated hydraulic conductivity or are very shallow to bedrock.

Well drained. Water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions. Wetness does not inhibit growth of roots for significant periods during most growing seasons. The soils are mainly free of the redoximorphic features that are related to wetness.

Moderately well drained. Water is removed from the soil somewhat slowly during some periods of the year. Internal free water occurrence commonly is moderately deep and transitory through permanent. The soils are wet for only a short time within the rooting depth during the growing season, but long enough that most mesophytic crops are affected. They commonly have a moderately low or lower saturated hydraulic conductivity in a layer within the upper 1meter, periodically receive high rainfall, or both.

Somewhat poorly drained. Water is removed slowly so that the soil is wet at a shallow depth for significant periods during the growing season. The occurrence of internal free water commonly is shallow to moderately deep and transitory to permanent. Wetness markedly restricts the growth of mesophytic crops, unless artificial drainage is provided. The soils commonly have one or more of the following characteristics: low or very low saturated hydraulic conductivity, a high water table, additional water from seepage, or nearly continuous rainfall.

Poorly drained. Water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods. The occurrence of internal free water is shallow or very shallow and common or persistent. Free water is commonly at or near the surface long enough during the growing season so that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below plow-depth. Free water at shallow depth is usually present. This water table is commonly the result of low or very low saturated hydraulic conductivity of nearly continuous rainfall, or of a combination of these.

Very poorly drained. Water is removed from the soil so slowly that free water remains at or very near the ground surface during much of the growing season. The occurrence of internal free water is very shallow and persistent or permanent. Unless the soil is artificially drained, most mesophytic crops cannot be grown. The soils are commonly level or depressed and frequently ponded. If rainfall is high or nearly continuous, slope gradients may be greater.

Soil Taxonomy. The system of soil classification used by the Natural Resources Conservation Service has six categories (Soil Survey Staff, USDA, 1999). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Appendix 1 shows the classification of the soils in Vermont. The categories are defined in the following paragraphs.

ORDER. Twelve soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in **sol**. An example is Spodosol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Orthod (**Orth,** meaning true, or common ones, plus **od**, from Spodosol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplorthods (**Hapl**, meaning minimal horizonation, plus **orthod**, the suborder of Spodosols that are most typical for the order).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective **Typic** identifies the subgroup that typifies the great group. An example is Typic Haplorthods.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineralogy class, cation-exchange activity class, soil temperature regime, soil depth, and reaction class. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is coarse-loamy, isotic, frigid Typic Haplorthods.

SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The Berkshire and Tunbridge series are two of the series within the coarse-loamy, isotic, frigid Typic Haplorthods family.

For more information on Soil Taxonomy, see the following websites:
http://soils.usda.gov/technical/classification/taxonomy/ or
http://soils.usda.gov/technical/classification/tax_keys/

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