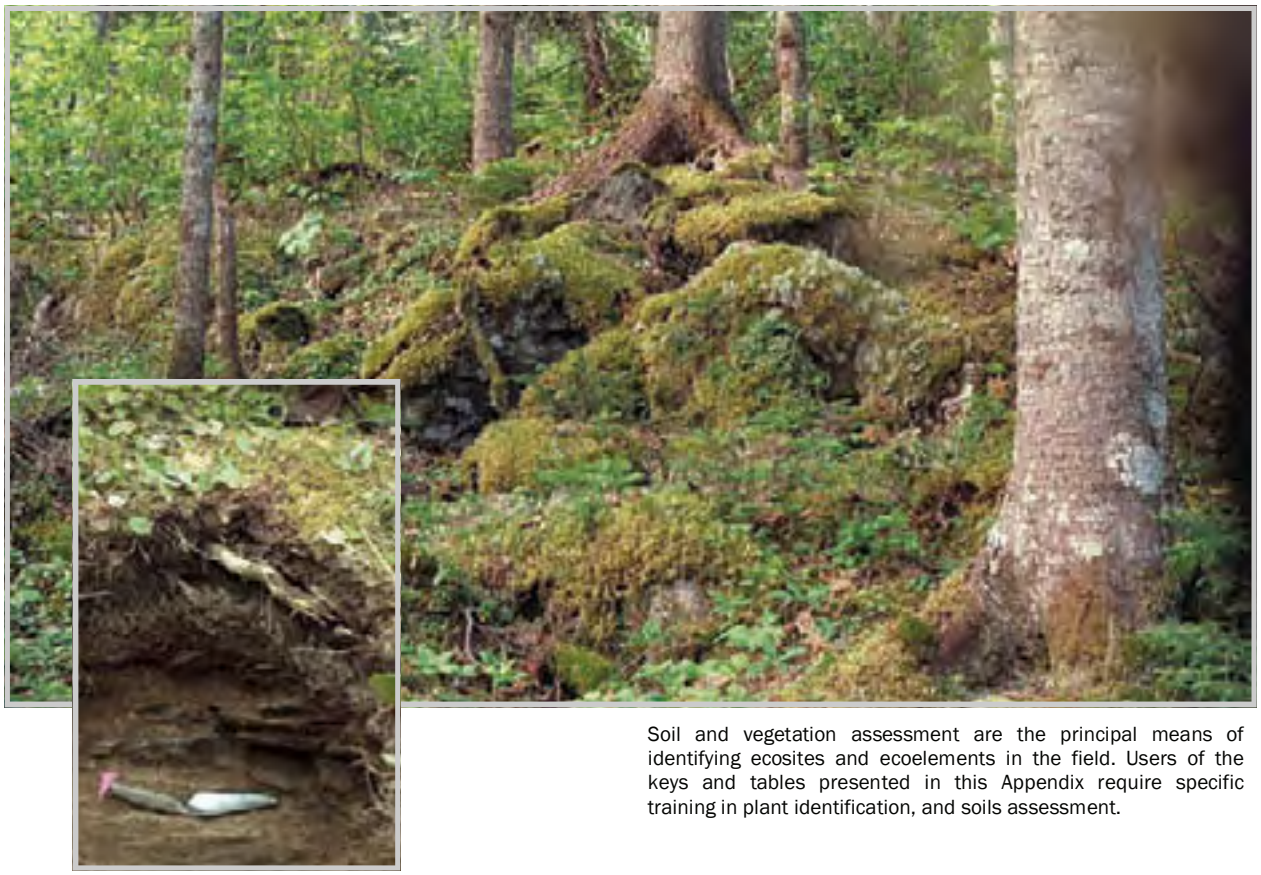


Soil and vegetation assessment are the principal means of identifying ecosites and ecoelements in the field. Users of the keys and tables presented in this Appendix require specific training in plant identification, and soils assessment.

Appendix 1

Ecosites and Ecoelements

The New Brunswick Ecological Land Classification System described thus far has provided us with general information about areas that are thousands of hectares in size. In this chapter, the focus becomes very specific and fine-scale. Readers are introduced to some specific tools for classifying forest land in the field. This chapter is focused on the forest and thus it doesn't describe how to classify wetlands.

Ecosites are sub-divisions of the New Brunswick Ecological Land Classification system that encompass enduring features at the scale of a landform or part of a landform. Ridgetops, hillsides, and eskers are examples of landforms typically associated with ecosites. The relatively fine scale of ecosites means that they are recognizable from a high vantage point such as a low-flying aircraft, rather than from within a forest stand. Ecosites are generally uniform from the standpoint of moisture and nutrient regime, and of topoclimate.

At the ecoelement level of classification we discern the fine-scale ecological differences of soil moisture and nutrient condition, topoclimate, and the associated plant species composition.

Ecoelements are uniform with respect to ecosystem processes of growth and nutrient cycling, as well as their associated plant communities. An ecoelement is identified on the ground by observing the presence of plant indicator species that indicate soil nutrient conditions, as well as soil features including moisture regime, stoniness, and soil parent material type (see field survey methods at the end of chapter).

A user of ecosite maps will find that a single ecosite map polygon will generally be made up of the ecoelement for which it is named. Mapped ecosite polygons frequently encompasses additional portions of other ecoelements. For example, small wet spots or seeps may occur within an area that is mapped as predominantly well-drained. Or, conversely, we can find small, dry promontories on a primarily wet, swampy ecosite. These are examples of ecoelement diversity within ecosites.

In other words, ecosites are identified through mapping and are "complex" map units, while ecoelements are the basic units of both the ecosite and ecoelement levels of ELC. Both ecosites and ecoelements are named and numbered according to the 8 basic edatopic grid types first introduced in Chapter 5.

Purpose of Ecosite Maps and Ecoelement Keys

The ecosite and ecoelement levels of classification were conceived and developed for use in the assessment and management of forest lands.

The identity of an ecosite or an ecoelement in the context of an ecoregion can suggest, for example, what level of productivity in terms of tree growth may be expected. This information is important for a timber resource manager to help to maximize fibre growth rate and to make decisions on where to carry out silviculture. It is also possible to assess what vegetation might be considered the most natural forest condition for a site, given the character of its landform, its soil attributes. Maintaining a natural forest cover is of critical importance for maintenance of biodiversity, and ecosite maps, along with information about the frequency of forest stand types by ecosite and ecodistrict is presented diagrammatically in chapters 7 through 13.

Naming of Ecosites and Variants

In addition to the 8 basic ecosite templates, variants of the ecosites have been identified, where the two gradients of moisture and nutrients/topoclimate are insufficient to adequately give a full

description of the site.

The suffix “s” is affixed to ecosites 1 and 2 when the slope is exceedingly strong. Extreme steepness of slope can contribute to very rapid drainage, or to intensified microclimatic effects.

The suffix “c” is assigned to sites that occur on soils derived from weathering of moderately to very calcareous rocks. Other factors being equal, increasing calcareousness of the soil parent material is correlated with higher soil pH and better overall nutrition for trees, leading to higher rates of growth and nutrient cycling.

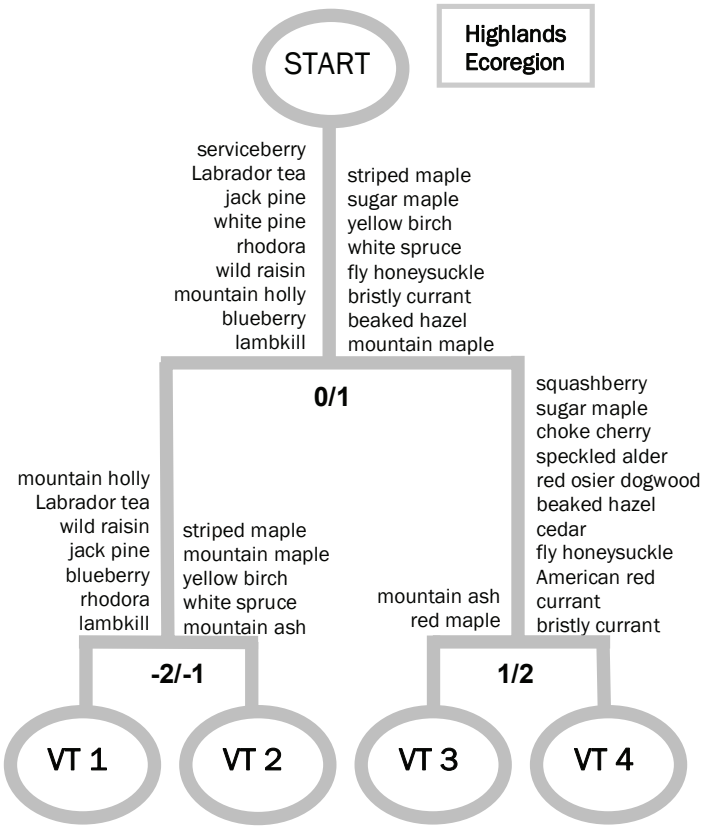
The suffix “h” is assigned to unusually high-elevation occurrences of ecosites 5 and 2. In both instances, the “h” describes predominantly coniferous sites that occur at high elevation in environments that are subalpine in character.

The suffix “o” is assigned to areas where peatlands are a prominent landscape feature, and “f”, describes bottomland sites on river floodplains and salt marshes (note, however, that ecosite maps do not reliably identify all salt marshes in the province).

Field Identification And Classification Of Ecoelements

While ecosites have been mapped across the area of the province, ecoelements are identified in the field from keys prepared for this purpose. Maps, however, will provide a starting point, as ecosites are named for their predominant ecoelement. It will often be necessary verify these attributes in the field. The following section provides a procedure for identifying ecoelements in the field that is supported by number of keys and tables designed for field assessments.

Field verification typically begins in the office with examination of aerial photographs of the site of interest and surrounding area to delineate possible ecosite variation. In most instances, ecological variation will be visible on the photographs, in terms of ruggedness of topography, and corresponding variation in vegetation composition. Fine scale topographic and soil maps may also be helpful. The photos can then be used to subdivide the landscape into relatively homogeneous units for survey purposes. At least one sample plot should be established in each of these subdivisions. Generally, a higher number of ground sample plots are assigned to subdivisions that account for a greater percentage of the geographic area, although the exact details of sampling methodology are dependent on the objective of the survey.



How to use Vegetation Type Keys

First determine what ecoregion you are in, and select the appropriate key. Mark a circular plot of approximately 450 square metres (11.3 metre radius) on an area representative of the overall site condition. Assess the presence or absence of the species listed at the first division of the vegetation type key within the plot. For each species listed on the left side of the division, score –1; for each species on the right, +1. When no more of the species listed are found, the scores are summed and the sum is compared with the numbers, separated by a slash, provided below the division. If the sum is equal to or greater than the number on the right, proceed right. If it is less than or equal to the number on the left, proceed left. Subsequent divisions are assessed in the same way until an endpoint Vegetation Type is reached.

At each sample plot, the Vegetation Type and the Soil Type are determined.

Determining Vegetation Type

Indicator species are plant species whose range of ecological tolerances is known and whose presence (either singly or in association with other indicators) suggests a relatively narrow range of soil status with respect to nutrient availability. Keys presented here use the concept of indicator species to guide the user to identify a Vegetation Type, which is an expression of nutrient status with four possible values, from 1 (poor) to 4 (rich). Three different Vegetation Type Keys were developed for the three groupings of ecoregion within which the relationships between plant indicators and soil conditions appear to be consistent.

Field Sampling and Determination of Soil Type

A soil type is ecological classification unit for upland soils that is uniform with regard to soil moisture regime, and lithological composition of the soil parent material. An assumption built into the concept of soil types is that soil moisture regime is the primary determinant of growth and nutrient cycling, and that a secondary but still important determinant is the lithology of the soil parent material (where this affects soil acidity and nutrient status).

Soil Moisture Regime describes the extent to which moisture is removed from the soil in relation to the supply. It is determined in the field by referring to the soil moisture regime table.

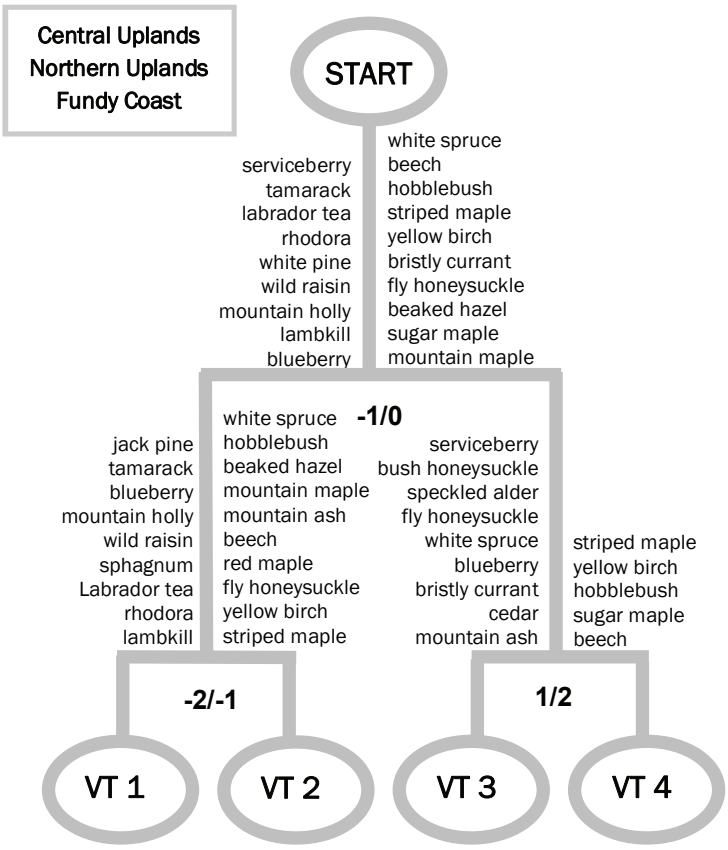
The source of precipitation is an important factor in the determination of soil moisture regime. Seepage is moisture that arrives at a site by downward flow from higher points on the landscape. Seepage may be greater on landforms that have a compact, fine textured soil horizon below the immediate rooting zone, or on shallow soils that lie above an impermeable layer of bedrock. Sites where seepage occurs will have more available soil

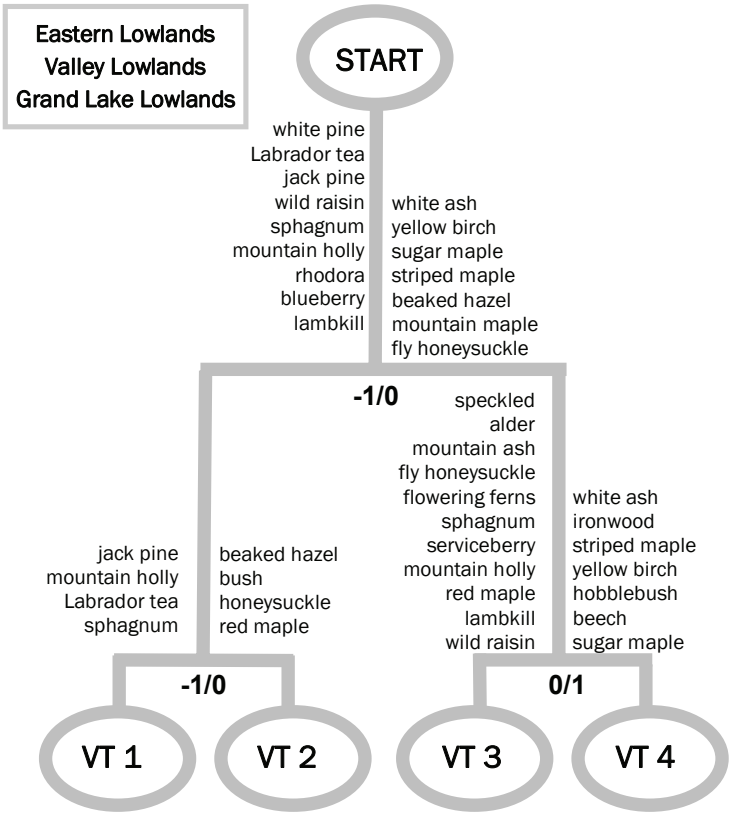
moisture than sites where precipitation is the only source of moisture.

Because the amount of moisture in the soil is a function of recent past weather, it is important to be aware of the characteristics of a soil pit that indicate moisture regime. For instance, moist or wet soils may appear dry after prolonged periods of fair weather, and dry soils may seem moist after a rainfall or during the early spring. Soils that have a "fresh" or "dry" soil moisture regime will tend to have very brightly coloured soil horizons—typically a whitish "A" horizon, and a bright rusty brown or chocolate brown upper "B" horizon beneath the "A". As moisture regime becomes progressively wetter, the colours of the soil profile become more dull and grayish, starting at the bottom of the pit and increasing gray towards the soil surface as soil moisture regime becomes wetter.

Soils that are flooded for much of the year may show "mottles" of gray or reddish colour that contrast with the predominant colour of the horizon. A compact, fine-textured soil horizon or impermeable bedrock layer will prevent or impede infiltration of water below the reach of the roots.

Just as important as assessing soil profile character is assessment of the lay of the land, or the extent to which a site may be moisture shedding or moisture receiving. If a site is crested, flat, or slightly funnel-shaped; if it is at the toe of a slope or





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Moisture Regime Assessment Guide							
moisture regime	defining characteristics		field recognition characteristics				
	description	primary water source	slope position	texture	drainage	available water storage capacity	slope gradient
dry	water removed rapidly in relation to supply; soil is moist for a short time after precipitation	precipitation	water shedding	coarse texture; loamy sand to sand; or > 80% coarse fragments between 30cm and 2m depth	rapid	low	may be steep
fresh	water removed somewhat slowly in relation to supply; soil may remain moist for a significant but sometimes short period of the year. Available soil moisture reflects recent weather events.	precipitation in medium to fine-textured soils or slight seepage in coarse-textured soils	upper to lower slopes	medium to fine texture; few coarse fragments; may be stonier or coarser with some seepage input	good to moderately good	moderate	moderately sloping
moist	water removed slowly enough to keep the soil wet for a significant part of the growing season; some soil mottling and seepage	precipitation and seepage	lower slopes or coves; receiving situations	variable depending on seepage	moderately good to imperfect	variable depending on seepage	slightly sloping or level
wet	water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage; mottling and gleying	seepage or permanent water table	lower slopes; level or depressions	variable depending on seepage	poor or very poor	variable depending on seepage	flat

This soil moisture regime assessment guide is recommended for those who have had training in soil assessment.

at the slope's crest will influence the soil moisture regime.

As discussed in Chapter 3, soil texture refers to the percent composition of sand, silt, and clay particles. Keys are also provided to guide field assessment of soil texture. Coarse soils have a relatively high percentage of sand; fine textured soils have a relatively high percentage of silt and/or clay. Coarse textured soils have poor moisture-holding capacity relative to medium and fine

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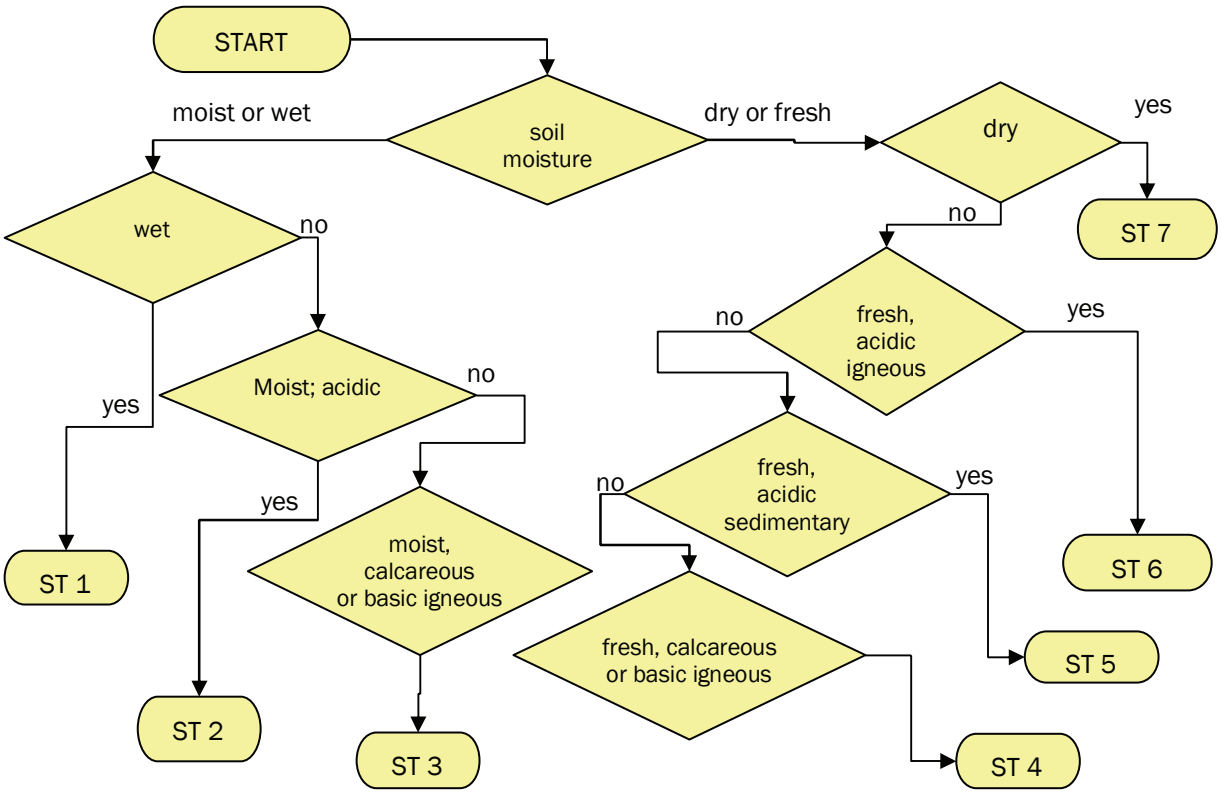

textured soils.

Coarse fragment content is an important consideration in assessment of soil moisture regime. Gravel, cobbles, stones and boulders occupy rooting space and preclude water storage. When bedrock is fractured and permeable to water, sites with bedrock near the surface may have dry moisture regimes.

Before assessing the geological origin of rock types in a soil pit, surveyors should already have familiarized themselves with local geology by various means at his or her disposal. These include: asking a geologist or soil scientist; using maps such as the *Forest Soils of New Brunswick*, regolith system maps, and/or bedrock geology maps; and examination of reference bedrock outcrops where they are well-exposed, such as road-cuts.

ST–VT grid and the edatopic grid

Once the vegetation type and soil type have been determined, the ST-VT grid for each ecoregion is used to determine the ecoelement classification of the site. Note the similarity between the ST-VT grid and the generalized edatopic grid depicted in Chapter 5. Due to the influence of precipitation on moisture regime, two ST–VT grids are presented here which correspond to different precipitation

Soil Type Key.

When conducting a soil type assessment, a soil pit of at least 90 centimetres depth is dug and pebbles are collected from each size- and shape-class until the sample is considered representative of the pit. Lithology is best determined from a "fresh", unweathered rock surface. Use a rock hammer to crack sampled pebbles to expose unweathered surfaces (safety glasses are needed). A solution of 10% dilute hydrochloric acid is applied to an unweathered surface to determine the calcite content of calcareous rocks (avoid getting acid on clothing). To be classified as calcareous, the percentage of calcareous pebbles in a pit must be at least 30%. To be classified as basic igneous, the percentage of basic igneous pebbles in a pit must be at least 50%.

Highlands, Central Uplands, and Fundy Ecoregions				
Soil Type	Vegetation Type			
	VT 1	VT 2	VT 3	VT 4
Dry	1	4	4	8
Fresh, acidic igneous	2	2	5	7
Fresh, acidic sedimentary	2	5	5	7
Fresh, calcareous or basic igneous	2C	5C	5C	7C
Moist, calcareous or basic igneous	2C	5C	5C	7C
Moist, acidic	3	2	5	6
Wet	3	3	6	6

ST-Vt grid for the Highlands, Central Uplands, and Fundy Ecoregions. Numbers in the grid squares indicate the ecoelement associated with Soil Type and Vegetation Type combination.

levels characteristic of ecoregion groupings.

Forest growth and yield

Ecosites and the edatopic grid is a convenient template for testing our ideas on rates of growth and yield. Forest productivity is not the same everywhere, just as some spots in our gardens are suitable for growing vegetables or flowers, while others will only support the growth of hardy weeds. The edatopic grid shown here is a graphical demonstration of a working hypothesis of the growth of managed, fully stocked stands relative to the edatopic grid.

On dry, moisture shedding sites (ecosites 4 and 8) in dry ecoregions, tree growth may be negatively affected during most years because of a lack of moisture in the soil. The vegetation itself will also have an important effect on soil moisture, due to the significant drain on soil moisture that occurs during plant growth. Plant foliage releases moisture into the air through evapotranspiration. The amount of water drawn through the roots, shoots, and eventually the leaves would be greater for a large amount of foliar biomass than for a smaller amount. The expected growth pattern over the life of a forest stand might follow the growth curve as outlined for ecosites 4 and 8 below: While trees are small, growth can proceed at its maximum rate; but as they gain roots and foliar biomass, their growth will strip the soil of its moisture on these dry, stony sites before the end of the growing season, and growth will decline as the trees mature relative to sites with more plentiful moisture.

On poor ecosites 1, 2, and 3, high soil acidity and slow nutrient

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cycling lead to conditions where growth is relatively slow due to a lack of nutrients, especially nitrogen. While all three conditions might be expected to perform less well than ecosites 5 and 7, where conditions are closer to optimal, ecosites 1 and 3 have moisture problems to contend with as well (too dry, and too wet respectively). Many of the same wetland forming process described in chapter 5 that lead to slow decomposition and accumulation of organic matter are active on Ecosite 3, and growth rate is normally quite low. Nevertheless, many natural stands on ecosite 3 support high volumes of high quality black spruce, though those high volumes normally take many years to develop.

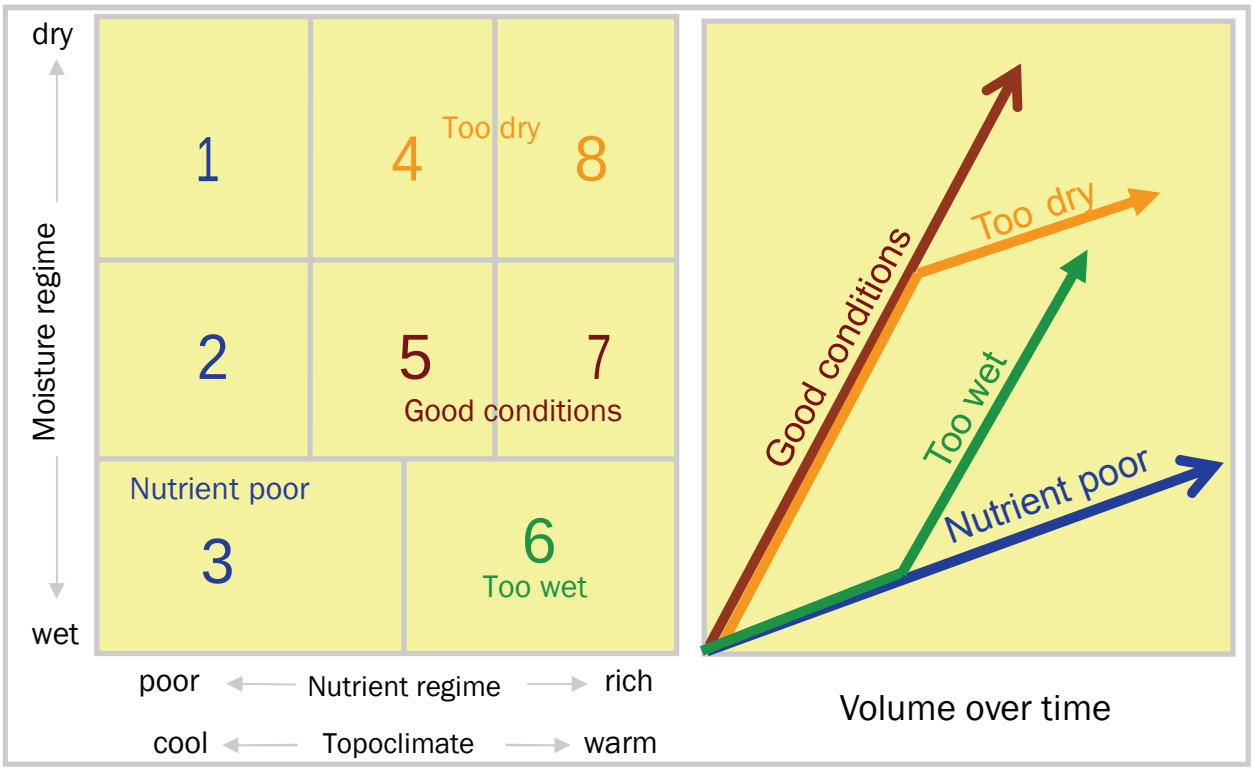
On wet ecosite 6, there is adequate soil nutrition to support rapid tree growth, but excessive moisture may be a problem. Excessive moisture can lead to low oxygen levels in the soil, slow nutrient cycling, and poor growth performance. Complete removal of the overstory when harvesting on these moist sites often causes the water table to rise, creating slow-growing conditions over the short term for the young trees left behind, until, after the passage of a number of seasons, sufficient foliar and root biomass develops to "dry out the site", and leading to higher growth rates reflective of good nutrient status.

Northern Uplands, Grand Lake Lowlands, Eastern Lowlands, and Valley Lowlands Ecoregions				
Soil Type	Vegetation Type			
	VT 1	VT 2	VT 3	VT 4
Dry	1	4	4	8
Fresh, acidic igneous	1	4	8	7
Fresh, acidic sedimentary	2	2	5	7
Fresh, calcareous or basic igneous	2C	5C	5C	7C
Moist, calcareous or basic igneous	2C	5C	5C	7C
Moist, acidic	3	2	5	6
Wet	3	3	6	6

ST-Vt grid for the Northern Uplands, Grand Lake Lowlands, Eastern Lowlands, and Valley Lowlands Ecoregions. Numbers in the grid squares indicate the ecoelement associated with each Soil Type and Vegetation Type combination.

Conclusion

In concluding this chapter, we briefly consider the adequacy of Ecological land classification, as a representation of ecological reality. This model has been used here to describe likely scenarios of forest growth and yield, and to describe forest community tree species composition for the purposes of conserving their diversity in the various regions of the province.



A simple model relating stand growth rates (right figure) to the edatopic grid of ecosites (left figure). See text for explanation.

The growth patterns described here are based on a hypothesis that has received limited testing. It is intended to provide a rough guide for site selection and classification.

Growth and yield and species selection models presented in this chapter reflect current knowledge and assumptions about how things work, and it is likely that we will reach a point where our limited understanding is confounded by real-world complexity, and will need to be re-cast or further elaborated.

Lastly, it is important that we acknowledge the uniqueness at some level of every landscape, landform, and site as we go about classifying them. At least, we should be open to the possibility of their uniqueness. By continuing to question and scrutinize the theory and practice of ecological land classification we might provoke new insights and create new applications not known at present.