Silvics II: Forest Soil and Site Factors

By Bob Seymour

Practical Silviculture

Understanding why different species grow where they do – the concept of the forest site or habitat – can be challenging. Just because a tree is growing in a particular spot, does that mean it "belongs" there and will thrive? Generalizations like "hardwoods are limited to deep well-drained soils" or "conifers dominate both saturated and droughty soils where hardwoods will not grow" are helpful, but the reality is more complex.

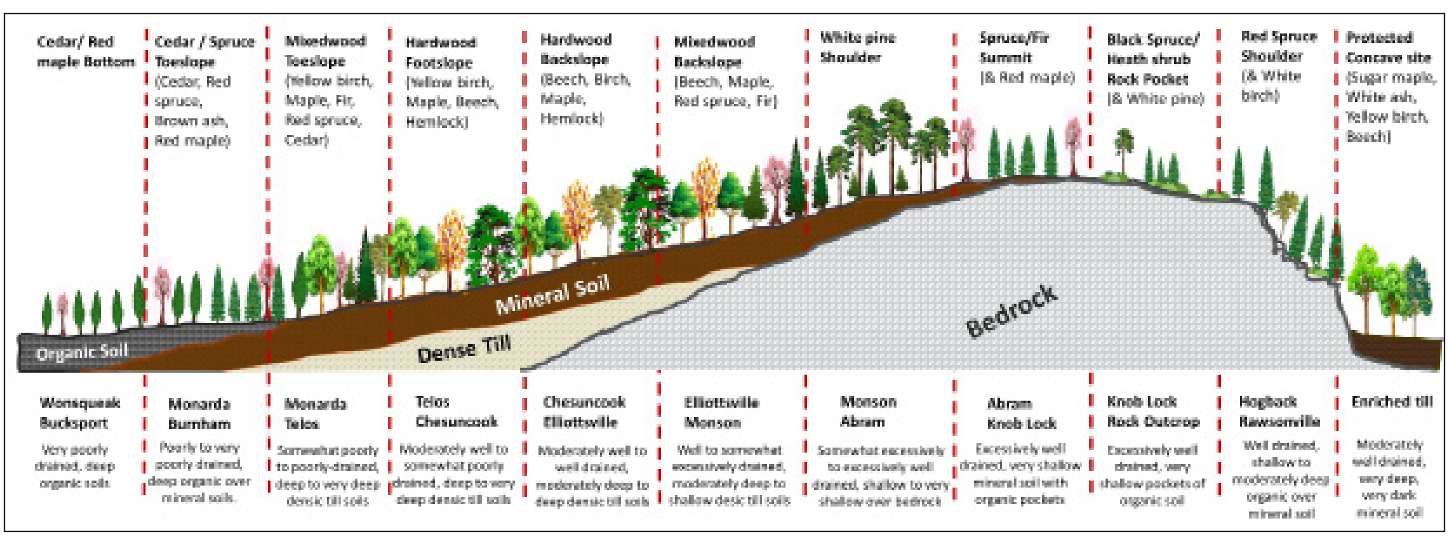
The glacier that melted about 9,000 years ago plastered an unsorted mixture of mineral material, from fine clay particles to large boulders, across Maine's landscape in the form of glacial till. As the forest re-invaded, soils began to form, driven by the process of weathering. Over millennia, biological activity and leaching converted raw parent material (the till) into recognizable horizons (layers) at different depths.

In a forest soil never farmed, the top-most layer is the O (for organic) horizon, formed of decaying leaves and woody material or humus. While some may link a thick humus layer to high fertility, the reality is just the opposite: the most fertile soils have very thin O horizons because leaves decompose within a few months of falling. Rapid decomposition is good because it releases nutrients from the leaves and wood, especially nitrogen, to the soil for uptake by the trees. Where decomposition is slow under saturated, cold, or excessively dry conditions, too much of the nutrient capital is tied up in the O layer.

Below the O layer is the B horizon where most of the tree roots live, and is the key to the soil's suitability for different species. The B horizon extends downward until reaching one of three restrictions: a compact layer (the basal till or C horizon) which roots cannot penetrate, the permanent water table (where roots cannot live owing to the absence of available oxygen for respiration), or bedrock (known as "ledge" in Maine). If one had to pick a single soil property that affects tree growth, the depth of the B horizon would be my choice. Deep soils promote more roots and are typically better drained, in contrast to shallow soils that can be overly saturated or droughty.

Site quality is also governed by texture (the fineness or coarseness of its soil particles, ranging from clay to sand) and the fertility of the parent material, particularly its calcium content that controls its acidity (pH). The best soils have fine textures derived from sedimentary rocks (like the potato belt of Aroostook County); the least fertile are coarse sands weathered from granite and quartz.

Another important factor is topography, or the position of the stand along a slope. Soils in glaciated regions are grouped into catenas – soils with the same parent material but different drainage classes. On the diagram below, the best places to grow trees are the enriched tills on the far right, located in sheltered locations with deep soils that are further enriched by subsurface groundwater seepage, and the Chesuncook/Elliotsville soils on the mid-slope to the



Forest vegetation patterns related to soils along the Chesuncook catena. Courtesy of Jamin Johanson, Maine NRCS left. The least productive sites are the Monson/Abram soils where tree roots are mostly in decayed organic material sitting atop bedrock, and the Wonsqueak muck (yet another parent material) to the far left formed from decayed peat.

Not all Maine soils formed from glacial till. Rapid glacial melting created cataclysmic floods that transported the fine particles (clay and silt) from the mineral soil out to sea but allowed the coarser material (sand and pebbles) to settle out on the landscape. Where this phenomenon was channelized, long, sinuous deposits formed that we call eskers or "horsebacks". As these glacial meltwaters fanned out near the ocean, expansive plains of sandy outwash developed. Because these outwash soils have no fine particles, they are excessively drained and low in fertility, and thus cannot support many species (most hardwoods) that require more nutrients and mesic conditions. Outwash soils are most productive growing pines, which have low nutrient requirements and can withstand seasonal droughts. Red oak and red maple may also grow here on lower-lying areas with more moisture, but other more demanding hardwoods like sugar maple and ash are "off-site" and will fail.

Another important soil resulting from water action is derived from fine clay particles that settled out of stagnant ocean embayments and inland lakes when the post-glacial sea level was much higher. Such soils are inherently fertile but often suffer from poor drainage resulting from their topographic position and lack of slope. Here we should favor mixtures of fir, spruce, red maple, and perhaps hemlock, paper birch and white pine.

Neither outwash nor marine sediments contain large stones, so if your woodlot has stone walls, then your trees are growing on glacial till. If not, then dig a little test pit. Wet the soil and try to roll it into a cylinder.

Photo: Bob Seymour

Stone walls are typically associated with soils derived from glacial till.

Photo: Bob Seymour

High-site 80-year-old northern hardwood stand on a cove site in Wicopy Woods in Sebec, Maine. The ash on the right is 110 feet tall with a merchantable height of 5 logs.

If it's grainy and falls apart, then you have outwash; if you get a seamless, long skinny ribbon, then you probably have marine clay.

Conditions that encourage regeneration of a given species can be unrelated to how well that species will grow once established. The decline of old-field white spruce along the Maine coast was at least partly a result of nutrient depletion from centuries of sheep grazing that did not prevent dense regeneration of these old pastures when abandoned. Meanwhile, old fields that reverted to red spruce or white pine, species with lower nutrient requirements, are still doing well.

Without exception, all species grow best on the lower-slope deep-soiled positions on any catena, including those not naturally found there. Maple, beech and birch tend to dominate these so-called "hardwood sites" as a result of other important silvical properties: competitive advantages conferred by their regeneration mechanisms, and their greater longevity once established. If we want to grow fir Christmas trees in a fertile old field (a natural hardwood site), or convert a beech-dominated stand to planted spruce, then we must recognize we are battling natural succession and employ chemical or manual methods to control the severe competition from hardwoods that are best adapted there.

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