3.5 SOIL PRODUCTIVITY

BACKGROUND

Forest soil productivity can affect how fast trees grow and what kinds of trees grow.

The characteristics of a forest soil are defined by varying combinations of mineral particles, organic matter, water, and air. Soil productivity is influenced by levels of mineral nutrients available from the rocks from which that soil is derived. For example, limestone-derived soils tend to have a higher pH, allowing nutrients to be more available and in turn, to be more fertile. Soils derived from granite tend to have a lower pH, which locks up nutrients and so tends to be less fertile. The lack of practical, economically feasible means of increasing soil productivity underscores the importance of maintaining existing soil nutrients.

Soil nutrients can be lost through leaching and timber harvesting. Acid deposition and other forms of air pollution leach certain soil nutrients, especially calcium. These losses may equal or exceed losses from timber harvesting over the length of the rotation. Exposing soil can result in small amounts of harvest-induced leaching. Soil type and the amount of trees removed also influence the amount of leaching. Prompt revegetation can minimize soil nutrient losses.

Nutrient loss from timber harvesting is affected by the portion(s) of a tree taken, the harvest method, and the frequency with which a stand is harvested. More frequent harvests and a higher percentage of fiber removed during harvests increase the amount of nutrients removed. Whole-tree (biomass) harvesting removes more nutrients than bole-only harvests, because the tops, limbs and leaves serve as a significant reservoir for many nutrients.

Though nutrient loss is a concern with biomass harvests, current knowledge is limited regarding the effect of intensive harvesting on soil productivity. Two studies at the Hubbard Brook Experimental Forest in Thornton, N.H. didn't find perceptible soil nutrient loss from whole-tree clearcutting. However, nutrient response is site-dependent and difficult to apply from one soil to another and additional research on a variety of soils is needed. Erosion control and other best management practices maintain soil integrity and minimize losses.

The greatest concern for nutrient depletion arises when the more intense practices are applied repeatedly on sites already low in nutrients (e.g., most coarse-textured sands, some shallow-to-ledge soils, and some soils with high seasonal water tables). In general, whole-tree harvests by the clearcut method on short rotations (e.g. 40 years) should produce the greatest nutrient losses.

Erosion and soil compaction may also diminish soil productivity for tree growth. Timber harvesting can cause soil damage by disrupting topsoil, mixing soil layers, creating deep ruts, or compacting soil layers. The primary factor contributing to soil erosion is the exposure of bare soil.

A typical soil is 45 percent mineral material, 25 percent air, 25 percent water, and 5 percent organic material. Half the feeder roots in a forest are found in the top 6 inches of soil. Roots need both air and water and activities that compact the soil, eliminating space for air and water, lower a site's productivity.

Repeated passes of heavy equipment over certain types of soil, especially during wet conditions, can compact soil pore space, reducing the availability of air and water necessary for trees, impeding root growth, and allowing the entry of pathogens that cause root diseases. To some extent, natural soil processes such as freeze/thaw cycles and activities of soil organisms help restore compacted soils to near preharvest conditions. The rate of recovery depends on soil type, soil depth, and degree of compaction.

3.5: Soil Productivity

Low-fertility soils, those with a high silt, clay, or organic matter content, and soils shallow to bedrock may be more subject to erosion and compaction or have most of the fine roots very near the surface, where they may be easily damaged.

OBJECTIVE

Maintain long-term soil productivity.

CONSIDERATIONS

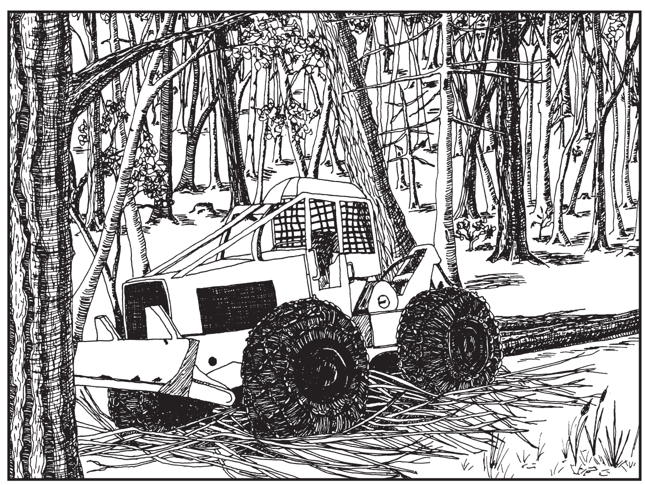
- Well-planned and executed timber harvests can minimize the effects on soil nutrients, erosion, and compaction.
- Leaves, branches, and small-diameter trees left after a harvest contribute to on-site nutrient recycling. Even whole-tree harvests leave behind a percentage of these fine, woody materials.
- Some exposure of mineral soil is important for regeneration of certain species (e.g., white pine and yellow birch).
- Growth decline in New England stands due to environmental effects isn't evident except in red spruce at high elevations.
- Commercial wood ash and biosolids from municipal wastewater treatment may become a sources of forest-soil nutrient additives. Their application is governed by state and federal law and may be limited by local regulation.

RECOMMENDED PRACTICES

✔ Contact the Natural Resources Conservation Service (NRCS) for soil maps and advice on which soils may be low fertility or susceptible to erosion or compaction. Or use the NRCS *Web Soil Survey,* an internet tool that provides easy-access, up-to-date soil mapping, interpretations, and descriptions. Incorporate soils information into forest management plans and activities.

✔ Limit disruption of soil organic layers except when needed to accomplish silvicultural objectives such as regeneration of species that need a bare mineral soil seedbed.

✔ Design roads, skid trails, and landings in advance of the harvest.



Cable skidder driving on limbs and tops.

✔ Minimize damage to areas susceptible to erosion or compaction by:

- Harvesting during dry, snow-covered, or frozen ground conditions.
- Using designated skid trails.
- Using equipment suited to the site and the size of material being harvested.
- Using low-impact equipment.
- Spreading limbs and tops on skid trails to cushion the impact of harvesting equipment.

✓ Use bole-only harvesting (taking out the main portion of tree only, leaving branches and limbs in the woods) on low-fertility soils as a precaution against nutrient loss. Lopping tops in the woods where they fall will leave a greater percentage of the nutrients to recycle.

CROSS REFERENCES

2.2 Forest Structure; 3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 4.3 Forest Management in Riparian Areas; 5.4 Logging Damage; 6.2 Cavity Trees, Dens and Snags; 6.3 Dead and Down Woody Material; Appendix-Important Forest Soils.

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