Maintaining & Enhancing Soil Health

5

Forest Operations Manual

The Conservation Forestry Program

Maintaining & Enhancing Soil Health

CHAPTER 5

5.1 The Nature Conservancy Philosophy

Because **soil quality** is vital to forest health and productivity, The Conservation Forestry Program will actively protect and develop this valuable resource as it manages forestland in the Clinch Valley. By doing so, timber quality and production will be enhanced and the water resource will be protected. Soil erosion and sedimentation are the primary threats to water quality.

Protecting the soil under southern Appalachian forestland is particularly important because of degradation from past uses. In the 19th and early 20th centuries, many of these sites suffered from poor logging practices and cycles of forest clearing, crop cultivation, abandonment, and reforestation–practices that caused erosion and reduced soil productivity throughout the region.

In managing soil resources on all managed land, we hope to reverse years of degradation and restore soil health, both by restoring damaged or eroded soil and by taking all the steps necessary to prevent future damage.

5.2 Key Strategies

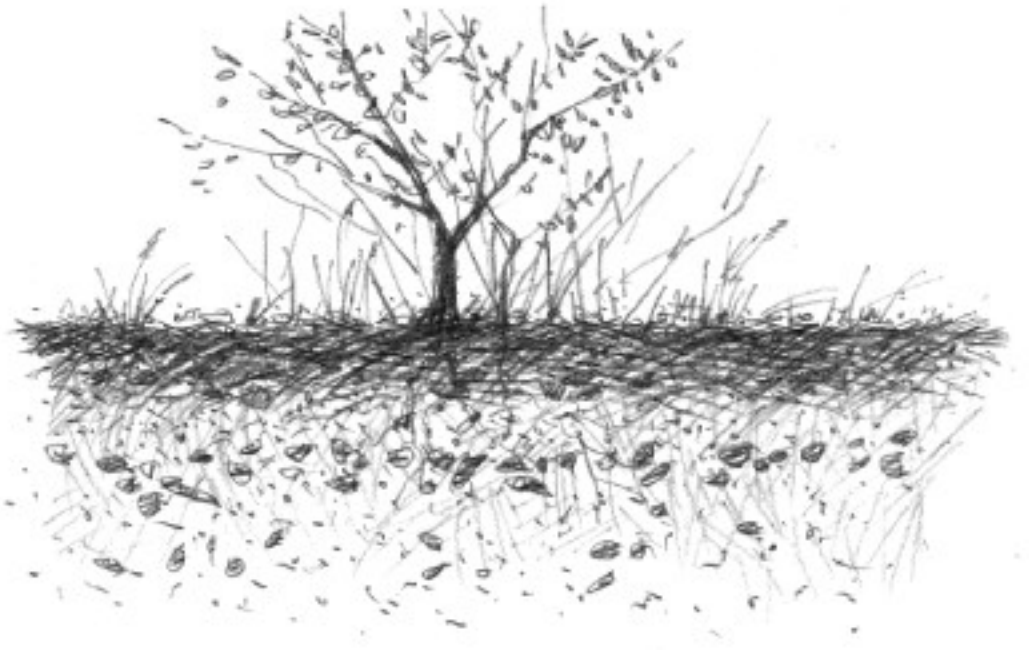
Forest management activities such as building roads and landings, skidding across the forest floor, and using heavy machinery will inevitably impact the soil structure. These activities do not have to cause permanent damage, and careful forest management can even help restore and improve damaged soils. Soils recover naturally to some degree through processes such as moisture and temperature changes, activities of soil biota, and plant root penetration and decay, which all loosen compacted soils. In addition, annual litter fall and the normally rapid growth of pioneer species such as blackberries, ragweed, black locust and yellow-poplar cover exposed soils and begin rebuilding the forest floor layers quickly.

To steadily improve each site's soil resources, foster natural recovery processes, and minimize the impact of any harvest activity, forest managers will adopt the following strategies:

- Include a soils map and descriptions with all management plans to insure that all forestry activities take the soil resource into account.
- Designate and protect Streamside Management Zones (SMZs) to protect stream banks and slow runoff in riparian zones as part of a comprehensive effort to prevent erosion.
- When planning and conducting a timber harvest, take all steps necessary to minimize impacts to the soil and safeguard soil health, including:
  - Assess soil conditions before using heavy equipment
  - Lay out and construct forest roads, skid trails, and log landings properly
  - Suspend skidding and road building during wet conditions
  - Conduct tree-bole-only harvests, leaving tops and branches in the woods to replenish the forest floor
  - Close out roads and landings promptly and completely
- Protect against damaging wildfires.
- Repair damaged sites as possible, including road cuts, cattle-damaged riparian areas, and abandoned fields, to stop erosion and restore productivity, preferably by reforesting with native trees or other vegetation.

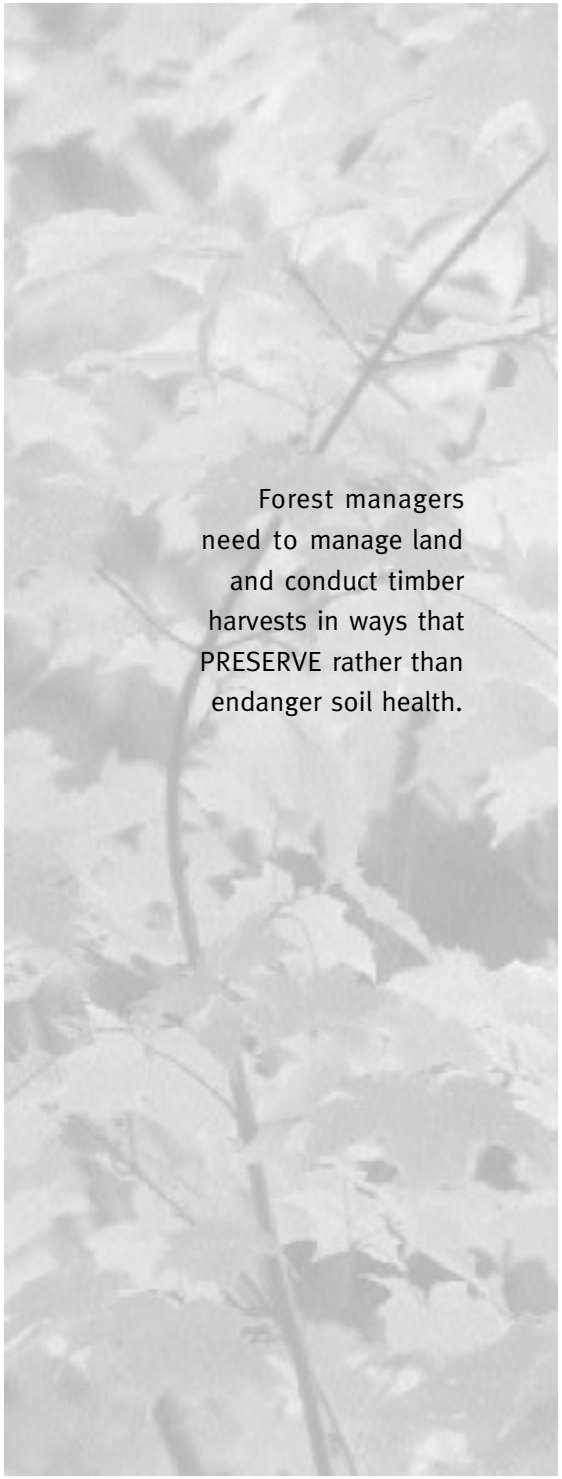
5.3 Soil Quality and Forest Health: Underlying Principles

To effectively protect soil quality, forest managers and landowners need to understand the make-up of forest soils and the complex ways these soils influence both the biological and the economic health of the land.



BENEFITS of HEALTHY SOIL

Forest soils differ from agricultural soils specifically because they develop under the influence of the forest cover–deep-rooted trees, organisms specific to forest vegetation, and the forest floor itself. The forest floor, which forms the top layer of the soil, is particularly important to forest health. It consists of both freshly fallen and decomposing organic debris from plants and animals, including leaves, roots, twigs, bark, fruits, stems, and animal parts (referred to as litter).



Forest managers need to manage land and conduct timber harvests in ways that PRESERVE rather than endanger soil health.

This debris contributes to overall forest health by:

- Recycling nutrients for plants
- Containing the seeds for new plant growth
- Protecting the soil surface from the impact of raindrops
- Absorbing rain water so that it later infiltrates the soil and retards run off
- Enabling the soil to hold more water
- Providing habitat for soil biota that coexist with and support forest vegetation

In addition to benefiting the forest as a whole, soil quality, and specifically soil depth or volume, plays a key role in a site's economic viability and timber production. While a tree's fine roots lie primarily in the upper eight inches of soil on most sites, the bulk of its root system lies within three feet of the soil surface. Soil volume thus affects a tree's root development, its ability to withstand high winds (i.e. its resistance to windthrow), and perhaps most importantly, its nutrient and water supplies. Studies show that water availability has the greatest influence on tree growth in most sites.

The differences can be dramatic: for example over 50 years, a northern red oak may reach 80 feet in a rich stream bottom and 70 feet in moderate soil on a side slope, but only 55 or 60 feet on the poor soil found on an upper mountain slope. In terms of timber production, not only do taller trees yield higher volumes; they also typically provide higher product quality and value, further emphasizing the need to maximize soil health on all managed sites.

THREATS to SOIL QUALITY

Soil changes over time, even in undisturbed forests. Erosion is a normal part of this process, particularly in stream channels. While some change is natural, outside influences, including forestry activities, can accelerate these changes and pose potential problems if they are not handled carefully. Forest managers need to be fully aware of these problems so that they can manage land and conduct timber harvests in ways that preserve rather than endanger soil health.

EROSION RESULTING from ROAD BUILDING

Studies show that the construction, use, and maintenance of forest roads and skid trails increases erosion rates more than all other forestry activities combined. In particular, poor road location and construction, along with activity in and around stream channels, accounts for up to 90% of the erosion caused by forest operations. Removing significant streambank vegetation and disturbing soil next to stream channels can cause far more erosion than would occur naturally. In addition, if cut slopes for roads are near streams, the exposed soil on these slopes may become a major source of sediment export.

Unless carefully managed, greater damage may occur after a harvest ends. Building roads and running heavy equipment over roadbeds displaces and compacts the forest floor and upper soil layers, which in turn causes precipitation to run off rather than infiltrate the soil. If not addressed, this runoff can persist long after the harvest is completed, and over time can remove even more soil than the initial road building. According to one study in the Piedmont, erosion resulting directly from a timber harvest lasted only six years, but erosion associated with road and stream channel encroachment lasted more than thirty years. This effect could be amplified in the mountains due to increased slope.

Other Potential Effects of TIMBER HARVESTS

In addition to creating potential erosion problems, bringing heavy equipment into the forest and removing trees can *affect soil quality* in other ways. These effects may be minor and temporary, such as moving the litter layer during skidding, or major and long-lasting, such as deep rutting and severe compaction caused by heavy machinery operating in wet areas.

James Willis

Poor road location and construction, along with activity in and around stream channels, accounts for up to 90% of the erosion caused by forest operations.

The primary areas of concern are:

- **Exposed mineral soil (i.e. scarification) and mixed soil layers:** Shifting or removing the forest floor inevitably disrupts the soil's natural layers. If the disturbance is extensive, the mixing and scarification that results can inhibit forest regeneration and recovery by restricting the flow of moisture and nutrients, and may impact the seed bank normally available in the forest floor.

- **Soil compaction:** Compaction from heavy equipment can reduce the pore space available for air and water, which in turn can limit root penetration and subsequent growth for seedlings, decrease the rate at which the soil absorbs water (infiltration capacity), increase the rate at which it loses water (leaching), and change the amount of water it can hold. However, careful planning and management will minimize the areas affected and actively foster the recovery process.

- **Nutrient loss:** The extent of the nutrient loss depends primarily on the parts of the tree removed, the harvest method, and the frequency of post-harvest treatments. Nitrogen is the nutrient in critical supply in most forest ecosystems, especially for regeneration.

One key source of nitrogen for regeneration is the "non-merchantable" part of the harvested timber— tops, leaves, branches, etc. The harvest method is critical here. Dragging whole trees to the harvest landing results in huge block piles of scrap wood at the landing that, in addition to creating an aesthetic problem, represent significant nutrient loss to the soil. In contrast, cutting out defects and leaving them in the woods provides an important nutrient source. A typical bole-only harvest (removal of only the log portion of the tree, leaving all of the limbs in the forest) removes only about half the nitrogen in the above-ground tree. The other half in the tree crown remains on the forest floor to facilitate regeneration.

Other potential side-effects of forestry activities such as leaching from disturbed or exposed mineral soil, runoff, and wildfires can also contribute to nutrient loss, but research suggests that those effects are minimal. Natural fires and occasional prescribed burns, in particular, seldom result in much erosion in humid climates because a well-developed root mat holds the soil in place until new growth takes hold, which occurs relatively quickly in the southern Appalachians.

5.4 Related Management Practices

Applying the strategies listed in Section 5.2 to adequately protect soil quality involves a broad range of practices, including:

- Developing a management plan that takes soil quality into account (*see Chapter 7*)