Watershed Management

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Forested Watersheds

Forests make excellent watersheds chiefly because their soils usually have a high infiltration capacity— they are capable of quickly absorbing large amounts of water. Therefore, rainstorms or melting snow in woodlands produce relatively little surface runoff with the associated problems of *erosion* (detachment and movement of soil) and *sedimentation* (the deposition of soil). *Turbidity* is the term applied to water that has reduced clarity due to suspended sediments. Turbid water looks cloudy. Generally, the water flowing through streams in stable forests has very low turbidity.

Trees contribute to the high infiltration capacity of forest soils. When tree roots remove water from soil pores, space is created for additional water to be stored. Forest soils also have a great deal of pore space. The abundance of organic matter from decaying plant parts creates a well-structured soil in which the individual soil particles tend to form *aggregates* (small clumps of soil stuck together). This clumping of soil particles produces large, interconnected pores between the aggregates. Water poured on the surface of such soils quickly disappears into the pores. Microorganisms, insects, small animals, and growing tree roots also contribute to soil aggregation (and consequently more pore space) by moving and mixing soil. These actions put soil particles in contact with each other, increasing the likelihood that soil particles will clump together, resulting in large pores through which water can easily drain. The *litter laye*r, which consists of leaves and bits of wood in various stages of decay on the forest floor, helps maintain healthy populations of soil organ-isms. By shielding the soil from the elements, the litter layer provides soil organisms with a less-hostile, more-stable environment.

Even in the winter, when forest soils may be frozen, they can maintain a high infiltration capacity. *Concrete fros*t, a solid impermeable layer of soil and ice, rarely forms in forest soils. The litter layer insulates soil from extreme cold. Also, because the loose forest soils have high amounts of organic matter and large pores, the frost penetrating such soils is of a more porous, granular, or honeycomb nature, permitting water to percolate through.

HOW FOREST VEGETATION SUPPORTS HEALTHY STREAMS

Vegetation	*Benefits*
Tree and shrub canopy overhanging the channel	• Stable water temperature improves conditions for desirable game fish • Source of large and fine plant debris • Source of terrestrial insects that fish eat
Leaves, branches, and other vegetative debris in stream channel (in proper amounts)	• Help create pools, riffles, and cover • Provide food source and stable base for many stream channel aquatic organisms
Roots in the streambank	• Increase bank stability • Create overhanging bank cover
Stems and low-growing vegetation in the floodplain	• Retard movement of water, sediment, and floating debris in flood water

Source: Adapted from Craven, S.; Jackson, G.; Swenson, W.; and Webendorfer, B. 1987. The Benefits of Well-managed Stream Corridors (G-3404). Department of Agricultural Journalism, University of Wisconsin-Madison.

The forest vegetation also protects the soil's infiltration capacity. Raindrops falling on exposed soil may have enough energy to break up soil aggregates. Individual soil particles are then easily eroded and washed into soil pores, clogging them and preventing rainwater absorption. When such conditions occur, water tends to flow over the soil surface, increasing the chance of erosion. But in a forest, rain is intercepted by the forest canopy, by the leaves of shrubs or small trees in the understory, and by the organic litter layer covering the forest floor, reducing the force with which rain falls on the soil. Soil pores remain unclogged, allowing infiltration.

Effects of Timber Harvesting

Cutting timber affects both water quantity and quality. Clearcutting (harvesting all trees) allows more water to flow to streams, because there are no leaves to intercept rain and snow (some of which would later evaporate) and roots no longer take water from the soil. Areas being considered for clearcutting should have a substantial ground layer of organic material to help minimize these effects. Much of the water taken into trees by their roots passes through the leaves into the atmosphere in a process called *transpiratio*n. Trees and other plants return water to the atmosphere through *evapotranspiratio*n—a combination of evaporation and transpiration. Evapotranspiration is an important process—during the growing season in a Pennsylvania hardwood forest, as much as sixty percent of the rainfall is returned to the atmosphere through evapotranspiration.

In the humid Northeast, the greatest increase in streamflow occurs during the first growing season after the clearcut. But in following years, as the area begins to revegetate, the increased flow lessens. Five to ten years after the cut, streamflow may return to precut levels. This effect on quantity is most important to managers of water-supply watersheds.

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Of greater concern to woodland owners is the effect of timber harvesting on water quality. Because of the possibility of accelerating erosion, logging can contribute to sedimentation—the most damaging and widespread water pollutant from forested watersheds. Sediment harms water resources by destroying fish habitat, reducing the storage capacity of reservoirs, and increasing treatment costs for municipal water supplies.

The greatest problems do not occur as a result of the actual cutting of trees, but from moving them out of the forest, which re-quires the use of heavy equipment on a system of trails and roads. If the transportation system is not carefully designed and maintained, erosion on the watershed can be greatly in-creased, because roads account for the vast majority of sediment associated with timber harvesting.

In Pennsylvania, any activity, including timber harvesting, that disturbs more than 25 acres of earth requires a permit from the Department of Environmental Protection (DEP). Most timber harvests disturb less than 10 percent of the harvested area, so a permit is seldom required for logging fewer than 250 acres. Even if you are cutting less acreage, you must develop an erosion and sedimentation control plan and have it on site throughout the operation.

Protecting the Watershed

SKID TRAILS

Skidding is the process of dragging logs (usually with a rubber-tired tractor called a skidder) from the stumps to a central location, called a *log landing*, where they are loaded onto trucks and transported to the mill. The process can be very damaging to the soil surface. The weight of the skidder compacts the soil, reducing its infiltration capacity. Dragged logs scour the soil surface, plowing away the protective litter layer and the upper inches of soil. These gouges become channels through which water can flow at erosive velocities, carrying sediment to the streams. The following practices help minimize the damage from skidding. Keep well away from streams and never use streambeds, even dry ones, as skid trails. If streams (even seasonally dry ones) must be crossed, cross them at a right angle with temporary bridges or culverts.

LOG LANDINGS

If not properly located, log landings have the potential to get very muddy or allow large amounts of soil to wash away. Log landings create large areas of unprotected, exposed soil. Because of the skidders and trucks working there, the soil can also become extremely compacted. Therefore, it is crucial that water be kept from flowing through, or collecting in, the landing area.

ROADS

Most erosion and sedimentation problems are caused by the haul roads constructed for logging trucks to carry harvested trees from the forest. Problems can occur both during road construction and after the transportation system is in place. Road construction greatly disturbs forest soil. The protective litter layer is removed, the mineral soil below is compacted, and steep, potentially unstable cut-and-fill slopes are often created. Roadbeds increase surface runoff (by reducing infiltration) and also concentrate the runoff, creating favorable conditions for accelerated erosion.

Natural drainage patterns may be altered—water that once flowed below the surface may be intercepted by road cuts. This formerly subsurface water now seeps from road banks. Road-stream crossing are an especially sensitive area. The presence of flowing water in a stream channel means any disturbance of the streambanks or bottom immediately sends sediment into the stream. To lessen these problems, a haul road system must be properly planned and designed. The shorter the better. Roads should be designed with grades of 2 to 10 percent. Some grade is needed to prevent water from collecting, but grades of more than 10 percent are hard on equipment and promote erosion.