Soil Productivity

Environmental Effects of Woody Biomass

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Background

Soil is the fundamental resource of the forest (MFRC 2007). Without it or its productive capacity, the other resources of the forest are diminished. For example, soil productivity influences what plants can grow on a site and how well they grow; maintaining soil productivity will facilitate the regeneration, survival, and long-term growth of desired vegetation; and productive soils sustain a variety of forest values such as timber harvesting, wildlife habitat and biodiversity.

Concerns

Growing and harvesting biomass has the potential to impact the following aspects of soils (MFCR 2007).

- Physical properties, including soil structure, texture, porosity, density, drainage, and surface hydrology,
- Chemical status, including nutrient status and pH, and
- Biological characteristics of soils (i.e., the organisms that live in the soil).

Management activities may impact soil physical and chemical properties which will eventually affect soil nutrients, organic matter and moisture-holding capacity (Hall and Richardson 2001).

Increased trafficking increases the potential for soil displacement, compaction and rutting, erosion, nutrient depletion and erosion. Soil compaction increases soil strength which commonly slows root penetration and reduces the regeneration and growth of trees (Greacen and Sands, 1980; Miller et al., 1996), reduces soil infiltration rates, increases the potential for erosion, changes landscape hydrology (Harr et al. 1979). Water tables can rise after a biomass harvesting operation as tree removal reduces stand water uptake and evaporative loss.

Where woody biomass is removed under a two-pass system (i.e., the harvesting and recovery of roundwood and biomass occur in separate passes), increased trafficking occurs across the harvested site. This additional trafficking can result in more compaction across the site.

Mechanical site preparation techniques such as tillage, raking, windrowing, disking and piling can lead to reductions in soil organic matter which is important for maintaining soil microbial communities, forming soil structure, soil carbon storage, nutrient cycling and regulation of soil hydrological processes (Lattimore et al., 2009). A reduction in soil organic matter and soil carbon storage will reduce the total capital and availability of nutrients especially nitrogen (N), phosphorus (P), potassium (K) and calcium (Ca).

Soil biological processes are generally decreased through compaction, exposure of mineral soils, drying, accumulation of toxic elements, and extreme temperatures that may be caused by removal of downed and dead wood from the forest floor (Swift et al. 1979, Dick et al. 1988).

Where root suckering or coppice regeneration (i.e., a cycle where are cut to ground level every few years and then regrow from the stumps into a clump of stems) is planned, it is especially important to avoid damaging the root systems through compaction and rutting.

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Mitigation Strategies

All states have published water quality best management practices and some have woody biomass harvesting guidelines which are intended to mitigate a variety of impacts. They can serve as an excellent source of strategies to consider. Selected strategies are presented below. When working with a third-party contractor, consider including relevant mitigation strategies in a written, signed contract.

- Implement forestry best management practices which help manage water movement on-site. Use extra caution when considering tillage and road construction operations on erosion-prone sites.
- Design planting and harvesting activities with local hydrological conditions in mind to minimize the need for intensive site restoration later.
- Minimize the amount of infrastructure (roads, skid trails, and landings).
- Schedule activities to occur when soils are dry or frozen (MFRC, 2007; Lattimore et al., 2009).
- Avoiding re-entry into the general harvest area with a second operation for the sole purpose of harvesting biomass.
- Identify nutrient-poor sites and avoid harvesting biomass on those sites.
- Retain adequate quantities of slash on-site. There is no consensus over the exact amount of residue that should remain on a site after biomass extraction. Finnish guidelines recommend leaving up to 30% of residue or the same amount of nutrients on the forest floor (Heninger et al., 1997). Minnesota's guidelines recommend intentionally retaining 20% of the slash (MFRC 2007). Other best management practices include retention of tree needles and foliage on-site for nutrients.
- Retain a suitable amount of organic matter and organic soil cover as it reduces soil erosion and helps maintain favorable soil temperatures and moisture relations.

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