Timber Harvesting and Forest Soil Rutting Workshop

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WORKSHOP NOTES

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Restoration of Rutted Sites

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Some rutting and soil disturbance are inevitable in normal harvesting operations. In endorsement of the previous speakers, the manager should do everything possible to limit the impact through planning and control of the ongoing operation. Before any restoration repair can be prescribed, the type and amount of damage must be known and understood. The most serious types of soil damage from logging are compaction, erosion, and drainage impediment. Repair must be designed to alleviate the damage, and it should be concentrated where the damage is not severe, such as on logging decks. The restoration of impacted sites essentially involves three approaches or some combination of these treatments.

Physical Methods

On many soils, physically breaking up the compacted layer is a desirable practice. Froehlich and McNabb (1984) summarized a number of studies in which cultivation was used to mitigate skid trails and logging impacts (Table 1). Results indicate that growth (height and biomass) was increased by 13 to 70 percent. Since fertilizer was used in some of the studies, the tillage effect may be confounded. These studies were done in Australia, New Zealand, Germany, and the West Coast and may not reflect conditions in the southeastern United States.

Ross and Malcomb (1982) found that ploughing to a depth of 24 inches mixed organic matter with the mineral soil on peaty sites in Scotland, resulting in improved weed control and better physical properties of the site. Growth of spruce seedlings was improved in the first three and a half years after treatment.

In a study on the Santee Experimental Forest in South Carolina, Hatchell (1981) and McKee and Hatchell (1987) reported on the response of loblolly pine to treatments designed to mitigate skid trails and log decks on a Coxville loam (Beathera), which was poorly drained and had been highly compacted in the logging operation. Bedding increased height growth by 10 percent at age 12, but disking the skid trails had no significant effect on height growth. Use of sawdust as a source of organic matter in itself did not improve growth of trees on this site. McKee et al. (1985) point out that when using tillage to mitigate compacted areas, care should be taken to apply the treatment when the soil moisture is low enough for the

Table 1. Seedling response to tillage practices as reported from several literature sources.

Site and Species	Stand Age	Tillage Treatment	Increase in Growth	Difference in Survival
	--- yr. ---		.... %	....
New Zealand, deep clay loam, radiata pine (Berg 1975)	3	skid trails, landings ripped to 18-24 in. depth*	36(1)**	+30
New Zealand, deep clay loam, radiata pine (Berg 1975)	1-2	compacted ridge tops, ripped to 18-24 in. depth*	73(1)	+10
NE Bavaria, heavy clay logged area, Scotch pine (Burschel et al. 1977)	8	rotary-tilled to 8 in. depth,*	33(2)	--
		ploughed to 16 in.	56(2)	--
New Zealand, gravelly loam, radiata pine (Craig et al. 1977)	2	ploughed and disked,*	17(1)	-9
		ripped to 39 in. depth*	17(1)	+20
New Zealand, shallow stony soil radiata pine (Guild 1971)	3	ripped to 18-24 in. depth	8(1)	+37
Australia, irrigated nursery, silty clay, plow pan at 8 in. depth (Minko 1975)	1	deep-ripped*	60(1)	--
Western Oregon, skid trails, Douglas-fir	5	disturbed with brush blade	50(1)	--
New Zealand, glacial tillite with high clay content, eroded area, radiata pine (Ritchie 1965)	2.5	ripped on contour to 18 in. depth*	70(1)	+38
Scotland, peaty gley podzol with hardpan on boulder till, Japanese larch, lodgepole pine, and Scots pine (Thomson and Neustein 1973)	15	ripped to 17 in. depth and ploughed to 7 in. depth*	13(3)	--
		ploughed to 13 in. depth*	23(3)	--

*Fertilizer applied to tilled and control plots.

**(1) Height growth; (2) dry photomass production; (3) study compared 6 tillage treatments but no control plots were established; for growth comparison purposes, the tillage treatment resulting in the least height growth was used as the control.

(Table taken from paper by Froehlich and McNabb 1984).

equipment to be used without further damage to the site. Tillage, when the soil is wet, can cause further compaction and puddling. The incorporation of organic material in the form of tree bark was found to be beneficial for increasing soil organic matter (Iyer and Benson 1981). Brown and Thomas (1987) indicate that injection of organic liquids in clay soils will improve their hydraulic conductivity when compacted. The organic liquid must have a low dielectric constant. The chemicals used were acetone and ethanol, which are rather expensive and may have other environmental impacts. No indication was given of the effects of the materials on plant growth.

Chemical Methods

Reduced aeration and restrictive soil layers place increased demand by plants on nutrients that are available. Switzer et al. (1978) indicate that, as of the time they wrote their paper, fertilization was not used as an ameliorative treatment for logging compaction in the Southeast. Ghent et al. (1983) indicate that normal cultivation may not be sufficient to mitigate compaction, since the effect extends to depths below that which can be easily treated with cultivation. Morris et al. (1983) indicated that windrowing could remove as much as 10 percent of the site's nutrient reserves, which would be an effect similar to dragging logs in a skid trail. On eroded infertile sites in the Piedmont, the effect may be more drastic. Most of the nutrients on forested sites are concentrated in the surface 2 or 3 inches of soil and the forest floor. These layers are susceptible to displacement when logs are dragged over the site, even under ideal moisture conditions.

Hatchell (1981) and McKee and Hatchell (1987) reported on the use of fertilization compared to cultivation treatments. Two fertilization treatments were employed: a 200-50-100 and a 400-175-175 treatment. Values represent pounds per acre of nitrogen, phosphorus pentoxide, and potassium oxide. Fertilizer at the low level increased tree heights by 56 percent on the compacted soil (Table 2). Fertilizer did not significantly increase heights on uncompacted soil. Stem volumes per acre were increased at age 12 by 83 percent on the compacted soil with fertilizer. The high fertilizer level was not significantly better than the low level. McKee et al. (1985) suggested the application of 300 to 500 pounds per acre of triple super phosphate or diammonium phosphate on wet, poorly drained areas and 300 pounds per acre of a 10-10-10 fertilizer on well-drained areas subject to erosion. Lime at 2 tons per acre is needed on steep, erosive areas where a permanent grass cover is needed. To date, no indication has been found that the fertilizer needs to be disked into the soil; hence, material can be broadcast over the site.

Table 2. Height of loblolly pine in stands at age 12 by site preparation and fertilizer treatments and class of logging operations.

Treatments	Uncompacted Soil	Compacted Soil
	--------- feet ---------	
Site Preparation		
Herbicide	34.2b*	33.6b
Disking	33.5b	31.7b
Bedding	37.1a	36.9a
Fertilizer		
None	31.8b	27.2c
Medium	36.5a	36.3a
High	36.7a	38.2a
Logging Disturbance	35.0	33.9

*Means for the site preparation x logging disturbance interaction or for the fertilizer x logging disturbance interaction followed by a common lower-case letter are not significantly different at $P = 0.05$.

The application of fertilizer is also a practical way to offset the effects of physical damage to the soil, especially on logging decks and skid trails. Particularly on wet or compacted soils, the application of phosphorus appears to allow the plant to overcome restricted aeration. The fertilizer does not completely replace good aeration, but represents a relatively inexpensive alternative to intensive mechanical treatments on wet sites. On sites that remain too wet to repair mechanically, fertilization may be the only alternative.

Another approach used on the West Coast is the seeding of legumes to fix nitrogen (Cromack et al. 1978). Use of this approach in the Southeast would probably require the application of fertilizer as well to establish the legumes; however, no references indicating the uses of this approach in the area were found for mitigating skid trails. There may be situations where application of limestone will be needed to mitigate logging compaction; but, as indicated with legumes, no references were found. The use of limestone may be needed where soil acidity is a specific problem. Another approach found for mitigation of areas devoid of topsoil and having a high bulk density is the application of municipal wastewater sludge as a soil amendment (Berry 1986). Berry found on eroded mountain sites in South Carolina and Tennessee that 35 tons of sludge per acre resulted in 45 percent more height growth of loblolly pine than the use of 850 pounds per acre of a 10-10-10 fertilizer. The use of sludge requires large volumes of material which is more difficult to apply, and sludge has other environmental problems.

Species and Site Use

If tillage or fertilization treatments are ineffective in restoring the site, the selection of adapted species and alternate uses may be appropriate. No specific research results were found, but the use of species selection to meet a specific site quality value is alluded to by Smith (1978), who indicates that it is important to identify different kinds of sites and fit species composition to them. Such uses as wildlife clearings should be considered. In terms of alternate tree species, no recommendations were found. A possibility might be the use of cypress or swamp tupelo on skid trails that hold water for extended periods compared to the surrounding unimpacted areas. Some specific sites require more intense restoration. Some examples are given below.

Erosion

Erosion can be a problem even on relatively gentle slopes if the soil is compacted, laid bare, or left with ruts running uphill and downhill. Sheet erosion should be prevented by tilling the site to reduce compaction and then revegetating the area as quickly as possible. Ditches and ruts should be filled to prevent the formation of gullies.

On sites with bare soil subject to erosion, nitrogen is needed as well as phosphorus because the original nitrogen was concentrated primarily in the forest floor and surface mineral soil. In general, 300 pounds per acre of mixed fertilizer, such as a 10-10-10, will speed revegetation.

In addition to fertilizer, a cover crop is often needed to prevent erosion of bare soil. Quick cover can be obtained by seeding a fast-growing species, such as rye grass, in early fall or spring along with a perennial species that will vegetate the site until woody plants become established. Because of its aggressiveness, the rye grass should not be seeded at a rate of over 5 pounds per acre. The perennial grass should be seeded at a heavier rate, 50 to 60 pounds per acre of tall fescue or 40 to 50 pounds per acre of Bermuda grass. Depending on site and climate requirements, other grass species may be desirable.

Drainage

The drainage of a site can be considerably disrupted during logging, and displaced soil may create dams. Such conditions can be alleviated by disking or bedding during site preparation. Even on sites with good internal drainage before logging, deep rutting may restrict lateral flow of water in the soil, raising the water table to the point where planted trees cannot survive. Bedding may be required on these sites to raise the seedlings above the new water table.

Rough Areas and Tree Regeneration

Leveling the ground surface with a dozer blade may be a practical alternative on heavily disturbed sites, such as skid trails and log decks, if compaction is not a problem. If the site is to be regenerated naturally, special consideration should be given to these areas. The skidding and repair operations in these areas will have destroyed the seedlings already there. These areas should either be planted or direct-seeded to ensure a uniform stand. Local guidelines for establishment of the species used should be followed.

A summary of treatments to restore logging-disturbed areas is as follows:

- Rip (subsoil), disk, or bed areas that are compacted or puddled--but only when the site is dry.
- Apply phosphorus or nitrogen and phosphorus fertilizer.
- When slopes exceed 6 percent, fertilizer and seed with grass before planting trees.
- Clear blocked drainage.
- If a natural regeneration system is used on the area as a whole, trails and log decks may have to be planted with seedlings.

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Notes