3F: Site Preparation and Forest Regeneration

Management Measure for Site Preparation and Forest Regeneration

Confine on-site potential NPS pollution and erosion resulting from site preparation and the regeneration of forest stands. The components of the management measure for site preparation and regeneration are:

(1) Select a method of site preparation and regeneration suitable for the site conditions.

(2) Conduct mechanical tree planting and ground-disturbing site preparation activities on the contour of sloping terrain.

(3) Do not conduct mechanical site preparation and mechanical tree planting in streamside management areas.

(4) Protect surface waters from logging debris and slash material.

(5) Suspend operations during wet periods if equipment used begins to cause excessive soil disturbance that will increase erosion.

(6) Locate windrows at a safe distance from drainages and SMAs to control movement of the material during high-runoff conditions.

(7) Conduct bedding operations in high-water-table areas during dry periods of the year. Conduct bedding in sloping areas on the contour.

(8) Protect small ephemeral drainages when conducting mechanical tree planting.

Management Measure Description

Regeneration of harvested forestlands is important not only in terms of restocking a valuable resource, but also in terms of minimizing erosion and runoff from disturbed soils that could degrade water quality. Vegetative cover on disturbed soils reduces raindrop impact and slows storm runoff, and the roots of vegetation stabilize soils by holding them in place and aiding their aggregation. Both of these factors decrease erosion.

Harvesters and landowners can follow certain practices to protect the soil and aid tree regeneration. For instance, leaving the forest floor litter layer intact during site preparation operations minimizes soil disturbance and detachment, maintains infiltration, and slows runoff. These factors in turn reduce erosion and sedimentation after site preparation is completed. It is especially important to leave the forest floor litter layer intact in areas that have steep slopes, or erodible soils, or where the prepared site is located near a water body, all of which increase the risk of erosion, landslides, and degraded water quality. Site preparation methods such as herbicide application and prescribed burning cause less disturbance to the soil surface than mechanical practices and can be considered where mechanical site preparation could pose a threat to water quality. Drum chopping, a form of mechanical site preparation, normally results in less soil exposure than other mechanical methods. The intensity of a prescribed burn in part determines whether use of the method will pose a threat to water quality.

Natural regeneration, hand planting, and direct seeding are other methods that can be used to minimize soil disturbance, especially on steep slopes with erodible soils. Mechanical planting with machines that scrape or plow the soil surface can produce erosion rills, increasing surface runoff and erosion and decreasing site productivity.

Data in Figures 3-38 to 3-42 compare sediment loss or erosion rates for numerous site preparation methods. Many of the data are site-specific, so site characteristics and experimental conditions are mentioned (when available) in the text below and regional locations are noted on the figures.

Ballard (2000) reviewed the effects of forest management on forest soils. Mechanical site preparation, he noted, both has benefits and causes problems. Nutrient depletion is one adverse effect. A study in northern British Columbia concluded that 500 kg N/ha were removed on a large area that had been bladed, raked, and piled for burning. Conducting research on intensively-managed loblolly pine plantations in the Piedmont region of North Carolina, Piatek and Allen (2000) found the following nutrient removal rates from sites that received different methods of site preparation: Shear-pile-disk, 591 kg N/ha and 34 kg P/ha; stem-only harvest, 57 kg N/ha and 5 kg P/ha; chop and burn, 46 kg N/ha and 0 kg P/ha. Piatek and Allen (2000) also found that the nutrients removed during site preparation had no observable effect on foliage production when measured 15 years after planting on the site.

Beasley (1979) studied the relative soil disturbance effects of site preparation following clear-cutting on three small watersheds in the hilly northern coastal plain of Mississippi and Arkansas (Figure 3-38). Slopes in the three watersheds were mostly 30 percent or more. One site was single drum-chopped and burned; another was sheared and windrowed (windrows were burned); and a third was sheared, windrowed, and bedded to contour. The control watershed was instrumented and left uncut. Soil exposure was 37 percent on the chopped site, 53 percent on the sheared and windrowed site, and 69 percent on the bedded site. A temporary cover crop of clover was sown after site preparation to protect the soil from rainfall impact and erosion. Increases in soil erosion and sediment production were similar for all three treatments in the first year after site preparation. Decreases in these processes were noted during the second year on all sites. During the second year,

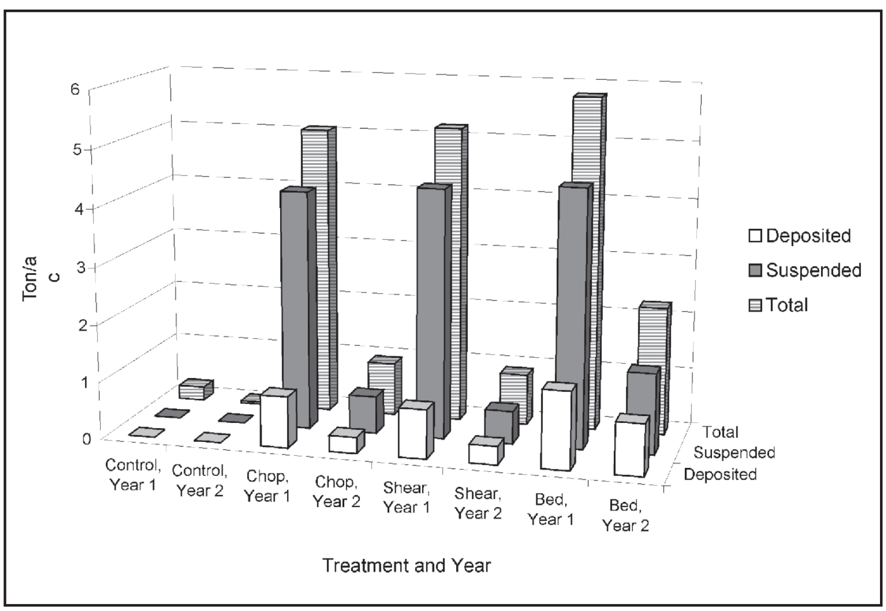

Figure 3-38. Deposited, suspended, and total sediment losses in experimental watersheds during water years 1976 and 1977 for various site preparation techniques (Mississippi, Arkansas) (after Beasley, 1979).

the clover and other vegetation covered 85 to 95 percent of the surface of each site and effectively decreased sediment production.

Golden and others (1984) summarized studies on erosion rates from site preparation (Figure 3-39). The rates reflect soil movement measured at the bottom of a slope, not the quantity of sediment actually reaching streams. Therefore, the numbers estimate the worst-case erosion if a stream is located directly at the toe of a slope with no intervening vegetation. Rates are averages for 3- to 4-year recovery periods.

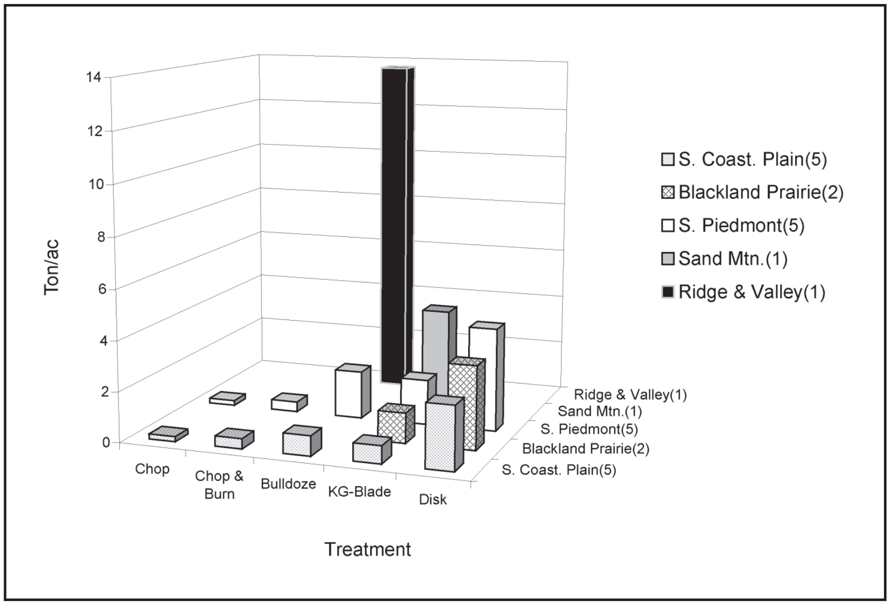

Figure 3-39. Predicted erosion rates using various site preparation techniques for physiographic regions in the southeastern United States (after Golden et al., 1984). Numbers in parentheses indicate number of predictions for the region.

Dissmeyer (1980) showed that discing produced more than twice the erosion rate of any other method (Figure 3-40). Bulldozing, shearing, and sometimes grazing were associated with relatively high rates of erosion, and chopping or chopping and burning produced moderate erosion rates. Logging also produced moderate erosion rates in this study when the effect of skid and spur roads was included. The lowest rate of erosion was associated with burning.

Beasley and Granillo (1985) compared storm flow and sediment losses from mechanically and chemically prepared sites in southwest Arkansas over a 4-year period. Mechanical preparation (clear-cutting followed by shearing, windrowing, and replanting with pine seedlings) increased sediment losses in the first 2 years after treatment. A subsequent decline in sediment losses in the mechanically prepared watersheds was attributed to rapid growth of ground cover. Windrowing brush into ephemeral drainages and leaving it unburned effectively minimized soil losses by trapping sediment on the site and reducing channel scouring. Chemical site preparation (using herbicides) had no significant effect on sediment losses.

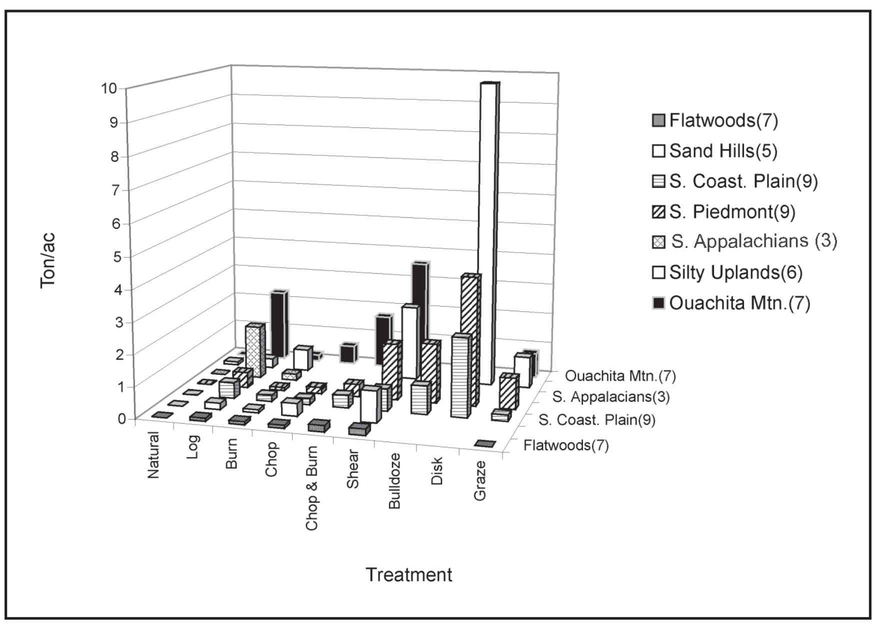

Figure 3-40. Erosion rates for site preparation practices in selected land resource areas in the Southeast (after Dissmeyer, 1980). Numbers in parentheses indicate the number of sites in the region.

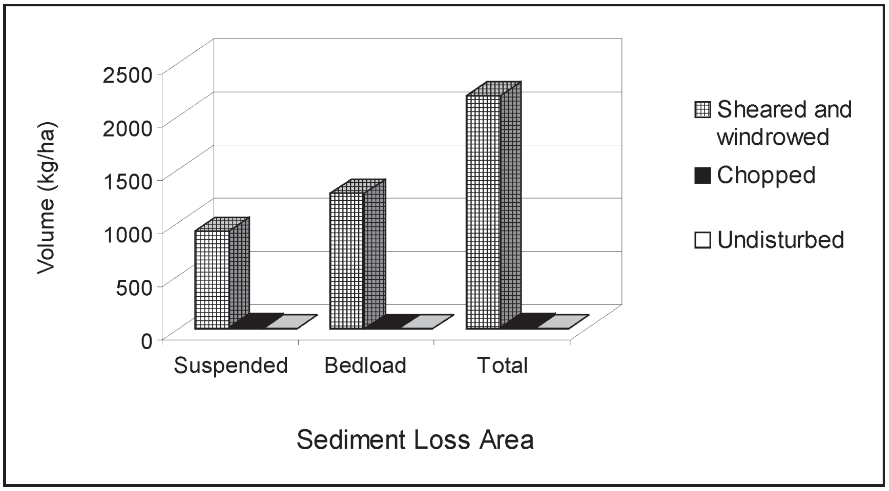

Figure 3-41. Sediment loss (kg/ha) in stormflow by site treatment from January 1, to August 31, 1981 (TX) (after Blackburn et al., 1982).

Blackburn and others (1982) studied water quality changes associated with two site preparation methods in Texas. Figure 3-41 shows that shearing and windrowing (which exposed 59 percent of the soil) produced 400 times more sediment loading than chopping (which exposed 16 percent of the soil) during site preparation in this study. The authors also found that total nitrogen losses from sheared and windrowed watersheds were nearly 20 times greater than those from undisturbed watersheds and three times greater than those from chopped watersheds (Figure 3-42).

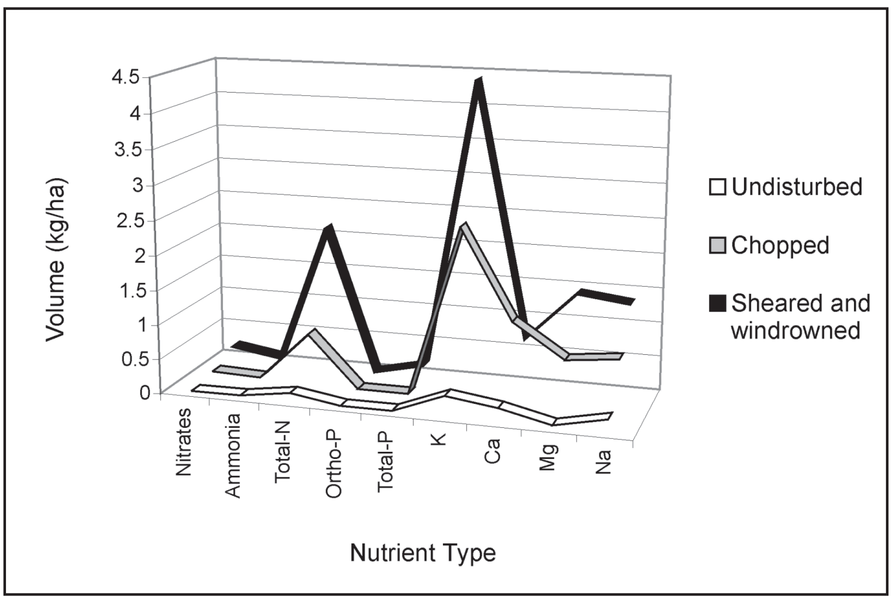

Figure 3-42. Nutrient loss (kg/ha) in stormflow by site treatment from January 1 to August 31, 1981 (TX) (after Blackburn et al., 1982).

Mechanical Site Preparation in Wetlands

Under certain circumstances, a permit is needed for mechanical forestry site preparation activities when used for the establishment of pine plantations in the Southeast. EPA and the U.S. Army Corps of Engineers recently issued a memorandum to clarify the applicability of forested wetlands BMPs to these circumstances. Refer to the Wetlands Forest Management Measure for a discussion of permitting requirements in forested wetlands.

Benefits of Site Preparation Practices

Three studies summarized here compare the costs and benefits of different site preparation methods. Dissmeyer and Foster (1987) estimated the long-term costs and benefits of light and heavy site preparation in the Southeast. They concluded that light site preparation would yield more wood production and a higher internal rate of return on investment (Table 3-30). Heavy site preparation methods involve a greater initial investment than light site preparation methods but did not yield more wood per unit area.

Table 3-30. Analysis of Two Management Schedules Comparing Cost and Site Productivity in the Southeast (Dissmeyer and Foster, 1987)

Year	Silviculture Treatment	Light Site Preparation[a]		Heavy Site Preparation[b]	
		Investment Per Hectare[c]	Wood Produced M³/ha	Investment Per Hectare[c]	Wood Produced M³/ha
1984	Site Prep/Tree Planting	$297		$420	
1999	Thinning	$252	64.2 pulpwood	$180	46.0 pulpwood
2010	Thinning	$256	22.3 saw timber 33.3 pulpwood	$331	5.3 saw timber 22.0 pulpwood
2020	Final Harvest	$2,422	133.5 saw timber 15.2 pulpwood	$2,071	112.3 saw timber 22.0 pulpwood
Present Net Value (at 4%)		$623		$304	
Internal Rate of Return		12.4%[d]		10.1%	

[a] Light site preparation includes chop and light burn or chop with herbicides, and reduces soil exposure and erosion.
[b] Heavy site preparation includes bulldozing or windrowing or shearing and windrowing, and increases erosion and sediment y ields over those for light site preparation.
[c] 1984 dollars.
[d] Based on 4% inflation rate assumed.
Source: Adapted from Patterson, 1984. Dollars in Your Dirt. Alabama's Treasured Forests. Spring: 20-21

Dissmeyer (1986) analyzed the economic benefits of controlling erosion during site preparation. Site preparation methods that increased soil exposure, displacement, and compaction increased site preparation costs and erosion from the site prepared (Table 3-31) and decreased timber production. Using light site preparation techniques such as a single chop and burn reduced erosion, increased timber production on the site, and cost less per unit area treated than more intensive site preparation methods. Heavy site preparation techniques such as shearing and windrowing removed nutrients, compacted soil, increased erosion and site preparation costs, and resulted in a lower present net value of timber.

The U.S. Forest Service (1987) examined the costs of three alternatives to slash treatment: (1) broadcast burn and protection of streamside management zones, (2) yarding of unmerchantable material (YUM) of 15 inches in diameter or more, and (3) YUM of

Table 3-31. Site Preparation Comparison (VA, SC, NC) (Dissmeyer, 1986)

Treatment	Treatment Cost ($/acre)	Erosion Index[a]
No site preparation	$59	1.0
Burn only	$67	1.1
Single chop and burn	$119	2.3
Double chop and burn	$178	3.0
Single shear and burn	$216	4.3
Shear twice and burn	$253	5.1
Rootrake and disk and burn	$253	16.0
Rootrake and burn	$253	16.0

Note: All costs updated to 1998 dollars
[a] The index is an expression of relative erosion potential resulting from each treatment.

8 inches in diameter or more (Table 3-32). The two YUM alternatives cost approximately $625-$1,180/acre, in comparison to broadcast burning at $1,300/acre (1998 dollars). In addition, the YUM alternatives protected highly erodible soils from direct rainfall and runoff effects, reduced fire hazards, resulted in meeting air and water quality standards, and allowed for the rapid establishment of seedlings on clear-cut areas.

Table 3-32. Comparison of Costs for Yarding Unmerchantable Material (YUM) vs. Broadcast Burning (OR) (USDA-FS, 1987)

Activity	Broadcast Burn and Protect SMA	YUM 15" in Diameter and No Burn	YUM 8" in Diameter and No Burn
Broadcast burn	$502/acre	N/A	N/A
SMA protection	$646/acre	N/A	N/A
YUM, fell hardwood, lop and scatter	N/A	$438/acre	$1,004/acre
Planting cost	$143/acre	$187/acre	$172/acre
Totals	$1,291/acre	$624/acre	$1,177/acre

Note: All costs updated to 1998 dollars.

Best Management Practices

Site Preparation Practices

◆ *Do not conduct mechanical site preparation, except for drum chopping, on slopes greater than 30 percent.*

On sloping terrain greater than 10 percent, or on highly erosive soils, operate mechanical site preparation equipment on the contour.

◆ *Do not conduct mechanical site preparation in SMAs.*

◆ *Do not place slash in perennial or intermittent drainages, and remove any slash that accidentally enters drainages.*

Slash can clog the channel and cause alterations in drainage configuration and increases in sedimentation. Extra organic material can lower the dissolved oxygen content of the stream. Slash also allows silt to accumulate in the drainage and to be carried into the stream during storm events.

◆ *Provide SMAs of sufficient width to protect streams from sedimentation by the 10-year storm.*

◆ *Locate windrows a safe distance from drainages to avoid material movement into the drainages during high-runoff conditions.*

Locating windrows above the 50-year floodplain usually prevents windrowed material from entering floodwaters.

◆ *Avoid mechanical site preparation operations during periods of saturated soil conditions, which might cause rutting and accelerate soil erosion.*

◆ *Minimize soil movement when shearing, piling, or raking.*

- *Minimize incorporation of soil material into windrows and piles during their construction.*

This can be accomplished by using a rake or, if using a blade is unavoidable, keeping the blade above the soil surface and removing only the slash. This helps retain nutrient-rich topsoil, which promotes rapid site recovery and tree growth and increases the effectiveness of the windrow in minimizing sedimentation.

Forest Regeneration Practices

- *Distribute seedlings evenly across the site.*
- *Order seedlings well in advance of planting time to ensure their availability.*
- *Hand plant highly erodible sites, steep slopes, and lands adjacent to stream channels (SMAs).*
- *Operate planting machines along the contour to avoid ditch formation.*
    - Ensure that soil conditions (slope, moisture conditions, etc.) are suitable for machine operation.
    - Close slits or drilling furrows periodically to avoid channeling flow.