Establishing Natural Regeneration Of Ponderosa Pine In Central Arizona

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*ABSTRACT— Since 1968, more than 11,000 acres of Rocky Mountain ponderosa pine (*Pinus ponderosa *var.* scopulorum *Engelm.) natural regeneration have been established on the Chevelon District of the Apache-Sitgreaves National Forest by timing site preparation and rodent control with seedfall. Domestic livestock is excluded from regeneration areas. At current prices, the average cost per acre of natural regeneration is about $41, which is $218 less than the cost of planting an acre in the Southwest.*

In the Southwest (Arizona and New Mexico), planting is the most reliable method of regenerating Rocky Mountain ponderosa pine. In order for planting to succeed, however, several measures are essential. These include planting healthy trees on well-prepared sites where grazing is excluded (Heidmann et al. 1977, Schubert et al. 1970).

Trees are planted by use of soil augers or, occasionally, planting bars. Machine planting in the Southwest is limited by rocky sites. Regeneration areas are usually prepared mechanically with large disks. However, herbicides are superior for preparing grassy sites because of the resulting increased soil moisture, reduced erosion potential, and lower costs (Heidmann 1969). Livestock should be excluded from regeneration areas for at least five years.

Planting trees, however, is expensive. In 1978, for example, costs reported by the USDA Forest Service averaged $259 to plant 641 trees per acre in Arizona and New Mexico (all overhead and support costs are included in this figure). Regionwide survival averaged 49 percent after three years, making the cost of each surviving tree approximately 82 cents.

Because of the high cost of planting, a decision was made in 1968 to attempt to devise a method of obtaining natural regeneration. Up to that time, no deliberate efforts had met with success, but there were areas, primarily on sedimentary soils, where natural regeneration has occurred in the past.

Considerations

Several factors make natural regeneration of ponderosa pine difficult in the Southwest. Total precipitation (14 to 30 inches yearly, occasionally more than 35 inches) is adequate for tree growth, but poor seasonal distribution limits seedling establishment (Schubert 1974). The annual spring drought may last for 90 days, until summer rains begin in July. A fall dry season is less predictable.

Effects of droughts are intensified by competing herbaceous vegetation, primarily bunchgrasses such as Arizona fescue (*Festuca arizonica* Vasey), which usually grows in association with mountain muhly (*Muhlenbergia montana* (Nutt.) Hitchc.) as a subclimax (Rietveld 1977). Arizona fescue begins growth in the spring, and its extensive root system enables it to use most of the available soil moisture (Schubert et al. 1970).

Reforestation is further complicated by soil type. Forest soils are mainly igneous or sedimentary in origin. Igneous soils derived from basalt are very fine-textured, containing as much as 65 percent silt, with the remaining portion primarily clay (Heidmann 1975). Trees on fine-textured soils are highly susceptible to frost heaving and drought (Heidmann 1976, Heidmann et al. 1977).

Frost heaving occurs because of a segregation of soil water which freezes into layers of ice. Segregation is related mainly to soil texture. Soils with high silt contents are highly susceptible to heaving, though the damage to pine seedlings tends to vary inversely with size of their tops (Schramm 1958). Growth of first-year ponderosa pine seedlings on fine-textured soils is quite slow, partially because availability of moisture is poor at low soil-moisture contents. Thus, a condition arises where very small seedlings (1½ to 2½ inches tall), highly susceptible to heaving, are growing in a soil with high heaving potential. In addition, these small seedlings are usually unable to withstand severe drought.

On sedimentary soils, which are coarser in texture, seedlings are usually larger because water is available even at low soil-moisture contents. Consequently, drought and frost heaving are less severe, although these soils will heave if they are at or near their maximum bulk densities (Heidmann and Thorud 1975).

Domestic livestock and big game, mainly mule deer (*Odocoiles hemionus crooki*) and elk (*Cervus canadensis merriami* Nelson), cause considerable damage by browsing terminals of small trees. Browsed seedlings may not die, but growth is slowed considerably (Heidmann 1972).

Problems with natural regeneration are further complicated because heavy logging and fire in early days opened stands and allowed perennial grasses to invade.

Despite these obstacles, personnel from the Chevelon District, Apache-Sitgreaves National Forest, and the Timber Management Research Staff of the Flagstaff Unit, Rocky Mountain Forest and Range Experiment Station, believed that regeneration efforts could succeed. This belief was reinforced by observations from the 25,000-acre Dudley Lake burn, on the district. The fire occurred in 1956, and by 1968 a considerable portion of the burn had restocked through natural means.

Studies on the Chevelon District

The Chevelon District covers approximately 210,000 acres in central Arizona. Ponderosa pine is the predominant forest type, occupying about 107,000 acres on fairly level to rolling terrain at an elevation of 6,500 to

7,500 feet. Soils are mainly sedimentary in origin. Annual precipitation varies from 14 to 15 inches at the northern boundary to about 36 inches on the Mogollon Rim to the south. Throughout a considerable portion of the pine type, alligator juniper (*Juniperus deppeana* Steud.) and Gambel oak (*Quercus gambelii* Nutt.) are components of the understory. The ground cover is mountain muhly, other grasses, and forbs.

In 1968, personnel on the district were concerned because 17,000 acres of ponderosa pine stands were understocked after logging between 1948 and 1952. Despite three good seed crops in subsequent years, few seedlings had become established. Lack of regeneration was initially attributed to competition from alligator juniper and Utah juniper (*J. osteosperma* (Torr.) Little) released by logging, but later observations indicated that competition from perennial grasses was the primary problem. In 1968, a pilot study aimed at getting natural regeneration was established on two 45-acre plots by district personnel. Treatments and procedures were outlined by the Timber Management Staff at Flagstaff and included chemical and mechanical site preparation, rodent control, and protection from grazing.

Recommended Practices

The pilot study was highly successful and revealed that mechanical site preparation, rodent control, and protection are essential for establishing natural regeneration. Over the past 10 years results from the study plus refinements have led to a prescription for obtaining natural regeneration on sedimentary soils.

The first step is to determine when a cone crop can be expected on the area scheduled for regeneration. Ponderosa pine cones mature two years after initiation of flower primordia. During the year before cone maturation, flowers are pollinated in spring, and conelets enlarge to marble size by fall. Because such conelets are small and difficult to see, seed tree areas must be carefully checked with binoculars; procedures have been outlined by Fowells and Schubert (1956).

In the Southwest, good cone crops occur every three to four years. Pearson (1950) states that large trees will yield two pounds of seed in a good year and four pounds in a bumper year (10,000–15,000 seeds per pound). Some individual trees on the Chevelon District, however, produced 25 pounds in one year. An adequate cone crop for natural regeneration on sedimentary soils should yield 100,000 or more seeds per acre. In a good year, this amount will be produced by five trees that are 20 inches in d.b.h. or larger.

If an adequate cone crop is expected, the next step is to census the rodent population in the fall preceding the year before cones mature. Traps are placed on the site for three successive nights. If 13 mammals are trapped per 100 trap nights, control is started. The area is treated with zinc phosphide on oats (2 pounds of phosphide per 100 pounds of grain) under the supervision of the USDI Fish and Wildlife Service. If 13 or more rodents are still taken the following fall, the area is treated again. The cost of two treatments runs from $9 to $11 per acre, while a single treatment costs about $6 per acre.

During the summer that cones are maturing, the area is logged, leaving about five trees having a d.b.h. of 20 inches or more. The residual stand resembles a shelterwood, because numerous trees approximately 12 inches d.b.h. and smaller remain (*fig. 1*). These trees contribute to seed production and furnish shade.

Figure 1. Typical view of regeneration area on the Chevelon District, Apache-Sitgreaves National Forest, illustrating number of seed trees left after logging.

Cattle are allowed to graze the area heavily during the summer preceding fall site preparation. Site preparation is accomplished by a disk with 38-inch blades. The disk is usually drawn in a criss-cross pattern so that approximately 70 percent of the area is thoroughly disturbed. Disking costs $18 to $25 per acre.

In August and November of the first year and in September of the second year, seedling counts are made on five randomly distributed plots per acre. On areas over 1,000 acres, about 1 acre per 100 is sampled, while on smaller areas 1 acre in 50 is checked. Counts are made again in the third and fifth year.

Disking appears to stimulate grasses, especially mountain muhly, which reduce tree seedling growth. As a consequence, seedlings are vulnerable for long periods to browsing animals and to tip moths (*Rhyacionia neomexicana* Dyar), which are particularly prevalent at Chevelon and cause considerable damage to leaders. Because the moths range only a few feet above the ground, damage from them as well as from grazing animals could be lessened if juvenile growth could be speeded. Studies are in progress to determine if seedlings can be released from grass competition with herbicides. Tip moths may be controlled by applying dimethoate (Cygon) to the terminals each year. Dimethoate, however, is moderately toxic to humans and should not be applied to large areas indiscriminately. If possible, cattle should be excluded for five years, but grazing may be allowed after three years, depending on the individual situation. When cattle are allowed on regeneration areas, use should be restricted to the growing season, and then only under careful supervision.

Applicability

In the past 10 years, ponderosa pine has been established by natural means on more than 11,000 acres of the Chevelon District (*fig. 2*). By the most recent Forest Service estimates, natural regeneration costs approximately $41 per acre in the Southwest. The cost to regenerate 11,000 acres would, therefore, be about $451,000, as compared to $2,849,000 for planting—a saving of $2,398,000.

Reliance on natural regeneration seems reasonable on sedimentary soils. It should not be attempted on volcanic soils until methods to minimize effects of drought

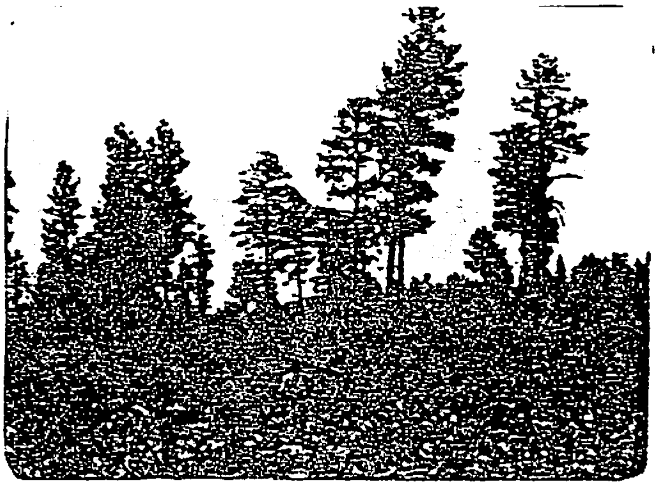

Figure 2. Stand of natural ponderosa pine seedlings on Chevelon Ranger District several years after application of cultural treatments.

and to accelerate growth are found. Because the Chevelon area is not unique, it is logical to expect that the methods developed there are applicable on other southwestern areas having sedimentary soils. For example, good stands of natural regeneration exist on the southern half of the Coconino, the North Kaibab, and Tonto national forests, and these areas can be regenerated naturally at a fraction of the cost of planting. ■

Literature Cited

FOWELLS, H. A., and G. H. SCHUBERT. 1956. Seed crops of forest trees in the pine region of California. USDA Tech. Bull. 1150. 48 p.

HEIDMANN, L. J. 1969. Use of herbicides for planting site preparations in the Southwest. J. For. 67:506–509.

HEIDMANN, L. J. 1972. An initial assessment of mammal damage in the forests of the Southwest. USDA For. Serv. Res. Note RM-219. 7 p.

HEIDMANN, L. J. 1975. Predicting frost heaving susceptibility of Arizona soils. USDA For. Serv. Res. Note RM-295. 7 p.

HEIDMANN, L. J. 1976. Frost heaving of tree seedlings: a literature review of causes and possible control. USDA For. Serv. Gen. Tech. Rep. RM-21. 10 p.

HEIDMANN, L. J., and D. B. THORUD. 1975. Effect of bulk density on frost heaving of six soils in Arizona. USDA For. Serv. Res. Note RM-293. 4 p.

HEIDMANN, L. J., F. R. LARSON, and W. J. RIETVELD. 1977. Evaluation of ponderosa pine reforestation techniques in central Arizona. USDA For. Serv. Res. Pap. RM-190. 10 p.

PEARSON, G. A. 1950. Management of ponderosa pine in the Southwest. USDA Agric. Monogr. 6. 218 p. Wash., D.C.

RIETVELD, W. J. 1977. Phytotoxic effects of bunchgrass residues on germination and initial root growth of yellow sweetclover. J. Range Manage. 30:39–43.

SCHRAMM, J. R. 1958. The mechanism of frost heaving of tree seedlings. Am. Philos. Soc. Proc. 102(4):333–350.

SCHUBERT, G. H. 1974. Silviculture of southwestern ponderosa pine: the status of our knowledge. USDA For. Serv. Res. Pap. RM-123. 71 p.

SCHUBERT, G. H., L. J. HEIDMANN, and M. M. LARSON. 1970. Artificial reforestation practices for the Southwest. USDA Agric. Handb. 370. 25 p. Wash., D.C.

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