FORAGE AND PINE GROWTH WITH CLEARCUTTING AND SITE PREPARATION[1/]

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Abstract.--Total available forage yield on three loblolly-shortleaf pine-hardwood forest sites in east Texas was sampled before clearcutting and one, three, and five growing seasons after planting site preparation. All sites were planted with 1-0 loblolly pine seedlings. Total forage yield averaged 345 kg/ha in the uncut forest. Yields peaked the first summer after site preparation on the untreated control (3294 kg/ha), burned (3719 kg/ha), and chopped plots (3416 kg/ha), and in the third year on the KG-bladed plots (3167 kg/ha). By the fifth growing season total forage yield declined to 1016, 1434, 1796, and 2132 kg/ha, respectively. After five growing seasons, pine survival averaged 87 percent on KG plots, 79 percent on chopped, 63 percent on burned, and 57 percent on control plots. Mechanical site treatments resulted in better pine height and diameter growth than the burned and control treatments.

INTRODUCTION

Clearcutting, site preparation, and planting are efficient means of harvesting and regenerating southern pines. However, there is considerable disagreement as to how these silvicultural practices affect other land uses and values.

The present study was conducted to find out how forage yields, plant species composition, and the growth of planted pines are affected by various site preparation methods after clearcutting of timber on pine-hardwood forest sites of east Texas. These data are needed to help clarify the effects of silvicultural operations on wildlife habitats.

Temple-Eastex Incorporated of Jasper, and International Paper Company of Nacogdoches, Texas, provided land, machinery, and manpower to establish and maintain this study.

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STUDY SITES

All three study sites are within the loblolly-shortleaf pine-hardwood forest type that covers nearly 28 million ha in the southern U.S., and reaches its westernmost extension in east Texas (Stransky 1976). All sites supported mature pine-hardwood stands before clearcutting in the fall of 1972.

The sites are part of the Gulf Coastal Plain's Quaternary deposits, which are underlain by sands, sandstones, and clays of the Tertiary's Oligocene period (Dumble 1918). Their topography is nearly level to gently sloping.

Site 1 is about 24 kilometers south of Nacogdoches, Texas, on the Stephen F. Austin Experimental Forest. The site has never been cleared for agriculture, and, based on ring counts, the timber had remained uncut for at least 50 years. Interspersed with the pines were several hardwoods as old as 117 years; the majority though were about 80 years of age. Tree basal area averaged 38 m^2/ha; 31 m^2 in pine and 7 m^2 in hardwood.

The principal pine species were loblolly pine (Pinus taeda L.) and shortleaf pine (P. echinata Mill.) in admixture with southern red oak (Quercus falcata Michx.), sweetgum (Liquidambar styraciflua L.) and winged elm (Ulmus alata Michx.).

Prominent among shrubs were American beautyberry (Callicarpa americana L.) and blackberry

(Rubus spp.). Virginia creeper (Parthenocissus quinquefolia (L.) Planch.), grape (Vitis spp.), and greenbriers (Smilax spp.) were among the most prominent vines. Vines made up 82 percent of the understory small stems, other hardwoods 9 percent, oaks 4 percent, shrubs 4 percent, and pines 1 percent. Longleaf uniola (Uniola sessiliflora Poir.), elephant's foot (Elephantopus tomentosus L.) and twinberry (Mitchella repens L.) were common herbaceous plants.

Site 2 is near Wells, in Cherokee County, and is owned by International Paper Company. It is 16 km due west of site 1 (Nacogdoches County). The area was cleared for agriculture around 1890 and was cultivated until about 1930. The abandoned land was invaded by pines. Several hardwoods on the site were as old as 85 years, the majority being about 45 years of age. Tree basal area averaged 21 m^2/ha; 11 m^2 in pine and 10 m^2 in hardwood.

The prevalent pine species were loblolly pine and shortleaf pine. These occurred together with southern red oak, post oak, water oak, sweetgum, and winged elm.

Principal shrubs were American beautyberry and blackberry. Virginia creeper, grapes, and greenbriers were the most prominent vines. Vines made up the greatest proportion of small stems (35 percent), followed by shrubs (33 percent), other hardwoods (17 percent), oaks (12 percent), and finally pines (3 percent). Most common herbaceous plants were longleaf uniola, pinehill bluestem (Andropogon spp.), and panic grasses (Panicum spp.).

Site 3 is about 80 km southeast of site 1 near Jasper, in Jasper County, Texas. It is owned by Temple-Eastex Incorporated. The site had never been cleared for cultivation but it had been grazed by livestock. The area supported a 45-year-old forest stand. Tree basal area averaged 24 m^2/ha; 18 m^2 in pine and 6 m^2 in hardwoods.

The principal tree species of the overstory were loblolly pine, shortleaf pine, southern red oak, water oak, post oak, willow oak (Quercus phellos L.), sweetgum, and blackgum (Nyssa sylvatica Marsh.).

The midstory was about 30 years old, consisting mainly of the same species as the overstory, plus American holly (Ilex opaca Ait.), red maple (Acer rubrum L.), mockernut hickory (Carya tomentosa Nutt.), and flowering dogwood (Cornus florida L.).

Common shrubs were American beautyberry, yaupon (Ilex vomitoria Ait.), blackberry, blueberry (Vaccinium spp.), and southern wax-myrtle (Myrica cerifera L.). Prevalent vines were yellow jessamine (Gelsemium sempervirens (L.) Ait.), muscadine grape (Vitis rotundifolia Michx.), and greenbriers. Vines made up 47 percent of the understory stems, shrubs 34 percent, other hardwoods 10 percent, oaks 6 percent, and pines 3 percent. Longleaf uniola, elephant's foot, and twinberry were the most abundant herbaceous plants.

METHODS

Site Treatments

The study had a randomized block design consisting of three adjacent blocks and four site treatments on each of the three sites. Individual site treatment plots were 0.6 ha squares. After the merchantable trees were cut and removed from the three study areas in the fall of 1972, the following site preparation treatments were applied during February and March 1974 on site 3, and during August and September 1974 on sites 1 and 2:

Control--No site preparation, all woody stems greater than 2.5 cm in diameter at breast height (dbh) were cut.
Burn--all stems greater than 2.5 cm dbh were cut and burned with the logging slash by head fires.
Chop--logging slash and all stems were cut with a chopper and burned.
KG--all stems were cut with a KG blade, and the logging slash was raked off the plots and burned. Sites 1 and 2, but not site 3, were cultivated with a heavy-duty disk after having been KG bladed.

The sites were handplanted with 1-0 loblolly pine seedlings at 2.4 by 3 m spacing. Site 3 was planted in mid-March 1974, and sites 1 and 2 in February and March 1975.

Vegetation Measurements

In the summer of 1972 and 1973 before and one year after timber cutting, the vegetation on all three sites was inventoried and forage yield sampled on 20 1-m^2 quadrats equally spaced within the central 0.4 ha of each 0.6 ha plot. The inventory and forage yield sample was again taken one, three and five growing seasons after site preparation. Site 1 was sampled in the summers of 1975, 1977, and 1979; site 2 only in the summers of 1975, and 1977; site 3 in the summers of 1974, 1976, and 1978. The annual growth of all herbaceous and woody plants was clipped up to a height of 1.5 m, dried at 70° C, and weighed to the nearest 0.1 g. We grouped these data to show yields in kilograms per hectare (kg/ha) for herbage (grasses, grasslike species, legumes, composites, and other forbs), and browse (pines, oaks, other trees, shrubs, and vines). Plant nomenclature followed Gray's Manual of Botany (Fernald 1970).

Pine seedling survival was tallied on randomly selected rows at all three sites at the end of the first and the fifth growing seasons after planting. Tree heights and diameters (dbh) were measured after the fifth growing season, and observations were made on crown class and insect damage.

For all data, differences among treatments were tested by analysis of variance at the 0.05 level of significance, and by Duncan's test.

RESULTS AND DISCUSSION

Forage Yield

Before Clearcutting (1972)

On site 1 total forage yield in the uncut timber ranged from 258 to 356 kg/ha, averaging 328 kg/ha. Of this 232 kg/ha were browse (70 percent), and 96 kg/ha were herbage -- mostly grass (30 percent). Thus, available browse greatly outweighed herbage (Table 1).

Species contributing most to browse yields were mockernut hickory, flowering dogwood, sweetgum, poison ivy (Rhus radicans L.), and rusty blackhaw (Viburnum rufidulum Raf.). Longleaf uniola contributed 79 percent of the total herbage yield.

On site 2 total forage yield ranged from 287 to 384 kg/ha, averaging 347 kg/ha. On this formerly cleared site, browse species contributed only 40 percent of the total forage, mostly Virginia creeper, greenbriers, post oak, sweetgum, winged elm, and American beautyberry. Longleaf uniola contributed 54 percent of the herbage. Along with panic grasses, pinehill bluestem, and longleaf uniola, grasses amounted to 68 percent of the total herbage.

On site 3 total forage yield ranged from 309 to 383 kg/ha, averaging 359 kg/ha. Browse species averaged 86 percent of the total, mostly yaupon, yellow jessamine, and sweetgum. Longleaf uniola, twinberry, and elephant's foot constituted 91 percent of the herbage yield.

After Clearcutting (1973)

On site 1, one growing season after clearcutting, forage yields ranged from 1330 to 2058 kg/ha, averaging 1714 kg/ha; a fivefold increase over the uncut stand. The most obvious feature of the post-cutting yield pattern in 1973 was the great increase in grasses and other herbaceous plants (Table 1).

The greatest total yields were obtained on the control and burned plots from which small pines and culls were cut by hand soon after the merchantable overstory was harvested. The KG and chop plots yielded less total forage because they still contained leftover cull trees. The proportion of herbage too, was less on these plots than on the other treatments.

Browse species contributing most to forage yield were American beautyberry, Virginia creeper, grapes, southern red oak, sweetgum, and winged elm.

Table 1.--Forage yield by sites, site treatments, and sampling dates

Forage	Control				Burn				Chop				KG			
	Before cut	After: Years after site cut			Before cut	After: Years after site cut			Before cut	After: Years after site cut			Before cut	After: Years after site cut		
		1st	3rd	5th		1st	3rd	5th		1st	3rd	5th		1st	3rd	5th
	preparation				preparation				preparation				preparation			
	kg/ha															
SITE 1																
Browse	168	1022	1722	1473	745	244	1045	1748	1654	885	248	978	1592	1871	1087	267	812	303	698	1003
Herbage	90	1036	1558	743	184	105	767	2274	942	299	102	680	1914	1152	352	89	518	2536	2431	951
Total	258	2058	3280	2216	929	349	1812	4022	2596	1184	350	1658	3506	3023	1439	356	1330	2839	3129	1954
SITE 2																				
Browse	110	297	877	842	--	196	373	747	908	--	152	273	390	808	--	104	394	144	334	--
Herbage	247	1092	2940	1242	--	164	1163	2850	1098	--	135	450	3299	1847	--	280	790	2398	2265	--
Total	357	1389	3817	2084	--	360	1536	3597	2006	--	287	723	3689	2655	--	384	1184	2542	2599	--
SITE 3																				
Browse	310	2356	1955	1612	1007	339	2007	1737	2098	1429	324	876	497	1823	1765	266	911	524	1267	1405
Herbage	72	561	829	371	96	22	524	1803	1029	254	59	1257	2556	1796	389	43	375	2411	2507	906
Total	382	2917	2784	1983	1103	361	2531	3540	3127	1683	383	2133	3053	3619	2154	309	1286	2935	3774	2311

The dominant herbaceous species were panic grasses and longleaf uniola. Other herbs showing large increases were sedges (Carex spp.) and dogfennel (Eupatorium capillifolium (Lam.) Small).

On site 2, total forage yield ranged from 723 to 1536 kg/ha, averaging 1208 kg/ha; a threefold increase over the uncut forest. Herbs increased more than browse on this formerly cleared site.

Browse species contributing most to forage yield were American beautyberry, post oak, and sweetgum. Panic grasses were the dominant herbaceous species. Other herbs showing large increases were pinehill bluestem, longleaf uniola and sedges.

On site 3, total forage yields ranged from 1286 to 2917 kg/ha, averaging 2217 kg/ha; a sixfold increase over the uncut forest. Herbs increased proprtionately more than browse plants, and constituted 31 percent of the total forage. Yields of both browse and herbage were relatively low on plots that were to be KG bladed because these plots, unlike the others, carried many leftover culls and small trees throughout the 1973 growing season.

Browse species contributing most to forage yield in 1973 were American beautyberry, blackberries, grapes, willow oak, and sweetgum. Panic grasses replaced longleaf uniola as the dominant herbaceous species. Other herbs showing large increases were sedges, rushes (Juncus spp.) and the composites fleabane (Erigeron spp.), dogfennel, and wild lettuce (Lactuca canadensis L.).

After Site Preparation

Total available forage yield peaked the first growing season following site preparation on the control, burn, and chopped treatments on all three sites (Table 1). The sole exception was the control on site 3 which peaked the year after clearcutting.

By and large on all three sites the total forage yield was similar the first year after site preparation for the control, burn, and chopped plots, but the proportion of browse and herbage varied between sites and site treatments. Sites 1 and 3 generally produced more browse than herbage. The formerly cleared site 2 produced much greater quantities of herbage than browse.

With one exception (KG treatment on site 3) herbage yields peaked the first growing season after site preparation. With gradual closure of the pine canopy and an increase in the height and density of other woody plants, herbage yields decreased. The decrease was faster on treatments that did not reduce the number of woody plants drastically (control and burn). Herbage decline was slow on chopped plots and especially on KG plots where many woody plants were eliminated or greatly reduced in size.

On the chopped plots, available browse increased up to the third growing season but decreased by the fifth. The reason for the third season increase was the recovery of woody plants from the effects of chopping. By the fifth season many woody plants had grown beyond the 1.5 m height limit that is easily accessible to deer (Odocoileus virginianus).

On the KG bladed plots total forage yield was greatest in the third growing season. Browse was still increasing by the end of the fifth growing season as woody plants continued to recover from the effects of blading, but herbage yield declined. By the end of the fifth season the average total forage yield was directly proportional to site preparation intensity and ranked: control (1016 kg/ha), burn (1434), chop (1796), and KG (2132 kg/ha).

Pine Survival And Growth

KG blading drastically reduced woody plant numbers and resulted in the highest pine survival on all three sites, being 91, 73, and 97 percent (Table 2). The chopping treatment attained the next highest survival with 83, 64, and 90 percent. Burning produced good survival (85 percent) on site 3 which was burned under very favorable wind and fuel moisture conditions. Survival on sites 1 and 2 was low because the fires did not carry as well and woody plant numbers were not reduced below that on control plots. Pine seedling survival on control plots averaged 57 percent, the lowest of all treatments.

Table 2.--Survival of planted pines after five growing seasons

Location	Site treatments			
	Control	Burn	Chop	KG
	percent			
Site 1	55	63	83	91
Site 2	52	41	64	73
Site 3	63	85	90	97
Mean	57	63	79	87 1/

1/ Values connected by the same line are not statistically different at the 0.05 level of probability.

Generally, seedling survival was poorest on the dry soils of site 2. Survival on sites 1 and 2 that were planted in spring 1975 was not as good as on site 3 which was planted in spring 1974. A rainy growing season followed in 1974 and was in contrast to the hot dry summer of 1975.

The severity of woody plant competition to planted pines is shown by the high percentage of pines that were overtopped by hardwoods and shrubs on the control and burned plots (Table 3). By contrast only few pines were overtopped on chopped plots and even less on KG bladed plots.

Table 3.--Planted pines overtopped by hardwoods

Location	Site treatments			
	Control	Burn	Chop	KG
	percent			
Site 1	43.2	41.2	7.2	0.7
Site 2	14.9	27.2	8.9	0.9
Site 3	32.3	9.0	0.7	1.0
Mean	30.1	25.8	5.6	0.9 1/

1/ Values connected by the same line are not statistically different at the 0.05 level of probability.

Height growth of pines was significantly better on KG bladed and chopped plots than on the control and burned plots (Table 4). Trees that grew tallest also had the greatest diameters (dbh). Several studies showed that the early advantages in growth due to site preparation are maintained for a long period in the life of the young stand, possibly through its entire expected rotation (Wagenknecht 1941, Stransky 1964, Schultz 1975).

Table 4.--Height of planted pines after five growing seasons

Location	Site treatments			
	Control	Burn	Chop	KG
	cm			
Site 1	285	290	355	410
Site 2	299	251	321	331
Site 3	306	305	370	311
Mean	297	282	349	351 1/

1/ Values connected by the same line are not statistically different at the 0.05 level of probability.

Nantucket tipmoth (Rhyacionia frustrana Comstock) severely damaged the growing tip of pines on all three sites and could have caused some growth losses. The damage averaged 76, 73, and 74 percent for sites 1, 2, and 3. Both mechanized site treatments showed 69 percent damage, 71 percent on controls, and 89 percent on burned plots. Possibly the initial rate of infestation was the same with all site treatments, but the more vigorous trees on chopped and KG plots appeared to have outgrown the visible signs of tipmoth damage by the fifth growing season.

SUMMARY

Total forage production averaged 345 kg/ha in the uncut timber stands. Differences between site and treatment plots were not significant.

After clearcutting, yields increased several fold. The least increase was on the KG and chopped plots that still supported unmerchantable trees.

Yields peaked the first year after site preparation on all treatments and sites except the KG plots, which peaked the third year.

Five years after site preparation the average forage yields on sites 1 and 3 had declined, but they were still about five times greater than they had been in the uncut forest. The yields were in direct proportion to intensity of site preparation.

On site 2, the area previously cultivated, the browse/herbage proportion was relatively low before and after site preparation. The opposite was true on sites 1 and 3 for the control and burn treatments. On the mechanical treatment plots the browse/herbage ratio was low the first few years after treatment but relatively high the fifth year.

Pine survival, height and diameter growth averaged highest on the KG bladed plots from which most of the non-pine woody vegetation was eliminated, followed by chopping, burning and control.

Continued observations will tell how long the forage production can be maintained by the various site treatments to support wildlife and how much the treatments affect pine tree growth in the long run.

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