Plant Species Composition Following Chemical and Mechanical Site Preparation

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Abstract: We examined plant species richness and species overlap among 3 site preparation treatments (roll-chop and burn, imazapyr and burn, and imazapyr only) and a mature pine-hardwood forest during 2 years following site preparation in east-central Mississippi. Treatments were applied beginning June 1990. Inventory of plant species in 2 to 5 1.6-ha plots/treatment was completed in spring 1991 and 1992. Species richness did not differ among treatments or between treatments and pine-hardwood forest ($P = 0.31$). Similarity indices showed no apparent grouping among treatments. All values were approximately equal and were similar within years for all treatments and growth forms. All treatments were more similar to other treatments than to pine-hardwood forest. Intercommunity similarity increased from 1991 to 1992 ($P = 0.001$). Although the plant communities resulting from site preparation were different in species composition, none could be described as depauperate in number of species or vegetative growth forms.

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Chemical and mechanical site preparation are used extensively to facilitate planting operations and reduce weed composition (DeByle 1976, Swindle et al. 1988, Miller et al. 1990). Because herbicides can be used in small areas on steep slopes or on wet soils and can provide more effective control of competing plants without severe soil compaction and loss associated with mechanical methods (Tuttle et al. 1984), managers opt for chemical preparation with increasing frequency.

Blake (1986) and Copeland (1989) reported more species were present 1 year post-treatment on plots prepared mechanically than on plots treated with mechanical and chemical application. Several authors (Lantagne and Burger 1987, Copeland 1989, O'Connell et al. 1992) reported greatest species richness in the year following treatment with diminishing effect in subsequent years for mechanically treated plots. Brooks et al. (1992) compared preparations with imazapyr, hexazinone, and piloram + triclopyr. They reported imazapyr to result in highest herbaceous species richness after 1 year.

As more private land is lost to development and agriculture, managed private forest land is becoming an increasingly important reservoir of biological diversity. Managers are weighing potential impact of management on non-target species and on biodiversity in their decision-making process. Unfortunately, a relative dearth of quantitative data linking site preparation methods, especially chemical application, with plant species composition constrains management options. In this study, we examined plant species richness and similarity of community composition 1 and 2 years after site preparation on plots mechanically and chemically prepared. We chose to examine floral diversity because of ease of measurement. We assume faunal populations would benefit from an increase in floral diversity.

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Methods

The study was conducted in Noxubee County, east-central Mississippi. Forest management in the area began in the early 1960s. Most of the area was clearcut and planted to loblolly pine (*Pinus taeda*). Due to an initial planting failure, the area was replanted approximately 5 years later. The second planting was only marginally successful. The area was control burned during winter 1977. Currently, loblolly pine site index at age 50 is 23.4 to 25.5 m. Soil types are Savannah, Marrieta, the Sweatman-Smithdale association, and the Oktibbeha-Sumter complex with texture ranging from sandy loam to clay.

During October to December 1989, all merchantable sawtimber and pulpwood were removed. In (month), (year), we surveyed 14 1.6-ha plots. Plot dimensions varied to allow site preparation. We randomly assigned 1 of 3 treatments to each plot: roll chop and burn (RCB), imazapyr and burn (IB), and imazapyr only (IM). RCB was accomplished by bulldozer and a drum roller with 20 cm blades using 1 pass and pushing trees over and cutting them into smaller pieces. Chopping increased the rate of wood desiccation. RCB areas were burned 14 days after mechanical treatment. IB and IM were accomplished by application of the herbicide imazapyr. Application rate was 1.1 kg of active ingredient/ha. IB plots were burned 90 days after herbicide application.

We applied treatments beginning June 1990. Pine seedlings were planted during February 1991, with a spacing of 2.4 × 2.7 m. We established 2 sample plots within an adjacent pine-hardwood forest to compare post-site preparation and local plant community composition.

In May and June 1991 and May 1992, two observers systematically traversed each plot by walking a series of parallel lines separated by 1.5 m. All species encountered were identified in the field or collected for later identification.

Number of species was compared among treatments and years with a 2-way analysis of variance (ANOVA) in a repeated measures design (Steele and Torrie 1980). We square-root transformed species richness to meet the assumption of continuous response. We set alpha at 0.10.

We used the Jacard index (Ludwig and Reynolds 1988) to compare similarity of species composition among treatments within years. Similarity was calculated for all species combined, forbs (i.e., herbaceous non-legume), legumes, vines, woody (non-vine) species, and grass-like species (i.e., grasses, sedges, and rushes). We chose this index for ease of interpretation, and because it was shown to be unbiased even with small samples (Goodall 1973). Because number of plots/treatment differed, we randomly selected plots from the treatment in each comparison with the most plots to ensure equal number of plots/treatment with each analysis. To determine if community composition became more similar over time, we compared similarity indices, paired by treatment contrast, between years with a paired t-test. We hypothesized that similarity values would increase from 1991 to 1992; therefore, a 1-tailed test with alpha = 0.05 was used.

Results

Plant species richness did not differ among treatments within years, including pine-hardwood (ANOVA, $F = 1.74$, df = 3, $P = 0.31$). Year affected richness ($F = 11.12$, df = 1, $P = 0.05$), with the number of species declining on all site-prepared treatments between 1991 and 1992 (Table 1).

Similarity indices were consistent within years among site preparation treatments (Table 2). Within vegetative growth forms, overlap remained consistent as did the relative number of species. Similarity indices between site preparation treatments and pine-hardwoods were lower than similarity indices among site prepared treat-

Table 1. Mean number (range) of plant species found in 1.6-ha site-prepared treatment plots (RCB = roll chop and burn, 5 plots; IB = imazapyr and burn, 5 plots; IM = imazapyr only, 4 plots) and adjacent pine-hardwood forest plots (PH), 2 plots, Noxubee County, Mississippi, 1991–1992.

Year	RCB	IB	IM	PH
1991	152 (137–178)	140 (130–155)	135 (128–141)	123 (101–144)
1992	129 (101–157)	119 (103–130)	119 (106–134)	137 (129–144)

Table 2. Numbers of plant species (N) and Jacard index of species overlap (O) by site prepared treatment combination (RCB = roll chop and burn, IB = imazapyr and burn, IM = imazapyr only) and comparison with pine-hardwood plots (PH) in Noxubee County, Mississippi, 1991–1992.

Treatment		Total			Forbs			Legumes			Grasses			Woody			Vines		
A B	Plots	N_A	N_B	O	N_A	N_B	O	N_A	N_B	O	N_A	N_B	O	N_A	N_B	O	N_A	N_B	O
1991:																			
RCB × IB	5	310	290	0.57	149	149	0.63	30	25	0.57	50	42	0.42	51	48	0.57	24	20	0.76
RCB × IM	4	279	262	0.55	133	117	0.55	24	22	0.59	45	45	0.45	49	50	0.65	23	19	0.68
IB × IM	4	263	262	0.57	136	117	0.59	22	22	0.57	38	45	0.46	45	50	0.61	18	19	0.68
RCB × PH	2	221	172	0.39	108	67	0.33	21	12	0.27	32	18	0.28	39	49	0.57	20	20	0.67
IB × PH	2	194	172	0.41	109	67	0.42	18	12	0.30	23	18	0.37	24	49	0.43	16	20	0.50
IM × PH	2	201	172	0.45	85	67	0.39	18	12	0.43	34	18	0.37	39	49	0.49	17	20	0.61
1992:																			
RCB × IB	5	264	233	0.61	126	103	0.57	24	23	0.57	36	34	0.59	53	49	0.70	23	19	0.75
RCB × IM	4	239	237	0.64	117	102	0.59	24	22	0.69	28	38	0.57	49	51	0.72	22	20	0.83
IB × IM	4	207	237	0.61	88	102	0.58	22	22	0.52	30	38	0.58	46	51	0.70	17	20	0.68
RCB × PH	2	179	191	0.50	87	81	0.47	15	17	0.52	20	20	0.29	39	50	0.62	17	21	0.73
IB × PH	2	170	191	0.49	77	81	0.48	15	17	0.45	25	20	0.32	38	50	0.60	13	21	0.62
IM × PH	2	171	191	0.49	72	81	0.43	17	17	0.42	23	20	0.34	40	50	0.64	17	21	0.81

ments. Similarity indices were consistent across vegetative growth forms, with the exception of woody and vine species. Woody and vine similarity indices were higher than those of all other vegetative growth forms. From 1991 to 1992, within treatment combinations, plots became more similar in species composition ($P = 0.001$).

Discussion

We observed no difference in species richness among treatments 1 and 2 years after site preparation. Although sampling methodologies do not allow for direct numerical comparison, as we used a complete count of species resulting in generally higher richness values, our data are in agreement with past studies. Mechanical site preparation and banded application of hexazinone had similar plant species richness 1 year post-treatment (Blake et al. 1987). Pine-hardwood forest had the same number of species as treatments with 2-4-5-T (Hurst and Perkins 1992).

We observed a significant decrease of species richness, except for pine hardwoods, between 1991 and 1992 in all treatments. Pine-hardwoods showed a slight increase. Because the effect was observed across all site-prepared treatments, it was possible that this response was from weather differences prior to measurement. Total precipitation was 76 cm for winter 1990–91 and early spring 1991 and 36 cm for the same period in 1991–92 (Wilson 1993). The increase in richness for pine-hardwoods and resulting higher values than site-prepared treatments in 1992 may be due to a more stable community more resistant to anomalous weather patterns.

In this study, similarity of plant species composition for all treatment combinations was close, regardless of vegetative growth form. Hurst (1987) reported lower grass and woody and higher forb and vine coverage following aerial application of imazapyr. Total biomass decreased following application of haxazinone (Blake et al. 1987). Relatively high similarity of woody and vine species, both among site prepared treatments and in comparison with pine-hardwoods, suggests that species occurrence patterns of these growth forms are robust to disturbance. Although these results indicate no deficiencies in total species or vegetative growth forms for any treatment, our use of species presence as a response variable may mask important patterns. Important rank by species for these plots, determined by summing relative density, dominance and frequency from line transect samples (Wilson 1993), indicate more divergent communities (Table 3).

Similarity indices increased from 1991 to 1992. Blake (1986) observed fewer plant species on broadcast hexazinone plots 1 year after treatment, but similar numbers of species 2 years post-treatment. Copeland (1989) reported that mechanically prepared plots had more than twice the number of plant species than plots prepared with both mechanical and chemical (hexazinone) methods after the first year. Again, plant species richness was similar 2 years post-treatment. We observed 3 site preparation methods to result in comparable communities in terms of plant species richness, and equally different communities in terms of similarity of plant species composition. Between years, observed differences in species composition became smaller, suggesting temporary impact of site preparation.

Table 3. Ten most important genera by site preparation method (RCB = roll chop and burn, IB = imazapyr and burn, IM = imazapyr only) and year in Noxubee County, Mississippi, 1991–1992 (from Wilson, 1993).

	RCB		IB		IM	
Rank	1991	1992	1991	1992	1991	1992
1	Erigeron	Panicum	Erigeron	Panicum	Rubus	Rubus
2	Panicum	Quercus	Panicum	Solidago	Panicum	Panicum
3	Quercus	Erigeron	Rubus	Rubus	Erichtites	Erigeron
4	Liquidambar	Solidago	Eupatorium	Eupatorium	Erigeron	Lonicera
5	Eupatorium	Liquidambar	Erechites	Cassia	Eupatorium	Eupatorium
6	Ambrosia	Lonicera	Solidago	Lonicera	Lonicera	Callicarpa
7	Solidago	Eupatorium	Lonicera	Erigeron	Acalphya	Solidago
8	Rubus	Rubus	Acalphya	Hypericum	Solidago	Ulmus
9	Ulmus	Agalinus	Cassia	Galium	Calicarpa	Cassia
10	Chasmanthium	Cassia	Gnaphalium	Andropogon	Chasmanthium	Hypericum

Management Implications

Desired results of site preparation are to facilitate planting, reduce competition, and improve seedling survival. There are advantages and disadvantages to any form of site preparation, mechanical or chemical. Type of herbicide used and method of application influence the new plant community, as does intensity of mechanical preparation. We observed no difference among site preparation methods in species richness and even less vegetative difference in the year following site preparation. Our results suggest that long-term loss of plant diversity from site preparation is unlikely. Future studies need to explicitly examine long-term community response to site preparation of both plant and animal species.

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