INITIAL RESPONSE OF INDIVIDUAL SOFT MAST-PRODUCING PLANTS TO DIFFERENT FOREST REGENERATION METHODS IN THE OUACHITA MOUNTAINS

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Abstract—Recent policy changes have eliminated clearcutting as the primary pine regeneration method on Federal lands in the Southern United States. However, the effects of alternative natural regeneration methods on soft mast production are unknown. We compared plant coverage and mast production of 37 soft mast-producing plants among four regeneration methods (clearcut, shelterwood, single-tree selection, and group selection), and in mature, unharvested stands the first, third, and fifth years after timber harvest in the Ouachita Mountains of Oklahoma and Arkansas. Species richness and diversity of plants that produced mast were greatest in unharvested stands the first postharvest year, although total mast production did not differ among treatments. By the fifth postharvest year, total mast production and species richness were greater in harvested stands than in unharvested stands. Overall, shelterwoods most closely approximated the abundant soft mast production usually associated with clearcuts. Most of the 37 taxa investigated produced little or no mast, regardless of treatment. Mast from only seven taxa made up 48-100 percent of total production in each treatment. Pokeberry (*Phytolacca americana* L.) was the most abundant soft mast produced in intensively harvested areas (clearcuts, shelterwoods, and group openings) the first year, but production declined dramatically in subsequent years. Blackberry (*Rubus* spp.) was the most abundant mast in these areas by the fifth year. Muscadine grape (*Vitis rotundifolia* Michx.) was generally the most abundant mast in other treatments.

INTRODUCTION

Quality forest habitats provide not only the vegetation structure needed by wildlife, but also adequate resources such as food and water. Soft mast is an important component of forest wildlife habitat, comprising a great percentage of the seasonal diets of many wildlife species (Martin and others 1951). Soft mast from different plant species varies in nutritional quality (Halls 1977), and individual wildlife species may prefer certain types of mast. Thus, wildlife managers need to know what factors affect the abundance and production of individual soft mast species.

Recent policy changes by Federal land management agencies, such as the USDA Forest Service, have increased the use of forest regeneration methods other than clearcut and plant. Prior research provides substantial information on soft mast responses to clearcutting (e.g., Campo and Hurst 1980, Johnson and Landers 1978, Stransky and Halls 1980). However, the effects of alternative natural regeneration methods on individual soft mast-producing species are unknown. Therefore, we compared the initial production and coverage of 37 soft mast-producing species among four regeneration methods (clearcut, shelterwood, single-tree selection, and group selection) and in mature, unharvested forest stands (controls). We sampled stands the first (1994), third (1996), and fifth (1998) years after initial harvest in 1993. We present data for all 37 species but focus on the seven species that produced the most mast.

METHODS

Study Areas

We conducted the study in the 20 wildlife research stands of the USDA Forest Service Ecosystem Management (phase II) research study, located in the Ouachita and Ozark National Forests of Oklahoma and Arkansas (Baker 1994, Thill and others 1994). Five late-rotation, mixed pine-hardwood stands were selected in four physiographic zones (north, south, east, and west blocks) of the Ouachita Mountains (Baker 1994). Within each of the four blocks, stands randomly received one of five treatments. Treatments were single-tree selection, group selection, shelterwood, clearcut, and late-rotation unharvested. Timber harvesting was conducted in spring and summer of 1993; site preparation in natural regeneration stands occurred the following winter. Mechanical ripping of clearcuts (prior to pine planting) occurred the following summer (1994). For a detailed description of treatments see Baker (1994) and Perry and others (1999).

Unharvested buffer strips or greenbelts (typically 15 m on both sides of ephemeral and intermittent streams) were established for water quality protection within harvested stands. We considered greenbelts a subtreatment of harvested stands; we averaged greenbelt data from all 16 harvested stands for comparison with other treatments.

Soft Mast Sampling

Prior to timber harvest, in each stand we established 100 permanent sampling stations at 15-m intervals along 4-9 (depending on stand size and shape) parallel transects (Thill and others 1994). Transects were 30-95 m apart, oriented perpendicular to stand slope, and >50 m from the stand edge. We randomly selected a subsample of these 100 stations to estimate plant cover and soft mast production.

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Table 1—Soft-mast-producing taxa surveyed for production and coverage in 20 forest stands under various treatments in the Ouachita Mountains of Arkansas and Oklahoma during summer 1994, 1996, and 1998

Downy serviceberry (*Amelanchier arborea* Michx.f)[a]	Pokeberry (*Phytolacca americana* L.)[b]
Rattan (*Berchemia scandens* Hill)	Black cherry (*Prunus serotina* Ehrh.)
Bumelia (*Bumelia lanuginosa* Michx.)[a]	Wild plums (*Prunus* spp.)
American beautyberry (*Callicarpa americana* L.)	Carolina buckthorn (*Rhamnus caroliniana* Walt.)
Hackberries (*Celtis* spp.)	Fragrant sumac (*Rhus aromatica* Ait.)
Fringe tree (*Chionanthus virginicus L.)*	Winged sumac (*Rhus copallina* L.)
Redberry moonseed (*Cocculus carolinus* L.)	Smooth sumac (*Rhus glabra* L.)
Flowering dogwood (*Cornus florida* L.)	Wild roses (*Rosa* spp.)
Narrow-leafed dogwood (*Cornus obliqua* Raf.)	Blackberries (*Rubus* spp.)
Hawthorns (*Crataegus* spp.)	Sassafras (*Sassafras albidum* Nutt.)
Persimmon (*Diospyros virginiana* L.)	Greenbriers (*Smilax* spp.)
Deciduous holly (*Ilex decidua* Ait.)	Coralberry (*Symphoricarpos orbiculatus* Moench)
American holly (*Ilex opaca* Ait.)	Poison ivy (*Toxicodendron radicans L.)*
Yaupon holly (*Ilex vomitoria* Ait)[a]	Sparkleberry (*Vaccinium arboreum* Marsh.)
Eastern redcedar (*Juniperus virginiana* L.)[a]	Blueberries (*Vaccinium* spp.)
Partridgeberry (*Mitchella repens* L.)	Rusty blackhaw (*Viburnum rufidulum* Raf.)
Mulberry (*Morus rubra* L.)	Muscadine grape (*Vitis rotundifolia* Michx.)
Blackgum (*Nyssa sylvatica* Marsh.)[a]	Other grapes (*Vitis* spp.)
Virginia creeper (*Parthenocissus quinquefolia* L.)[a]	

[a] No cover estimates were derived for these species in 1994.
[b] Herbaceous species

We estimated soft mast production and percent coverage, by species, during the summers of 1994, 1996, and 1998 (table 1). In 1996 and 1998, we included additional percent cover estimates for some species not measured in 1994, although we detected no production by these species throughout the study. In 1994, we sampled three 1-m^2 plots, located at 30 of the 100 sampling stations (90 m^2 sample area), in each unharvested and group selection stand. In each clearcut, shelterwood, and single-tree selection stand, we sampled one 1-m^2 plot at 40 of the stations (40 m^2 sample area). However, because we observed heterogenous distribution of soft mast within all stands in 1994, we increased sampling effort at all stations to one 3x3-m plot, located at each of 60 stations (540 m^2 total sample area in each stand) in 1996 and 1998. For further information on sampling effort by treatment and year, see Perry and others (1999).

We conducted soft mast surveys in mid-June, mid-July, and mid-August. During each sampling period, we measured a different set of species to coincide with ripening phenology of the major fruit-producing species. During sampling, we counted all soft mast, including green fruits, located within plots to a height of 2 m. To reduce potential bias from herbivory, we tallied evidence of removed fruits when possible. We developed wet to dry mass conversion factors by collecting, drying to constant mass, and weighing samples of each fruit type. We visually estimated percent coverage of each fruit-producing species at each plot in mid-July. A single observer estimated coverage in west- and south-block stands, and another observer estimated coverage in east- and north-block stands. Although we measured coverage of downy serviceberry (*Amelanchier arborea* Michx.f.), sampling occurred too late in the season to include soft mast from this early-spring producer.

For species with large seed heads containing numerous individual fruits [e.g., winged sumac (*Rhus copallina* L.)], we developed regression equations to convert volume estimates to mass. First, we collected 20-50 fruit heads per species. We then measured these fruit heads in three dimensions to determine volume, then measured mass to derive volume-to-mass estimates. During fruit surveys, we measured volume of each seed head on each plot to estimate mass produced.

Data Analysis

We derived means of soft mast production (kg/ha dry mass) and percent coverage for each soft mast species in each stand. We calculated treatment means from the four stands/treatment, except for clearcuts in 1994. In 1994, one clearcut was being ripped during the July surveys; therefore, we only included three clearcuts in the 1994 analysis. We used the same stands for sampling each year except for one unharvested stand. In 1997, the east-block unharvested stand was inadvertently harvested and subsequently replaced in 1998 with a similar stand. Because data for individual soft mast species among treatments were not parametric, we compared means among treatments using analysis of variance (ANOVA) on ranks and Duncan's multiple range test at the 0.10 level (SAS Institute Inc. 1988). Measured values, rather than ranks, are presented in all tables. However, because of ranking, some values are statistically lower than others even though the presented means are greater.

Group selection stands were comprised of group openings, where basal areas (BA) averaged 4.1 ± 0.7 m^2/ha, and the surrounding forest matrix, which was thinned to 20.3 ± 0.8 m^2/ha. Because of notable differences in BA and mast production between the openings and surrounding matrices,

Table 2—Mean (± SE) percent cover of soft-mast-producing plants, by treatment and habitat types within treatments, measured during July 1994 (the first post-harvest year) in the Ouachita Mountains

Species	Unharvested	Greenbelt[b]	Single tree selection	Group selection[c] Matrix	Group selection[c] Openings	Group selection[c] Combined	Shelterwood	Clearcut
American beautyberry	0.03 ± 0.03	0.06 ± 0.06	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.13 ± 0.13	0.00 ± 0.00
American holly	0.15 ± 0.15	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Blackberries	0.04b[a] ± 0.04	0.17b ± 0.17	0.13ab ± 0.08	0.22 ± 0.11	0.31 ± 0.24	0.25a ± 0.12	1.35a ± 0.59	0.09ab ± 0.06
Black cherry	0.10 ± 0.08	1.59 ± 1.32	0.19 ± 0.15	0.07 ± 0.07	0.02 ± 0.01	0.04 ± 0.04	0.00 ± 0.00	0.34 ± 0.27
Blueberries	10.06 ± 3.01	2.19 ± 1.36	5.66 ± 3.22	1.49 ± 1.13	1.22 ± 0.43	1.38 ± 0.87	1.54 ± 1.07	2.10 ± 1.79
Flowering dogwood	10.96 ± 5.44	4.01 ± 1.46	6.47 ± 3.51	2.03 ± 0.44	1.01 ± 0.59	1.90 ± 0.35	3.12 ± 1.47	0.68 ± 0.60
Fragrant sumac	0.00 ± 0.00	0.00 ± 0.00	0.06 ± 0.06	0.00 ± 0.00	0.01 ± 0.01	<0.01	0.00 ± 0.00	0.00 ± 0.00
Greenbriers	2.86 ± 1.51	2.05 ± 1.06	0.49 ± 0.14	0.81 ± 0.23	0.75 ± 0.75	0.95 ± 0.35	0.95 ± 0.47	0.22 ± 0.20
Hackberries	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.06 ± 0.06	0.00 ± 0.00	0.06 ± 0.06	0.00 ± 0.00	0.00 ± 0.00
Hawthorns	0.07b ± 0.07	0.02b ± 0.02	0.22ab ± 0.21	0.21 ± 0.13	0.00 ± 0.00	0.31a ± 0.15	0.00b ± 0.00	0.00b ± 0.00
Muscadine grape	2.64 ± 0.71	2.28 ± 0.80	1.76 ± 0.84	5.11 ± 3.60	6.93 ± 6.32	5.05 ± 3.74	4.25 ± 1.83	1.37 ± 1.35
Other grapes	0.43 ± 0.28	0.02 ± 0.02	0.01 ± 0.01	0.72 ± 0.62	0.24 ± 0.24	0.54 ± 0.47	0.35 ± 0.35	0.10 ± 0.10
Partridgeberry	<0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Persimmon	0.08 ± 0.08	0.38 ± 0.38	0.01 ± 0.01	0.00 ± 0.00	0.02 ± 0.02	<0.01	0.00 ± 0.00	0.00 ± 0.00
Poison ivy	2.86 ± 0.60	5.19 ± 1.43	4.67 ± 2.41	3.69 ± 1.70	3.94 ± 1.76	3.73 ± 1.42	1.87 ± 0.19	1.97 ± 1.10
Pokeberry	0.00b ± 0.00	0.08b ± 0.08	0.63b ± 0.63	0.02 ± 0.02	1.43 ± 1.43	0.37b ± 0.37	1.46a ± 1.25	1.63a ± 1.37
Rattan	0.02 ± 0.02	0.41 ± 0.22	0.08 ± 0.08	0.18 ± 0.17	0.08 ± 0.08	0.17 ± 0.12	0.00 ± 0.00	0.00 ± 0.00
Rusty blackhaw	0.00 ± 0.00	1.03 ± 0.76	0.07 ± 0.06	0.02 ± 0.02	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.11 ± 0.10
Sassafras	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.02 ± 0.02	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00
Smooth sumac	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.05 ± 0.05	0.00 ± 0.00
Sparkleberry	1.85 ± 1.16	1.81 ± 1.35	0.29 ± 0.25	2.08 ± 1.56	0.42 ± 0.42	1.86 ± 1.46	0.00 ± 0.00	0.01 ± 0.01
Wild plums	<0.01b	0.07b ± 0.07	0.11ab ± 0.07	0.12 ± 0.11	0.00 ± 0.00	0.06ab ± 0.05	0.00b ± 0.00	0.92a ± 0.77
Winged sumac	0.00b ± 0.00	0.10b ± 0.08	0.01b ± 0.01	0.11 ± 0.09	0.71 ± 0.68	0.32a ± 0.21	0.47a ± 0.16	0.59a ± 0.30

[a] Within rows, means followed by the same letter were not different ($P < 0.10$) using ANOVA on ranks and Duncan's MRT.
[b] Averaged across all harvested stands which contained greenbelt plots ($N = 15$).
[c] Only combined values were included in the ANOVA.

we present data for these two habitats separately. However, only combined data (derived from stand-wide averages) were included in the ANOVA analysis. We also determined total soft mast production and coverage in the greenbelts of each stand (*n* = 15 stands in 1994 and *n* = 16 stands in 1996 and 1998). We then determined mean soft mast production and coverage in greenbelts by averaging across all stands.

We calculated richness, evenness, and diversity of species which produced mast and compared these measures, by year, among the five primary treatments (clearcut, shelterwood, single-tree selection, group selection, and unharvested) using analysis of variance and Duncan's multiple range test at the 0.10 level (SAS Institute Inc. 1988). Richness was defined as the total number of species producing soft mast per stand. Species diversity was the Shannon index (Shannon and Weiner 1949); Pielou's J was our evenness measure (Pielou 1969).

RESULTS AND DISCUSSION

Soft mast plant coverage was relatively low in harvested stands the first postharvest year, apparently due to logging disturbance (table 2). Only nine species produced mast among all stands in 1994 (table 3). In group openings and clearcut stands, pokeberry (*Phytolacca americana* L.) was the only mast produced. In the third postharvest year (1996), coverage of most plant species increased in harvested stands (table 4). Overall soft mast production in the third year was greater in harvested stands than in unharvested stands (Perry and others 1999). In the third year, the number of species producing mast increased to 16 (table 5). By the fifth postharvest year, coverage of many plant species was greater in harvested stands than in unharvested stands or greenbelts (table 6). Twenty-five species produced mast the fifth year, although many of these species produced only trace amounts in a single stand (table 7). Total production in the fifth year was greatest in clearcut and shelterwood stands, intermediate in single-tree selection and group selection stands, and lowest in unharvested stands; shelterwood and clearcut stands produced more than twice as much mast as single-tree selection and group selection stands (Perry and others 1999).

Species richness was greatest in unharvested stands the first postharvest year (table 8). In the third year, no difference existed in richness among treatments. By the fifth year, richness was greater in harvested stands than in unharvested stands. Diversity of mast-producing species was greatest in unharvested stands, and evenness was greatest in unharvested and group selection stands the first year. However, differences were not significant ($P > 0.10$) in subsequent years.

Pokeberry, blackberries (*Rubus* spp.), blueberries (*Vaccinium* spp.), muscadine grape (*Vitis rotundifolia* Michx.), other grapes (*Vitis* spp.), winged sumac, and American beautyberry (*Callicarpa americana* L.) were the seven most abundant soft mast producers during the study (table 9). Therefore, the following discussion focuses on these seven taxa.

Table 3—Mean (± SE) dry-weight of soft mast (kg/ha) produced, by treatment and habitat types within treatments, measured during summer 1994 (the first post-harvest year) in the Ouachita Mountains

Species	Unharvested	Greenbelt[b]	Single tree selection	Group selection[c]			Shelterwood	Clearcut
				Matrix	Openings	Combined		
Blueberries	0.58a[a] ± 0.52	0.00b ± 0.00	0.00b ± 0.00	0.09 ± 0.09	0.00 ± 0.00	0.07b ± 0.07	0.07b ± 0.07	0.00b ± 0.00
Flowering dogwood	1.42 ± 0.98	1.13 ± 1.00	0.23 ± 0.23	0.71 ± 0.42	0.00 ± 0.00	0.47 ± 0.30	0.00 ± 0.00	0.00 ± 0.00
Greenbriers	0.25a ± 0.18	0.02b ± 0.02	0.00b ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00b ± 0.00	0.00b ± 0.00	0.00b ± 0.00
Muscadine grape	0.52a ± 0.29	2.06b ± 2.06	0.22b ± 0.22	0.00 ± 0.00	0.00 ± 0.00	0.00b ± 0.00	3.33b ± 3.33	0.00b ± 0.00
Other grapes	0.46 ± 0.46	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Poison ivy	0.02 ± 0.01	0.04 ± 0.04	0.00 ± 0.00	0.02 ± 0.02	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00
Pokeberry	0.00b ± 0.00	2.57b ± 2.57	0.00b ± 0.00	0.00 ± 0.00	13.13 ± 13.13	3.28b ± 3.28	26.51a ± 21.60	23.05a ± 18.56
Rattan	0.00 ± 0.00	0.04 ± 0.04	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Sparkleberry	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.02 ± 0.02	0.00 ± 0.00	0.02 ± 0.02	0.00 ± 0.00	0.00 ± 0.00

[a] Within rows, means followed by the same letter were not different ($P < 0.10$) using ANOVA on ranks and Duncan's MRT.
[b] Averaged across all harvested stands which contained greenbelt plots (N = 15).
[c] Only combined values were included in the ANOVA.

Table 4—Mean (± SE) percent cover of soft-mast-producing plants, by treatment and habitat types within treatments, measured during July 1996 (the third post-harvest year) in the Ouachita Mountains

Species	Unharvested	Greenbelt[b]	Single tree selection	Group selection[c]			Shelterwood	Clearcut
				Matrix	Openings	Combined		
American beautyberry	0.03ab[a] ± 0.02	0.00b ± 0.00	0.06ab ± 0.05	0.01 ± 0.01	0.42 ± 0.27	0.08ab ± 0.05	0.80a ± 0.78	0.13a ± 0.08
American holly	0.07 ± 0.07	0.06 ± 0.06	0.08 ± 0.08	0.00 ± 0.00	1.38 ± 1.38	0.31 ± 0.31	0.01 ± 0.01	0.00 ± 0.00
Blackberries	0.08b ± 0.02	0.48b ± 0.31	2.08a ± 0.64	0.48 ± 0.10	8.92 ± 2.01	2.59a ± 0.84	7.86a ± 4.02	4.07a ± 1.43
Black cherry	0.17b ± 0.12	0.69b ± 0.31	1.76a ± 0.87	0.19 ± 0.10	0.00 ± 0.00	0.12b ± 0.07	1.48ab ± 0.48	1.39ab ± 1.12
Blackgum	4.54a ± 1.88	1.04bc ± 0.44	2.61ab ± 1.27	0.32 ± 0.07	0.57 ± 0.48	0.39bc ± 0.15	2.41abc ± 1.49	0.69c ± 0.68
Blueberries	10.40 ± 2.70	3.66 ± 1.35	7.66 ± 5.16	2.88 ± 2.24	2.41 ± 0.88	2.63 ± 1.77	2.78 ± 1.76	2.46 ± 1.36
Bumelia	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.15 ± 0.15	0.05 ± 0.05	0.00 ± 0.00	0.00 ± 0.00
Carolina buckthorn	0.04 ± 0.04	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.05 ± 0.05	0.00 ± 0.00
Coralberry	0.00 ± 0.00	0.00 ± 0.00	0.03 ± 0.03	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Downy Serviceberry	0.19a ± 0.07	0.06b ± 0.06	0.07b ± 0.07	0.00 ± 0.00	0.00 ± 0.00	0.19b ± 0.19	0.00b ± 0.00	0.00b ± 0.00
Eastern redcedar	0.06 ± 0.06	0.10 ± 0.07	0.05 ± 0.05	0.27 ± 0.27	0.00 ± 0.00	0.14 ± 0.14	0.12 ± 0.12	0.00 ± 0.00
Flowering dogwood	4.52 ± 1.06	4.11 ± 0.80	8.52 ± 4.28	2.43 ± 0.83	2.04 ± 0.86	2.33 ± 0.73	3.33 ± 1.02	1.03 ± 0.91
Fragrant sumac	0.15ab ± 0.15	0.01ab ± 0.01	0.18a ± 0.11	0.16 ± 0.12	0.42 ± 0.27	0.20a ± 0.12	0.19a ± 0.13	0.00b ± 0.00
Fringe tree	0.00 ± 0.00	0.25 ± 0.25	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Greenbriers	4.61 ± 2.93	2.18 ± 0.47	1.75 ± 0.61	1.35 ± 0.48	1.87 ± 1.56	1.60 ± 0.82	2.57 ± 0.93	0.98 ± 0.53
Hackberries	0.00 ± 0.00	0.05 ± 0.05	0.04 ± 0.04	0.01 ± 0.01	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00
Hawthorns	0.08 ± 0.07	0.19 ± 0.14	0.28 ± 0.10	0.21 ± 0.13	0.31 ± 0.24	0.30 ± 0.15	0.11 ± 0.09	0.05 ± 0.05
Mulberry	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Muscadine grape	3.76b ± 1.25	3.24b ± 0.89	6.84ab ± 2.36	6.56 ± 3.46	13.22 ± 7.77	8.11b ± 4.37	17.88a ± 2.79	4.77b ± 2.98
Narrow-leaf dogwood	0.17 ± 0.17	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Other grapes	0.43ab ± 0.23	0.05c ± 0.02	0.74a ± 0.28	0.68 ± 0.50	1.17 ± 0.48	0.71ab ± 0.39	0.86ab ± 0.33	0.26bc ± 0.22
Partridgeberry	0.49a ± 0.30	0.00b ± 0.00	0.00b ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00b ± 0.00	0.00b ± 0.00	0.00b ± 0.00
Persimmon	0.06 ± 0.02	0.24 ± 0.11	0.21 ± 0.06	0.41 ± 0.19	2.20 ± 1.71	0.72 ± 0.36	0.34 ± 0.26	0.17 ± 0.15
Poison ivy	4.50 ± 1.47	9.15 ± 2.48	12.62 ± 7.10	10.11 ± 4.74	14.26 ± 5.53	10.69 ± 4.43	10.07 ± 1.76	7.68 ± 5.56
Pokeberry	0.00b ± 0.00	0.00b ± 0.00	0.15a ± 0.13	0.06 ± 0.06	1.22 ± 0.78	0.26a ± 0.14	0.37a ± 0.19	1.60a ± 1.28
Rattan	0.07 ± 0.05	0.14 ± 0.06	0.23 ± 0.18	0.01 ± 0.01	0.00 ± 0.00	<0.01	0.22 ± 0.19	0.00 ± 0.00
Redberry moonseed	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.11 ± 0.11	0.00 ± 0.00
Rusty blackhaw	0.02 ± 0.02	0.59 ± 0.37	0.14 ± 0.14	0.06 ± 0.04	0.03 ± 0.03	0.14 ± 0.08	0.01 ± 0.01	0.01 ± 0.01
Sassafras	0.02c ± 0.02	0.01c ± 0.01	0.11ab ± 0.07	0.06 ± 0.03	1.58 ± 1.37	0.45a ± 0.23	0.00c ± 0.00	0.15bc ± 0.15
Smooth sumac	0.00b ± 0.00	0.00b ± 0.00	0.00b ± 0.00	0.00 ± 0.00	0.14 ± 0.14	0.02ab ± 0.02	0.09a ± 0.06	0.10ab ± 0.10
Sparkleberry	0.73 ± 0.52	1.47 ± 0.85	1.11 ± 0.34	2.82 ± 2.17	3.38 ± 3.38	3.00 ± 2.51	0.81 ± 0.61	0.78 ± 0.22
Virginia creeper	2.82 ± 2.39	1.52 ± 0.48	2.07 ± 0.87	1.62 ± 0.50	2.94 ± 1.75	1.85 ± 0.57	4.17 ± 2.31	0.73 ± 0.61
Wild plums	0.03b ± 0.03	0.09b ± 0.07	0.33ab ± 0.22	0.64 ± 0.37	0.84 ± 0.56	0.79a ± 0.45	0.60 ± 0.43	0.64a ± 0.35
Wild rose	0.00c ± 0.00	0.05bc ± 0.03	0.03bc ± 0.03	0.38 ± 0.27	0.58 ± 0.55	0.37a ± 0.30	0.15ab ± 0.09	0.00c ± 0.00
Winged sumac	0.01c ± 0.01	0.38c ± 0.37	0.62b ± 0.27	0.26 ± 0.09	3.93 ± 2.39	1.38ab ± 0.81	3.10a ± 0.04	4.62a ± 2.46

[a] Within rows, means followed by the same letter were not different ($P < 0.10$) using ANOVA on ranks and Duncan's MRT.
[b] Averaged across all harvested stands which contained greenbelt plots ($N = 16$).
[c] Only combined values were included in the ANOVA.

Table 5—Mean (± SE) dry-weight of soft mast (kg/ha) produced, by treatment and habitat types within treatments, measured during summer 1996 (the third post-harvest year) in the Ouachita Mountains

				Group selection[c]				
Species	Unharvested	Greenbelt[b]	Single tree selection	Matrix	Openings	Combined	Shelterwood	Clearcut
American beautyberry	0.00 ± 0.00	0.00 ± 0.00	0.12 ± 0.12	0.00 ± 0.00	0.01 ± 0.01	<0.01	0.71 ± 0.71	0.03 ± 0.03
Blackberries	0.00d[a] ± 0.00	0.01d ± 0.01	0.20bc ± 0.05	0.05 ± 0.02	1.51 ± 1.34	0.51c ± 0.46	3.15a ± 2.08	1.17ab ± 0.80
Blueberries	0.04 ± 0.02	0.10 ± 0.06	0.22 ± 0.12	0.08 ± 0.08	<0.01	0.06 ± 0.06	0.76 ± 0.74	0.76 ± 0.74
Carolina buckthorn	<0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	<0.01	0.00 ± 0.00
Flowering dogwood	0.02 ± 0.02	0.11 ± 0.09	0.17 ± 0.13	0.03 ± 0.03	0.10 ± 0.10	0.06 ± 0.03	0.10 ± 0.10	0.00 ± 0.00
Greenbriers	0.13 ± 0.10	0.02 ± 0.01	0.94 ± 0.94	0.02 ± 0.01	0.48 ± 0.48	0.18 ± 0.17	0.75 ± 0.44	0.01 ± 0.01
Muscadine grape	0.09b ± 0.04	1.00b ± 0.65	6.65a ± 2.03	0.53 ± 0.30	4.46 ± 3.94	1.76b ± 1.42	10.25a ± 5.60	0.95b ± 0.52
Other grapes	0.43ab ± 0.43	0.00b ± 0.00	0.20ab ± 0.20	0.00 ± 0.00	0.51 ± 0.51	0.09ab ± 0.09	1.59a ± 0.96	0.00b ± 0.00
Poison ivy	0.03bc ± 0.02	0.01c ± 0.01	0.13a ± 0.06	0.02 ± 0.01	0.00 ± 0.00	0.01bc ± 0.01	0.21ab ± 0.15	0.34bc ± 0.34
Pokeberry	0.00d ± 0.00	0.00d ± 0.00	0.64cd ± 0.64	0.02 ± 0.02	9.72 ± 6.55	2.11bc ± 1.41	1.92a ± 1.00	28.74ab ± 24.98
Rattan	0.00 ± 0.00	0.00 ± 0.00	<0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Redberry moonseed	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.02 ± 0.02	0.00 ± 0.00
Sassafras	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	1.40 ± 1.40	0.24 ± 0.24	0.00 ± 0.00	0.00 ± 0.00
Sparkleberry	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	<0.01
Wild rose	0.00b ± 0.00	<0.01b	0.00b ± 0.00	0.15 ± 0.13	0.23 ± 0.23	0.16a ± 0.15	0.29a ± 0.20	0.00b ± 0.00
Winged sumac	0.00c ± 0.00	0.32c ± 0.32	0.00c ± 0.00	0.52 ± 0.52	0.00 ± 0.00	0.40bc ± 0.40	4.25ab ± 4.06	8.86a ± 8.15

[a] Within rows, means followed by the same letter were not different ($P < 0.10$) using ANOVA on ranks and Duncan's MRT.
[b] Averaged across all harvested stands which contained greenbelt plots ($N = 16$).
[c] Only combined values were included in the ANOVA.

Table 6—Mean (± SE) percent cover of soft-mast-producing plants, by treatment and habitat types within treatments, measured during July 1998 (the fifth post-harvest year) in the Ouachita Mountains

Species	Unharvested	Greenbelt[b]	Single tree selection	Group selection[c]			Shelterwood	Clearcut
				Matrix	Openings	Combined		
American beautyberry	0.05bc[a] ± 0.02	0.63c ± 0.63	0.04bc ± 0.02	0.07 ± 0.06	0.98 ± 0.47	0.24ab ± 0.09	1.93a ± 1.64	0.26bc ± 0.15
American holly	0.06 ± 0.05	0.65 ± 0.62	0.10 ± 0.09	0.19 ± 0.19	1.32 ± 1.23	0.40 ± 0.26	0.03 ± 0.03	0.00 ± 0.00
Blackberries	0.27c ± 0.13	1.39c ± 0.66	3.34b ± 0.84	2.04 ± 1.12	20.84 ± 4.18	6.76ab ± 2.45	14.08a ± 4.32	14.60a ± 1.51
Black cherry	0.33 ± 0.08	1.48 ± 0.65	2.05 ± 1.57	0.83 ± 0.46	3.43 ± 2.06	1.52 ± 0.88	3.29 ± 1.92	2.69 ± 1.34
Blackgum	4.42 ± 1.89	2.26 ± 0.71	4.17 ± 1.69	1.38 ± 0.72	6.88 ± 6.45	2.28 ± 1.65	3.26 ± 2.04	1.11 ± 0.73
Blueberries	10.25 ± 2.60	3.94 ± 1.39	7.51 ± 4.14	3.10 ± 2.07	3.08 ± 1.63	2.91 ± 1.80	3.52 ± 2.02	3.97 ± 1.71
Bumelia	0.00 ± 0.00	0.63 ± 0.62	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Carolina buckthorn	0.24 ± 0.24	0.84 ± 0.65	0.10 ± 0.10	0.04 ± 0.04	0.01 ± 0.01	0.03 ± 0.03	0.46 ± 0.46	0.00 ± 0.00
Coralberry	0.00 ± 0.00	0.63 ± 0.63	0.04 ± 0.04	0.00 ± 0.00	0.01 ± 0.01	<0.01	0.00 ± 0.00	0.00 ± 0.00
Deciduous holly	0.00 ± 0.00	0.89 ± 0.65	0.00 ± 0.00	0.00 ± 0.00	0.22 ± 0.22	0.07 ± 0.07	0.00 ± 0.00	0.00 ± 0.00
Downy Serviceberry	0.07 ± 0.04	0.64 ± 0.62	0.00 ± 0.00	0.00 ± 0.00	0.03 ± 0.03	0.01 ± 0.01	0.06 ± 0.06	0.00 ± 0.00
Eastern redcedar	0.13 ± 0.10	0.66 ± 0.32	0.15 ± 0.11	1.26 ± 0.76	0.50 ± 0.40	0.92 ± 0.43	0.56 ± 0.24	0.08 ± 0.07
Flowering dogwood	4.35 ± 1.38	5.56 ± 0.97	9.52 ± 4.85	3.81 ± 0.87	2.37 ± 1.00	3.49 ± 0.70	4.97 ± 1.15	1.75 ± 1.38
Fragrant sumac	0.13 ± 0.10	0.94 ± 0.68	0.33 ± 0.19	0.10 ± 0.07	1.56 ± 0.97	0.34 ± 0.21	0.56 ± 0.33	0.01 ± 0.01
Fringe tree	0.00 ± 0.00	1.00 ± 0.71	0.03 ± 0.03	0.01 ± 0.01	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.01 ± 0.01
Greenbriers	4.42 ± 2.02	5.91 ± 1.47	2.21 ± 0.36	4.03 ± 2.06	4.77 ± 4.39	4.41 ± 2.74	5.75 ± 2.24	2.51 ± 1.73
Hackberries	0.00 ± 0.00	0.66 ± 0.62	0.07 ± 0.07	0.01 ± 0.01	0.03 ± 0.03	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00
Hawthorns	0.19 ± 0.06	0.75 ± 0.62	0.46 ± 0.13	0.27 ± 0.14	0.42 ± 0.26	0.34 ± 0.17	0.21 ± 0.06	0.29 ± 0.20
Mulberry	0.00 ± 0.00	0.66 ± 0.62	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.17 ± 0.10	0.03 ± 0.03
Muscadine grape	6.55 ± 2.34	6.87 ± 2.03	8.43 ± 3.15	11.24 ± 5.97	10.30 ± 7.13	10.77 ± 5.92	22.42 ± 4.20	7.52 ± 4.17
Narrow-leaf dogwood	0.09 ± 0.09	0.63 ± 0.63	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Other grapes	0.61ab ± 0.34	0.75b ± 0.62	0.95a ± 0.37	0.89 ± 0.47	2.32 ± 1.33	1.12ab ± 0.59	1.79a ± 0.62	0.70ab ± 0.53
Partridgeberry	0.49a ± 0.30	0.63b ± 0.63	0.00b ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00b ± 0.00	0.00b ± 0.00	0.00b ± 0.00
Persimmon	0.07 ± 0.04	0.73 ± 0.62	0.10 ± 0.06	0.36 ± 0.30	1.26 ± 0.72	0.58 ± 0.40	0.17 ± 0.17	0.04 ± 0.02
Poison ivy	6.82 ± 1.97	10.84 ± 2.39	16.61 ± 7.80	13.19 ± 5.94	20.62 ± 6.79	14.52 ± 5.85	15.89 ± 2.80	8.60 ± 5.17
Pokeberry	0.00b ± 0.00	0.63b ± 0.63	0.07b ± 0.07	0.00 ± 0.00	0.13 ± 0.13	0.03b ± 0.03	0.00b ± 0.00	0.22a ± 0.14
Rattan	0.20 ± 0.16	1.56 ± 0.77	0.41 ± 0.19	0.32 ± 0.18	1.04 ± 1.04	0.77 ± 0.51	0.61 ± 0.53	0.18 ± 0.18
Redberry moonseed	0.01 ± 0.01	0.65 ± 0.62	0.01 ± 0.01	0.01 ± 0.01	0.00 ± 0.00	0.01 ± 0.01	0.17 ± 0.16	0.00 ± 0.00
Rusty blackhaw	0.08 ± 0.05	1.26 ± 0.63	0.48 ± 0.36	0.10 ± 0.04	0.26 ± 0.15	0.15 ± 0.03	0.26 ± 0.15	0.34 ± 0.32
Sassafras	0.04 ± 0.02	0.68 ± 0.62	0.14 ± 0.07	0.19 ± 0.11	1.06 ± 0.67	0.46 ± 0.19	0.13 ± 0.09	0.35 ± 0.35
Smooth sumac	0.00c ± 0.00	0.63c ± 0.63	0.07bc ± 0.07	0.00 ± 0.00	0.42 ± 0.27	0.09abc ± 0.05	0.12ab ± 0.05	0.95a ± 0.84
Sparkleberry	1.03 ± 0.52	2.03 ± 0.89	1.38 ± 0.48	2.81 ± 2.07	4.24 ± 2.58	2.70 ± 1.52	1.26 ± 0.73	1.31 ± 0.55
Virginia creeper	4.50 ± 2.84	2.19 ± 0.74	2.54 ± 0.72	2.31 ± 0.92	4.13 ± 2.33	2.70 ± 1.13	4.98 ± 2.76	0.55 ± 0.41
Wild plums	0.27 ± 0.08	1.58 ± 0.73	1.55 ± 0.28	0.86 ± 0.49	1.08 ± 0.64	1.88 ± 1.23	1.26 ± 0.85	0.98 ± 0.81
Wild rose	0.05 ± 0.04	0.78 ± 0.62	0.08 ± 0.05	0.26 ± 0.19	1.11 ± 1.11	0.38 ± 0.33	0.40 ± 0.26	0.06 ± 0.06
Winged sumac	0.05b ± 0.05	1.21b ± 0.77	1.35a ± 0.39	0.47 ± 0.19	6.88 ± 3.49	2.47a ± 1.34	5.21a ± 0.68	9.04a ± 4.52
Yaupon holly	0.00 ± 0.00	0.63 ± 0.63	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

[a] Within rows, means followed by the same letter were not different ($P < 0.10$) using ANOVA on ranks and Duncan's MRT.

[b] Averaged across all harvested stands which contained greenbelt plots ($N = 16$).

[c] Only combined values were included in the ANOVA.

Table 7—Mean (± SE) dry-weight of soft mast (kg/ha) produced, by treatment and habitat types within treatments, measured during summer 1998 (the fifth post-harvest year) in the Ouachita Mountains

Species	Unharvested	Greenbelt[b]	Single tree selection	Group selection[c] Matrix	Group selection[c] Openings	Group selection[c] Combined	Shelterwood	Clearcut
American beautyberry	<0.01bc[a]	0.00 ± 0.00c	0.14bc ± 0.14	0.00 ± 0.00	3.42 ± 3.17	0.57ab ± 0.53	3.61a ± 3.36	0.45ab ± 0.31
American holly	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	<0.01	0.00 ± 0.00
Blackberries	0.00c ± 0.00	0.04c ± 0.02	1.46b ± 0.66	0.90 ± 0.37	82.34 ± 23.45	18.31a ± 4.02	46.10a ± 32.37	48.37a ± 20.85
Black cherry	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	1.67 ± 1.67
Blueberries	0.50 ± 0.49	0.39 ± 0.20	0.11 ± 0.04	0.40 ± 0.40	0.78 ± 0.76	0.48 ± 0.47	2.63 ± 2.58	0.85 ± 0.79
Carolina buckthorn	0.02 ± 0.02	0.00 ± 0.00	0.09 ± 0.09	0.00 ± 0.00	<0.01	<0.01	0.21 ± 0.21	0.00 ± 0.00
Coralberry	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01	<0.01	0.00 ± 0.00	0.00 ± 0.00
Deciduous holly	0.00 ± 0.00	<0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Flowering dogwood	0.00 ± 0.00	0.07 ± 0.07	0.30 ± .030	0.11 ± 0.11	0.00 ± 0.00	0.08 ± 0.08	0.12 ± 0.12	0.00 ± 0.00
Fringe tree	0.00 ± 0.00	0.47 ± 0.47	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fragrant sumac	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	<0.01	0.00 ± 0.00	<0.01	<0.01	0.00 ± 0.00
Greenbriers	0.06b ± 0.06	0.18b ± 0.11	0.02b ± 0.02	0.03 ± 0.03	0.11 ± 0.11	0.07b ± 0.07	0.61a ± 0.14	0.06b ± 0.06
Hawthorns	0.00 ± 0.00	0.00 ± 0.00	0.05 ± 0.05	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Muscadine grape	0.34c ± 0.31	2.33c ± 2.19	9.89a ± 4.34	2.37 ± 1.55	9.99 ± 9.72	4.76bc ± 3.98	33.87a ± 20.05	6.09ab ± 3.65
Other grapes	0.00c ± 0.00	0.00c ± 0.00	0.48ab ± 0.28	0.24 ± 0.24	0.74 ± 0.74	1.25ab ± 1.09	1.16a ± 0.69	0.02bc ± 0.02
Partridgeberry	0.01a ± 0.01	0.00b ± 0.00	0.00b ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00b ± 0.00	0.00b ± 0.00	0.00b ± 0.00
Poison ivy	0.01ab ± 0.01	0.05b ± 0.03	0.13a ± 0.08	0.04 ± 0.02	0.00 ± 0.00	0.03ab ± 0.02	0.08ab ± 0.07	0.92ab ± 0.82
Pokeberry	0.00b ± 0.00	0.00b ± 0.00	0.54b ± 0.54	0.00 ± 0.00	0.22 ± 0.22	0.05b ± 0.05	0.00b ± 0.00	0.86a ± 0.71
Rattan	0.00 ± 0.00	0.00 ± 0.00	0.06 ± 0.06	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Sassafras	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	<0.01
Smooth sumac	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.65 ± 0.65
Sparkleberry	0.01bc ± 0.01	0.23bc ± 0.23	0.02bc ± 0.02	0.02 ± 0.02	0.12 ± 0.10	0.05b ± 0.03	0.00c ± 0.00	0.28a ± 0.23
Wild plums	0.00b ± 0.00	0.00b ± 0.00	0.06ab ± 0.06	0.01 ± 0.01	0.08 ± 0.08	0.04a ± 0.03	0.00b ± 0.00	0.23ab ± 0.23
Wild rose	0.00b ± 0.00	0.00b ± 0.00	0.00b ± 0.00	0.01 ± 0.01	0.40 ± 0.40	0.07a ± 0.06	0.45a ± 0.30	<0.01ab
Winged sumac	0.00c ± 0.00	0.00c ± 0.00	0.00c ± 0.00	0.00 ± 0.00	3.43 ± 3.43	0.58c ± 0.58	11.06a ± 7.41	22.07b ± 12.82

[a] Within rows, means followed by the same letter were not different ($P < 0.10$) using ANOVA on ranks and Duncan's MRT.

[b] Averaged across all harvested stands which contained greenbelt plots ($N = 16$).

[c] Only combined values were included in the ANOVA.

Table 8—Comparison of mean soft-mast species richness (number of species actually producing soft mast), diversity of production, and evenness among five silvicultural treatments during the first (1994), third (1996), and fifth (1998) year after initial harvest in the Ouachita Mountains

Measure	Year	Unharvested	Single-tree selection	Group selection	Shelterwood	Clearcut
Richness	1994	3.75a[a] ± 0.25	0.50b ± 0.29	1.50b ± 0.65	1.25b ± 0.63	0.50b ± 0.29
	1996	3.75 ± 0.25	6.50 ± 0.87	6.00 ± 1.08	7.25 ± 1.03	5.00 ± 1.08
	1998	4.00a ± 0.41	7.00b ± 0.41	7.00b ± 1.22	8.75b ± 1.38	7.75b ± 1.03
Diversity	1994	0.87a ± 0.15	0.00b ± 0.00	0.16b ± 0.15	0.16b ± 0.16	0.00b ± 0.00
	1996	0.78 ± 0.23	0.83 ± 0.21	0.76 ± 0.12	1.10 ± 0.05	0.67 ± 0.25
	1998	0.70 ± 0.21	0.94 ± 0.18	0.74 ± 0.22	0.96 ± 0.24	0.84 ± 0.17
Evenness	1994	0.54a ± 0.19	0.15b ± 0.14	0.64a ± 0.10	0.15b ± 0.15	0.00b ± 0.00
	1996	0.34 ± 0.18	0.46 ± 0.06	0.53 ± 0.18	0.39 ± 0.15	0.45 ± 0.12
	1998	0.40 ± 0.13	0.50 ± 0.08	0.46 ± 0.12	0.44 ± 0.16	0.38 ± 0.03

[a] Within rows, means followed by the same letter were not different ($P < 0.10$) using ANOVA and Duncan's MRT.

Table 9—-Percent of total soft-mast production represented by pokeberry, blackberry, blueberry, winged sumac, American beautyberry, muscadine grape, and other grapes during first (1994), third (1996), and fifth (1998) year after initial harvest in five silvicultural treatments and unharvested greenbelts in the Ouachita Mountains

Year	Unharvested	Greenbelts	Single tree selection	Group selection	Shelterwood	Clearcut
1994	48	79	49	87	100	100
1996	76	91	86	89	94	99
1998	90	73	95	99	99	95

Pokeberry

In the first postharvest year (1994), pokeberry coverage was greatest in clearcuts and shelterwoods (table 2). Pokeberry plants were not abundant in other treatments and were not detected in unharvested stands. Pokeberry production was greatest in shelterwoods and clearcuts in the first year, and this species produced more soft mast than any other species (table 3). In the third postharvest year, pokeberry coverage was greater in harvested stands than in unharvested stands and greenbelts (table 4), but production had declined. Pokeberry production was greatest in clearcuts, shelterwoods, and group openings (table 5). By the fifth postharvest year, pokeberry coverage was low in all stands, although clearcuts had the highest abundance (table 6). Production in the fifth year declined dramatically, being highest in clearcuts (table 7).

Pokeberry is probably the most important soft mast producer immediately after intensive logging because of its ability to establish quickly and produce abundant levels of soft mast. Pokeberry, a colonizing herbaceous species, invaded the more intensely harvested areas (clearcuts, shelterwoods, and group openings) immediately after harvest, but quickly disappeared because of its inability to compete with the intense woody vegetation growth. This trend suggests pokeberry production reaches a peak about 1-3 years after harvest and then declines quickly.

Blackberry, Winged Sumac, and American Beautyberry

Blackberry plants were present in all treatments the first year (table 2), but produced no soft mast. By the third year, coverage was greatest in harvested stands (table 4). Production was greatest in shelterwoods; no blackberries were produced in unharvested stands and production was almost nonexistent in greenbelts (table 5). By the fifth year, blackberry coverage and production was greatest in clearcuts, shelterwoods, and group openings (tables 6 and 7). Blackberry was the most abundant soft mast in intensively harvested areas the fifth year.

In the first postharvest year, winged sumac coverage was greatest in group selections, shelterwoods, and clearcuts (table 2); however, no production occurred in any stands. In the third year, coverage was greatest in clearcuts, shelterwoods, and group openings (table 4); production was greatest in clearcuts and shelterwoods (table 5). In the fifth year, coverage was greatest in harvested stands (table 6), and production occurred only in clearcuts, shelterwoods, and group openings (table 7).

American beautyberry coverage was low in all stands the first year (table 2), and production was nonexistent. Coverage and production was still low in the third year, and no significant differences in production existed among treatments (tables 4 and 5). By the fifth year, production was greatest in shelterwoods, clearcuts, and group openings (table 7).

Blackberry, winged sumac, and American beautyberry were similar in their response to treatments. Each occurred predominantly in intensively logged areas (clearcuts, shelterwoods, and group openings), and each produced the most soft mast during the fifth postharvest sampling year. These species tended to produce high levels of soft mast when stands were thinned to a residual BA $\leq$11.5 m^2/ha. Blackberry was probably the most important soft mast producer in intensively logged areas by the fifth postharvest year because of its extreme abundance and the high carbohydrate and water content of its mast, which are likely important traits for wildlife during the relatively dry July and early August period.

Muscadine and Other Grapes

Although muscadine grape coverage did not differ among treatments the first postharvest year (table 2), production was greatest in unharvested stands (table 3). In the third year, production was greatest in shelterwoods and single-tree selection stands (table 5). Although no significant difference existed in coverage the fifth year (table 6), production was greatest in shelterwoods and single-tree selection stands (table 7).

For other species of grapes, no difference in coverage or production existed among treatments the first year. In the third year, coverage was greater in single-tree selection stands than in clearcuts or greenbelts (table 4), and production was greater in shelterwoods than in clearcuts or greenbelts (table 5). In the fifth year, production in shelterwoods was greater than in clearcuts, greenbelts, or unharvested stands (table 7).

Initial logging disturbance greatly affected muscadine and other grape species the first year after harvest. However, by the fifth year, grapes (primarily muscadine) were abundant in thinned stands with some intact overstory (shelterwoods, single-tree selections, group openings), but were not abundant in areas with no overstory (clearcuts) or areas with closed canopies and low ground-level light penetration (unharvested areas and greenbelts). However, differences in site, seedbed, previous land uses, or other factors unrelated to treatment may have affected muscadine abundance. For example, among the group selection stands in 1998, muscadine grape covered 23.8 percent of the ground in the north-zone stand (C1124 S11), but was absent in the south-zone stand (C35 S42). Among clearcuts, the north-zone stand (C458 S16) had 19.8 percent muscadine ground cover, whereas the west-zone stand (C1292 S2) had less than 1.3 percent cover.

Blueberries

Blueberry coverage did not differ among treatments any year. However, production was greatest in unharvested stands the first year (table 3); no differences existed in subsequent years. Logging disturbance appeared to reduce production in harvested stands the first year, but production in harvested stands increased in years three and five to levels equal to unharvested stands.

CONCLUSIONS

The importance of individual mast species varied by treatment and years since harvest. Pokeberry was the most abundant mast produced in intensely harvested areas (clearcuts, shelterwoods, and group openings) the first year after harvest, but its production quickly declined in subsequent years. Pokeberry was the only abundant mast-producing herbaceous species on study areas. Herbaceous species tend to recover and establish quickly, whereas woody species tend to recover and establish more slowly. By the fifth year, blackberry became the dominant soft mast available in intensively harvested areas. Winged sumac and muscadine grape were the second and third most abundant mast in these areas by the fifth year. Muscadine grape was generally the most abundant mast in single-tree selections, unharvested stands, the thinned matrix areas of group-selection stands, and greenbelts. Differences in site, seedbed, previous land uses or other factors unrelated to treatment, which were not controlled in this study, may have contributed to the large variance in production and cover we observed among stands of similar treatment.

Providing high-quality, early-successional wildlife habitat is often a priority for land managers. Clearcutting provides abundant soft mast for the first 5 years after harvest, but many people are opposed to this management on public lands. The public generally accepts partial cutting methods more than clearcuts. Our results suggest young shelterwood cuts provide soft mast levels comparable to young clearcuts during the first 5 years of growth. By the fifth postharvest year, total soft mast production in clearcuts and shelterwoods were more than twice the levels of other treatments (Perry and others 1999).

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