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PROMOTING SOFT MAST FOR WILDLIFE IN INTENSIVELY MANAGED FORESTS

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The fruit of woody plants is important as food for wildlife (Martin et al. 1951, Lay 1965). The relation of fruit production to southern forest stand conditions has been explored in only a few studies. Fruit production is greater in forest clearings than in closed forest stands (Lay 1966, Halls and Alcaniz 1968). In Georgia slash pine (*Pinus elliottii*) plantations, fruit yields of shrubs are greatest in 4-year-old stands, and soil disturbance in site preparation greatly reduces fruit yields (Johnson and Landers 1978). Total fruit production is greatest in 5-year-old bedded loblolly pine (*P. taeda*) plantations in Mississippi (Campo and Hurst 1980). Data are limited, however, on how fruit yields are affected by various site preparation treatments for planting pines and by conditions in developing pine stands over a period of years. In this study, we compare fruit production after 4 site treatments on clear-cuts 3, 5, and 8 growing seasons after pine planting.

STUDY AREAS

All 3 study areas are in level or gently sloping topography in the Gulf Coastal Plain region of eastern Texas. The areas are within the westernmost extension of the loblolly-shortleaf (*P. echinata*) pine-hardwood forest type. Before clear-cutting in the fall of 1972,

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[1] Laboratory maintained in cooperation with the School of Forestry, Stephen F. Austin State University.

the areas supported mature pine-hardwood forest stands.

Area 1 is on the Stephen F. Austin Experimental Forest near Nacogdoches. None of the area had been cleared for agricultural use or grazed during the past 20 years before 1972. Soils are moderately well-drained, fine sandy loams. Before clear-cutting, the forest consisted of loblolly pines averaging 70 years old, interspersed with some hardwoods up to 100 years old (Stransky and Halls 1981).

Area 2 is 16 km due west of area 1 near Wells, Cherokee County, and owned by International Paper Company. The area was cleared for agriculture about 1890 and under cultivation until about 1930. The abandoned land was invaded by pines, forming a stand that averaged 45 years old at the time of clear-cutting. Principal trees were shortleaf pine, American sweetgum (*Liquidambar styraciflua*), post oak (*Quercus stellata*), and blackjack oak (*Q. marilandica*). Soils are well-drained loamy sands and sandy loams.

Area 3 is about 80 km southeast of area 1 near Jasper, Jasper County, and is owned by Temple-Eastex Incorporated. The land has never been cleared for agricultural crops but has been grazed by livestock. Soils are similar in texture and drainage to those of area 1. Principal trees were loblolly pine, averaging 45 years old, mixed in with American sweetgum, blackgum tupelo (*Nyssa sylvatica*), and oaks.

Fruiting shrubs, small trees, and woody vines of a variety of species were present before clear-cutting. Principal species included blackberries (*Rubus* spp.), American beautyberry (*Callicarpa americana*), blueberries (*Vaccinium* spp.), southern waxmyrtle (*Myrica cerifera*), flameleaf sumac (*Rhus copallina*), Sebastian bush (*Sebastiania fruticosa*), muscadine grape (*Vitis rotundifolia*), yellow jessamine (*Gelsemium sempervirens*, yaupon holly (*Ilex vomitoria*), Alabama supplejack (*Berchemia scandens*), dwarf pawpaw (*Asimina parviflora*), Carolina buckthorn (*Rhamnus caroliniana*), rusty blackhaw viburnum (*Viburnum rufidulum*), and St. Andrews cross (*Ascyrum hypericoides*).

METHODS

Design Treatments

The study used a randomized complete block design with repeated measurements consisting of 3 replications of 4 site treatments on each of the 3 areas. Individual site treatment plots were 0.6-ha rectangles.

After merchantable trees were cut and removed from the areas in the fall of 1972, the following site preparation treatments were applied during February and March 1974 on area 3, and during August and September 1974 on areas 1 and 2 (Stransky and Halls 1980):

Control.—All woody stems larger than 2.5-cm dbh (diameter at breast height) were cut and left in place.

Burn.—All stems larger than 2.5-cm dbh were cut (as in control) and burned with the logging slash. The headfires consumed the tops of all herbaceous plants, most shrubs and small trees, nearly all leaf litter, and all but the largest branches of the logging slash.

Chop.—Logging slash and all stems were cut with a chopper and burned in spots. The chopper is a large roller equipped with cutting blades parallel to the long axis of the cylinder. Pulled by a crawler tractor, the chopper cut nonmerchantable trees and shrubs into 50-cm lengths and crushed some of the debris into the surface soil.

KG.—All stems were cut with a KG blade. The KG blade resembles a straight razor and is mounted at an angle on the front of a tractor to shear off all stems. The cutting process greatly churned up the soil surface and pushed some litter and topsoil off the planting site. The logging slash was raked off the plots and burned. Areas 1 and 2, but not area 3, were cultivated with a heavy-duty disc after blading.

All 3 areas were handplanted with 1-year-old nursery-grown loblolly pines at spacings of 2.4 × 3.0 m during winter and early spring following site preparation.

Measurements

Fruits of shrubs and woody vines were counted on 20 quadrats, each 1.0 m^2, spaced at 11-m centers within each 0.6-ha plot. The location, but not the spacing, of the 20 quadrats was changed at each sampling date to avoid the effect of human disturbance caused by fruit collection and plant measurements. Fruits (ripe and unripe) of early- and late-fruiting species were counted once on each species from late May through early August of the third, fifth, and eighth growing seasons after site preparation and pine planting.

Fresh ripe fruits ($n = 100$) were collected from each species and dried to constant weight at 70 C. Dry weight per fruit was multiplied by the number of fruits per quadrat and converted to kg/ha. Differences in fruit yields among site treatments and areas were tested by analysis of variance for the randomized complete block design, and by Duncan's New Multiple Range Test (Duncan 1955). All testing was at the 0.05 level of probability.

Stems of trees and shrubs were counted and their heights were measured on the same sampling points used for the fruit counts, and at the same time. The relation of fruit yield to hardwood and pine tree heights was explored by Pearson's Product Moment Correlation (Nie et al. 1975) for each site treatment.

RESULTS AND DISCUSSION

Site treatments had a dominant influence on fruit yields, tree and shrub heights, and shrub numbers. However, fruit yields and shrub heights were influenced also by the species composition of the shrub community present on the study areas before clear-cutting.

Table 1. Fruit yield (kg/ha) of woody plants by area, site treatment, and year after site preparation.

Areas and years	Yield by site treatments				
	Control	Burn	Chop	KG	$\bar{x}$
Area 1					
3	129.9 a[1]	112.4 a	71.0 ab	6.5 b	79.9
5	6.8 a	20.3 a	10.9 a	26.8 a	16.2
8	0.2 a	0.3 a	0.5 a	1.1 a	0.5
Area 2[2]					
3	64.4 a	41.6 a	38.1 a	9.4 a	38.4
8	4.1 a	1.3 a	5.4 a	10.1 a	5.2
Area 3					
3	73.8 a	120.2 a	40.6 a	56.6 a	72.8
5	13.3 a	14.2 a	24.0 a	10.3 a	15.4
8	2.5 a	29.9 a	22.7 a	31.7 a	21.7
All areas, $\bar{x}$					
3	89.4 a	91.4 a	49.9 ab	24.2 b	63.7
5	10.0 a	17.2 a	17.4 a	18.5 a	15.8
8	2.3 a	10.5 a	9.5 a	14.3 a	9.1

[1] Treatment means within a row that are not followed by the same letter are different ($P \leq 0.05$).
[2] Area 2 was not sampled in the fifth year.

Fruit Yield

During the third growing season after site preparation, average fruit yield on control and burn plots was not higher than that on chop plots but was higher than that on KG plots (Table 1). Blackberries produced over 74% of the fruit weight. Other common fruit producers were American beautyberry, blueberries, and southern waxmyrtle. On area 3, flameleaf sumac, Sebastian bush, and muscadine grape contributed to total fruit production.

A greater variety of fruits was present 5 growing seasons after site preparation than during the third season, but mean weight for the 2 sampled areas (15.8 kg/ha) averaged 75% less (Table 1). Except for southern waxmyrtle, species which fruited in the third season were still fruiting in addition to yellow jessamine, yaupon holly, Alabama supplejack, and dwarf pawpaw. Blackberries dropped from 74 to 20% of the total yield. American beautyberry fruit yield increased by 40% on the chop plots as the plants recovered from chopping. With the addition of new fruiting species and the increased yield from American beautyberry, the chop plots ranked high on area 3 (24.0 kg/ha), exceeded only slightly by fruit weights on area 1's KG plots (26.8 kg/ha), where flameleaf sumac increased greatly.

Average fruit yield during the eighth growing season (9.1 kg/ha) was less than during the third growing season (63.7 kg/ha). Fruiting species were blackberries, American beautyberry, Sebastian bush, muscadine grape, southern waxmyrtle, blueberries, yellow jessamine, and yaupon and possumhaw hollies (*Ilex decidua*). Sebastian bush yielded most fruit on area 3, which showed the greatest variety of species. The proportion of blackberries in the total fruit yield (22%) was about the same as in the fifth growing season inventory. Fruit production on the other 2 areas was much less and, what little there was, consisted almost entirely of blackberries and American beautyberry.

Comparing our results to others reported in the literature, we note that Johnson and Landers (1978) found total fruit yields of 39.5 and 70.8 kg/ha in 3- and 4-year-old slash pine plantations in Georgia, but their principal fruiting species were different from those of our study areas. Our results after the fifth growing season are similar to the fruit yield (17.32 kg/ha) recorded in a 4-year-old loblolly pine plantation on a tree-crushed and burned site in Mississippi (Campo and Hurst 1980).

Tree and Shrub Growth

To explore any relationship between fruit yield and the growth of both trees and shrubs, we measured tree and shrub heights and shrub density. The measurements of hardwood and pine heights revealed differences between areas and treatments as well as growing seasons (Table 2). Trees which made up the dominant canopy were American sweetgum, blackgum tupelo, southern red oak (*Quercus falcata*), water oak (*Q. nigra*), white oak (*Q.

Table 2. Average height of dominant hardwood trees and planted pines 3, 5, and 8 years after site preparation.

Areas and years	Tree height (cm) by site treatment: Hardwoods, Control	Hardwoods, Burn	Hardwoods, Chop	Hardwoods, KG	Pines, Control	Pines, Burn	Pines, Chop	Pines, KG	$\bar{x}$, Hardwood	$\bar{x}$, Pine
Area 1										
3	247 a[1]	212 ab	176 b	88 c	204 a	132 b	150 b	159 b	181	161
5	328 a	302 a	255 b	152 c	379 a	291 a	318 a	314 a	259	325
8	478 a	381 b	370 b	241 c	582 a	573 a	701 a	672 a	367	632
Area 2[2]										
3	153 a	171 a	123 a	57 b	167 a	141 a	139 a	135 a	126	145
8	307 a	344 a	305 a	165 b	540 a	517 a	577 a	629 a	280	566
Area 3										
3	277 a	204 b	129 c	116 c	143 a	138 a	160 a	147 a	182	147
5	358 a	289 b	199 c	205 c	279 a	272 a	323 a	325 a	263	300
8	450 a	337 b	296 b	273 b	541 a	653 a	559 a	498 a	339	563
All areas, $\bar{x}$										
3	226 a	195 a	143 b	83 c	171 a	137 b	150 ab	147 ab	163	151
5	343 a	297 b	227 c	173 d	329 a	281 a	352 a	319 a	261	320
8	411 a	356 ab	324 b	220 c	554 a	581 a	612 a	600 a	330	587

[1] Treatment means within a row that are not followed by the same letter are different ($P \leq 0.05$).
[2] Area 2 was not sampled in the fifth year.

alba), post oak, blackjack oak, red maple (*Acer rubrum*), and loblolly pine.

After the eighth season, height of the dominant hardwood canopy still averaged higher on the control plots (411 cm) than on either the chop (324-cm) or KG (220-cm) plots. Hardwood heights on burn plots (356 cm) were not different from those on control or chop plots (Table 2). Also, over the growing period, average height of the dominant canopy increased at a faster rate on the control plots than on any of the others. In the eighth season, hardwood heights on area 2 (280 cm) were lower than on area 1 (367 cm) or area 3 (339 cm). The drought-prone sandy soils of area 2 partially accounted for the lower hardwood heights.

Average heights of the planted pines after 8 growing seasons did not differ among treatments (Table 2). Neither were mean pine heights different among areas. However, a larger sample of planted pines measured after 5 growing seasons showed that pines on mechanically prepared plots were taller than on the control or burn plots (Stransky and Halls 1981). Pine survival at the end of the fifth season ranked 63% on control, 85% on burn, 90% on chop, and 97% on KG plots.

To assess shrub growth, 9 prevalent shrubs were measured: blackberries, American beautyberry, Carolina buckthorn, flameleaf sumac, Sebastian bush, rusty blackhaw viburnum, St. Andrews cross, blueberries, and southern waxmyrtle. Average height of these shrubs increased from the third to the eighth season (Table 3). KG plots had the shortest shrubs in the third and again in the fifth season, but were not shorter than shrubs on control or burn plots in the eighth season. Shrub heights over all treatments in the eighth growing season averaged 194 cm on area 1, 205 cm on area 3, and 176 cm on area 2; these heights were not different.

Initially the number of shrub stems on control plots was high (2,702), but gradually declined (Table 3). The controls had the fewest shrub stems (1,721) by the eighth growing season. The average number of shrub stems per

Table 3. Average number per hectare and height (cm) of fruiting shrubs 3, 5, and 8 years after site preparation.

Areas and years	No. shrubs/ha				Height (cm)				$\bar{x}$	
	Control	Burn	Chop	KG	Control	Burn	Chop	KG	No.	Height
Area 1										
3	2,236 a[1]	2,546 a	2,818 a	1,577 a	156 a	137 ab	123 b	79 c	2,294	124
5	1,645 a	1,941 a	2,510 a	2,291 a	182 a	173 a	181 a	123 b	2,097	165
8	958 a	1,331 a	2,085 a	2,282 a	155 a	209 b	223 b	193 ab	1,664	194
Area 2[2]										
3	3,504 a	1,245 a	2,355 a	2,696 a	123 a	109 a	107 a	59 b	2,450	99
8	1,956 a	1,596 a	2,811 a	2,780 a	185 a	165 a	209 a	143 a	2,286	176
Area 3										
3	2,366 a	2,960 a	3,532 a	2,358 a	152 a	132 b	112 b	112 b	2,804	128
5	2,111 a	2,305 a	3,306 b	1,718 a	186 a	161 ab	162 ab	140 b	2,360	164
8	2,249 a	2,299 a	2,892 a	1,970 a	203 a	198 a	223 a	186 a	2,352	205
All areas, $\bar{x}$										
3	2,702 a	2,250 a	2,902 a	2,210 a	144 a	125 ab	114 b	80 c	2,516	116
5	1,878 a	2,123 a	2,908 b	2,004 a	184 a	168 a	172 a	130 b	2,228	165
8	1,721 a	1,742 a	2,596 a	2,344 a	181 ab	189 ab	218 a	173 b	2,101	191

[1] Treatment means within a row that are not followed by the same letter are different ($P \leq 0.05$).
[2] Area 2 was not sampled in the fifth year.

hectare throughout the observations was greatest on the chop plots (2,802), where the site treatment produced many stems by cutting residual plants.

Examining the relationship of fruit yield to forest stand conditions, we found that both pine and hardwood heights were correlated (negatively) with fruit yields on the control, burn, and chop plots. Tree heights and fruit yields were not correlated on the KG plots (Table 4). Fruit yield of most species declined sharply as pines and hardwoods grew taller and crown canopies became closed on the control and burned plots.

The limiting factor for fruit production on the control, burn, and chop plots appears to have been available sunlight. As the dominant pine and hardwood tree canopy closed, fruit production on these plots declined. The KG plots, however, had few fruit-bearing plants even in the third growing season. In the fifth and especially in the eighth season, as the tree canopy gradually closed, the shrub numbers were still insufficient to produce amounts of fruit similar to the third season yields of the other treatments. The generally low production might be the reason why fruit yields on KG plots showed no significant correlation to either pine or hardwood tree heights.

Site Preparation and Fruit Production

The effect of area and site preparation is evident in the patterns of fruit yield, although none of the 4 possible interactions (area/treatment, area/season, treatment/season, and area/treatment/season) were statistically significant. Three growing seasons after site preparation, shrubs, vines, and trees on control plots produced much fruit. By the fifth growing season, as the canopy began to close, fruit yields from each species declined. Eventually, fruit diversity also diminished. Fruit yields were high in the third season on burn plots, but dropped sharply in subsequent seasons. Peak fruit production 3 years after burning in established stands, with subsequent decline, was noted also by Johnson and Landers (1978). On area 3, yield increased in the eighth growing season, largely because of the fruit crop of

Table 4. Relation of fruit yield to pine and hardwood tree height by site treatment over all 3 areas and sampling dates.

Trees	Correlation values by site treatments[a]			
	Control	Burn	Chop	KG
Pines	−0.57368**	−0.68305**	−0.62424**	−0.23066
Hardwoods	−0.51316**	−0.63099**	−0.50216*	−0.01991

[a] Pearson Product Moment correlations: * = $P \leq 0.05$, ** = $P \leq 0.01$.

Sebastian bush. The shade-tolerant Sebastian bush showed an increase in fruit production, while shade-intolerant species such as American beautyberry, blackberries, and flameleaf sumac had a reduced yield.

Shrubs, vines, and trees in mechanically treated plots produced less fruit than on the burn and control in the third growing season. In the fifth season, however, as the plants began to recover from site preparation, fruit production on mechanical treatments did not decline as severely as that of the control and burn.

Area patterns may be related to past land use. The highest average fruit yields sampled in the third growing season were on areas 1 and 3: 79.9 and 72.8 kg/ha, respectively. Neither of these areas had been cleared for agriculture. In contrast, fruit yield was only 38.4 kg/ha on area 2, which had been in agricultural cultivation. While fruit on areas 1 and 3 was collected from 16 and 14 species, respectively, only 4 fruiting species were noted on area 2. The lower fruit yield, fewer plants, and lower shrub heights in area 2 may also be due partly to drier site conditions. The low number of shrubs and vines, however, and the preponderance of herbaceous plants on area 2 even before clear-cutting may possibly be due to cultivation over a long time.

MANAGEMENT IMPLICATIONS

Because clear-cutting and site preparation reduce hard mast availability for as long as 25 years, it is important to promote soft mast for wildlife in intensively managed forests. The results reported suggest that practices causing the least soil disturbance were better for woody plant fruit production than mechanical treatments which destroyed or injured most plants. Prolonged agricultural cultivation reduced the number and variety of fruit-bearing woody plants.

Blackberries are the most-used soft mast, but they are suppressed by severe soil disturbance (Johnson and Landers 1978). Other plants that might be favored are neither as prolific nor attractive to wildlife. Forest managers can increase within-stand fruit diversity by leaving patches, such as our control or burn treatment, within mechanically prepared areas. As soft mast production declines in a rather short time in a given young plantation, another stand of fruit-bearing age should be provided nearby to insure between-stand diversity.

SUMMARY

Fruit production of shrubs, small trees, and woody vines was compared on 3 east Texas clear-cut, pine-hardwood forest sites 3, 5, and 8 growing seasons after site preparation for pine planting by burning, chopping, KG-blading, and control (untreated). During the third growing season, average fruit production for the 3 areas was 91.4 kg/ha on burned, 89.4 on control, 49.9 on chopped, and 24.2 on KG plots. During the fifth and eighth growing seasons, as the planted pines and residual hardwoods grew taller and their crown canopy closed, fruit yield on all treatments declined. Black-

berries, American beautyberry, and blueberries produced most fruit. Fruit production over all 3 areas and sampling dates were correlated (negatively) to hardwood and pine tree heights on all but the KG treatment. Practices that caused the least soil disturbance were better for woody fruit production than mechanical treatments. Soft mast production declines in a short time in young pine plantations. Therefore, stands should be created periodically to provide continued fruit availability.

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LITERATURE CITED

CAMPO, J. J. AND G. A. HURST. 1980. Soft mast production in young loblolly plantations. Proc. Annu. Conf. Southeastern Assoc. Fish and Wildl. Agencies 34:470–475.

DUNCAN, D. B. 1955. Multiple range and multiple F tests. Biometrics 11:1–42.

HALLS, L. K. AND R. ALCANIZ. 1968. Browse plants yield best in forest openings. J. Wildl. Manage. 32:185–186.

JOHNSON, A. S. AND J. L. LANDERS. 1978. Fruit production in slash pine plantations in Georgia. J. Wildl. Manage. 42:606–613.

LAY, D. W. 1965. Fruit utilization by deer in southern forests. J. Wildl. Manage. 29:370–375.

———. 1966. Forest clearings for browse and fruit plantings. J. For. 64:680–683.

MARTIN, A. C., H. S. ZIM, AND A. L. NELSON. 1951. American wildlife and plants. McGraw-Hill Book Co., New York. 500pp.

NIE, N. H., C. H. HULL, J. G. JENKINS, K. STEINBRENNER, AND D. H. BENT. 1975. SPSS—statistical package for social sciences. Second ed. McGraw-Hill Book Co., New York. 675pp.

STRANSKY, J. J. AND L. K. HALLS. 1980. Fruiting of woody plants affected by site preparation and prior land use. J. Wildl. Manage. 44:258–263.

——— AND ———. 1981. Forage and pine growth with clearcutting and site preparation. Pages 343–348 *in* J. P. Barnett, ed. Proc. First Biennial Southern Silvicultural Res. Conf. U.S. Dep. Agric., For. Serv., Southern For. Exp. Sta. Gen. Tech. Rep. SO-34. New Orleans, La. 375pp.

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