Effects of Burning Dates on Vegetative Production On Ozark Forests

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The purpose of this study was to determine whether burning at various dates would affect forage production and plant composition on non-commercial timber sites in the Missouri Ozarks. Additional information was sought relative to the value of burning as a management technique for deer and wild turkey.

Prescribed or controlled burning has been used for many years as a game management tool in the southeastern United States. Stoddard (1931) advocated the use of fire as essential in bobwhite quail management in Florida and Georgia, and later (1935) indicated that wild turkeys also benefited as a result of controlled burning.

Harlow and Bielling (1961) reported that a 3-year burning rotation was most desirable on the Ocala National Forest when soil, wildlife, and pine were given equal consideration.

Read (1951) evaluated forage production on forest lands in the Arkansas Ozarks. He found that legumes and composites replaced other weeds following a fire. Production of tree and shrub browse was temporarily reduced the first growing season.

Forbs comprised approximately 45 per cent of the vegetation in a freshly burned woods and only 33 per cent in an unburned area. Grass production was comparable on burned and unburned areas, with bluestems *(Andropogon sp.)* comprising approximately 60 per cent of the total grasses.

Study Area

This study was conducted on the 5,500 acre Caney Mountain Wildlife Refuge located in the south central portion of the Missouri Ozarks. Most of the land in this area is too steep and rocky to be good forest land. The only productive sites are the narrow ridges, north slopes and small creek bottoms. South and west facing slopes are in "glades" which occupy about 20 per cent of the refuge. Extensive glades are unique physiographic features of the southwestern Ozarks. Glade soils are shallow and are generally considered non-commercial timber sites. Grasses interspersed with scrubby stands of post oak, *(Quercus stellata)* and red cedar *(Juniperus virginiana)* and mixed hardwoods comprise the principal vegetative cover.

Kucera and Martin (1951) found that grasses made up 78 per cent of the herbaceous plant cover on the glades and that little bluestem *(Andropogon scoparius)* was the dominant species comprising 51 per cent of the total herbaceous cover. Other grasses which were dominant locally on the glades, but lacked complete distribution included big bluestem, *(Andropogon Gerardi)*, side-oats grama, *(Bouteloua cur-*

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tipendula); switchgrass, *(Panicum virgatum);* Indian grass, *(Sorghastrum nutans);* prairie dropseed, *(Sporobolus heterolepis);* and purple top, *(Tridens flavus).*

Woody species other than cedar and post oak included, Prairie Acacia, *(Acacia angustissima* var. *hirta),* Chittim-wood *(Blumelia lanuginosa),* Dwarf Hackberry *(Celtis tenifolia* var. *georgiana),* Smoke tree *(Cotinus obovatus),* Winged Elm *(Ulmus alata),* and Fragrant Sumac *(Rhus aromatica).* Some of the north slopes have fair to medium site capabilities and there are some stands of black oak *(Q. velutina),* and white oak *(Q. alba),* but these have a low commercial value because of the long years of burning prior to the establishment of the refuge. The present timber stand on the refuge consists of two age classes, overmature saw timber (largely cull with a dense understory of small trees from 2-4 inches in diameter)and new tree growth which has come in since the refuge was established in 1940. Since that time, the area has been protected from fire and grazing.

Caney Mountain Refuge was established primarily as a study area for wild turkeys *(Meleagris gallopavo silvestris),* (Leopold, 1943). Attempts were made to increase the turkey population on the refuge through the construction of waterholes and the maintenance of annual food plots. Initially this program appeared to be very successful. The turkey population increased from 10 in 1940 to 135 in 1944-45. Despite the continuance of the management program, the turkey population both on and outside the refuge began to decline after 1945.

Specific reasons as to why the turkeys started dwindling in this region is not fully understood, but gradual changes in habitat condition may have been a factor.

Deer *(Odocoileus virginianus)* were not present on Caney Mountain Refuge when it was established. During the fall and winter of 1940, 30 deer were released on the area. The deer population increased to the point that by the early 1950's food plots using buckwheat, corn, milo etc. were no longer of any value for turkeys. A special season was held in the refuge in 1953 and 140 deer (16 per square mile) were removed (Murphy, 1961). By 1958 deer again became so numerous that they were interferring with the food plots so another season removed 150 deer (17 per square mile). While the deer population may have competed with the turkeys, they alone were not thought to be the reason as to why the turkey populations declined.

Work was started in 1956 to try and improve habitat conditions for turkeys by girdling overstory trees and thinning of the understory vegetation. This work particularly on the glade sites resulted in lush stands of grasses. This present study was initiated in an attempt to determine if, through the use of fire, plant composition on these glade areas could be altered so that they would be more desirable for turkeys and other wildlife.

Methods

Four blocks, each containing 5 plots, were laid out in February 1960. Two blocks were located on north to northwest facing slopes and two blocks on south and southeast facing slopes. Individual plots were approximately one acre and were separated by plowed fire lanes. Four plots in each block were randomly selected and burned with the fifth serving as a control.

The following burning dates were scheduled: (1) Early March, before plant growth had started, (2) Mid-April, when most of the plants were just beginning to grow, (3) Early June, when most of the plants were actively growing, but before the summer dry period, and (4) August, when soil and plants are dry.

Due to an extremely late winter, the first burn was delayed until March 24, 1960, but plant growth had been retarded so the ef-

fect was the same as planned. The second burning was delayed until May 2. The third and fourth treatments followed the prescribed schedule.

The following information was collected for each of the individual treatments and for each plot:

1) Weather conditions, type and condition of fuel, time of day, fire danger and description of procedure and results.
2) Ground cover and plant density were measured by use of three randomly located step-point transects on each plot (Evans and Love, 1957). Measurements were taken in October.
3) Vegetative production was determined by the double sampling method (Wilm, et al., 1944). Twenty quadrats (2.4 feet square) were taken per plot. Production was estimated on 18 quadrats. Production was estimated and then clipped and weighed on two randomly located quadrats. These measurements were also taken in October.
4) Estimates of production (green weight) were converted to dry weight by dry weight factors computed from samples of vegetation which were collected and weighed in the field, oven dried at 100° C for 24 hours and then reweighed.
5) Hardwood sprout survival was measured on permanently located belt transects (two) in each burned plot. Observers recorded all living sprouts within 2.18 feet on each side of a 100-foot line, an area of .01 acre.

Success of Burning

The March burns were relatively unsuccessful because of excessive moisture left by late winter snows, especially on north slopes. April burns were more successful with good uniform coverage of the plots and some hot spots. June burns were rated as good in uniformity and rate of burning. The August burns were very hot and covered the plots completely.

All of the burns resulted in removal of litter and exposure of bare soil and rock the first year (Figue 1). The amount of litter removed was in proportion to success of burning. The August burns were not measured the first year because less than two months had elapsed between treatment and measurement. The very hot fire consumed nearly all litter and vegeation and the plots were almost entirely bare. Litter probably covered less than 10 per cent of the area on the August burns.

Results of the extremely hot August fires were still evident the second year after burning. The August burns still had a greater percentage of rock and bare soil than did any of the other plots. Accumulation of litter on the March burn was comparable to the control one year after burning but it took two years for the April and June burns to reach a comparable level.

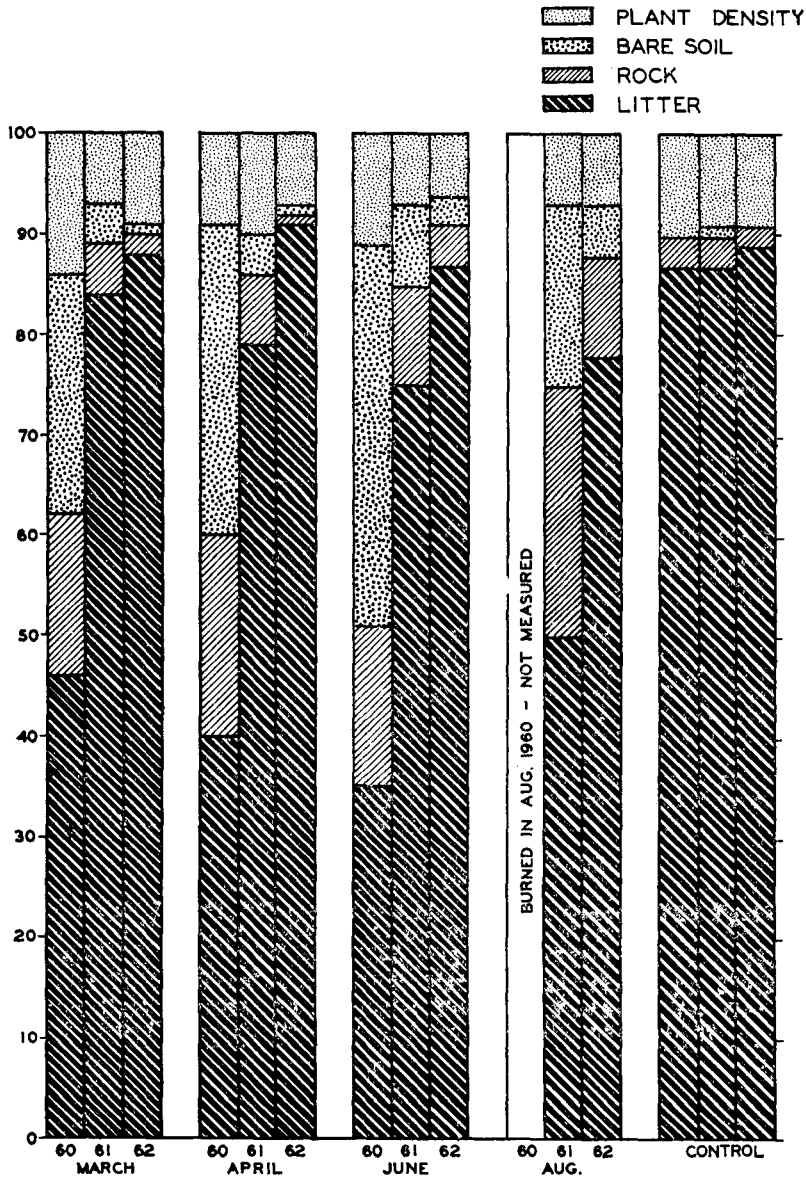
These data indicate the danger of erosion which is a factor to be considered in use of fire as a management tool. This erosion hazard should be considered in any use of fire especially in regions of steep slopes such as occur throughout the Ozarks.

Findings

No measurements were taken in the August burned plots in 1960 because the burn had destroyed the vegetation. Therefore we have only two years of data on this treatment to be compared with three years of data on the other plots.

There was also an obvious difference in growing seasons between years. The unusually heavy snow which occurred during February and March in 1960 created excellent growing conditions. The growing

FIGURE 1
SUMMARY STEP POINT DATA 1960-62



seasons of 1961 and 1962 were dryer and almost drouthy.

To compensate for the above variables, we have combined the data for the three years and calculated a mean annual production for the years measured.

Comparison of mean annual production and confidence intervals showed no difference in production between plots on north aspects and on south aspects. Therefore, we have combined the plots from both aspects in the following analyses.

Grass Production

Mean annual production of grass was highest on the plots burned in March and April (Table 1). However, examination of confidence intervals indicates that there was no statistically significant difference between the treatments. Mean annual production on the March burn was significantly greater than on the control.

The mean annual production on the March and April burns is greater because of the increased production the first year. The increase in production lasted only one year and production the second and third years was comparable to the unburned plots. However, as mentioned previously, moisture conditions may have caused the decrease in the later years as shown by decreased production on the control plots.

Table 1
Grass Production by Time of Burning
(Pounds per acre—Oven Dry)

	March	*April*	*June*	*August*	*Control*
1960	995	1,375	765	--	675
1961	550	495	625	585	495
1962	550	440	350	445	480
Aver. Annual Production	695	770	580	515	550
95% C.I.	616-774	524-1,016	450-710	192-838	478-622

Forb Production

Forb production showed a definite response to burning (Table 2). The August burn produced the greatest mean annual production. Only the August burn showed a statistically significant increase in mean annual production.

Forb production on the March burn and control plots showed a decrease annually which probably reflects the growing seasons.

The June burn, made while forbs were growing, apparently reduced forb production for the first year.

The August burn produced a large increase in forbs the first year after burning. This burn removed most of the litter and promoted earlier warming of the soil with less competition.

Lay (1956) reported increased forb production that persisted for as long as three years. Our study indicated a similar condition. Forb production the third year was higher on all burned plots than on the control.

Legume Production

Legume production was significantly increased by all burning treatment. (Table 3). June and August burns had a higher annual mean production than the two earlier burns but the difference is not significant statistically.

Table 2

Forb Production by Time of Burning
(Pounds per Acre—Oven Dry)

	March	*April*	*June*	*August*	*Control*
1960	350	185	120	-----	230
1961	255	295	170	420	195
1962	115	165	210	230	90
Aver. Annual Production	240	215	165	325	170
95% C.I.	184-296	175-255	129-201	255-395	123-217

Table 3

Legume Production by Time of Burning
(Pounds per acre—Oven Dry)

	March	*April*	*June*	*August*	*Control*
1960	70	75	105	-----	20
1961	55	85	85	85	45
1962	65	65	110	90	25
Aver. Annual Production	65	75	100	90	30
95% C.I.	46-84	49-101	64-136	65-115	21-39

Woody Vegetation

Our measurements did not show any difference in production of woody vegetation by different treatments. However, confidence intervals are very large which indicates an inadequate sample. Evidently, the quadrat which we used (2.4 feet square) did not provide an adequate sample of woody vegetation.

Table 4

Browse Production by Time of Burning
(Pounds per acre—Oven Dry)

	March	*April*	*June*	*August*	*Control*
1960	25	60	75	-----	55
1961	65	120	90	95	80
1962	40	90	110	65	35
Aver. Annual Production	45	90	90	80	55
95% C.I.	20-70	56-124	38-142	32-128	27-83

Preferred Wildlife Foods

One of our objectives was to see if occasional burning would increase production of species preferred by deer and turkey.

Except for the March treatment, burning increased the productioon of desirable forbs, Aster *(Aster sp.)*, Sunflower (*Helianthus sp.)*, and Goldenrod *(Solidago sp.)* (Table 5).

It did not increase production of Indian-tobacco *(Antennaria sp.)*. These four forbs are important deer foods in Missouri (Dunkeson, 1955 and Korschgen, 1962).

Table 5

Production of Forbs Preferred By Deer—1962
(Pounds per Acre)

	March	*April*	*June*	*August*	*Control*
Sunflower	30	45	50	50	10
Aster	15	35	25	40	20
Goldenrod	10	25	30	55	10
Indian-Tobacco	25	15	20	20	20
Total	80	120	125	165	60
Per Cent of Total Forbs	76%	72%	59%	70%	67%

Except for the June burn, desirable forbs made up a slightly higher per cent of total production on burned areas than on the control. Forb production on the June burn had a lower per cent of preferred forbs than any other treatment. All of the burning treatments increased production of preferred legume, *Lespedeza* sp. and *Desmodium* sp. (Table 6). These legumes are especially important to turkeys but are also used by deer and other wildlife.

Table 6

Production of Preferred Legumes—1962
(Pounds per Acre)

	March	*April*	*June*	*August*	*Control*
Lespedeza	30	35	40	25	10
Desmodium	20	20	35	40	10
Total	50	55	75	65	20
Per cent of Total Legume	80%	80%	67%	73%	20%

Burning also altered the composition of legume production. The preferred legumes made up a much higher per cent of total legume production on the burned plots than on the controls.

Burning did not change the composition of grasses. Three grasses, little bluestem, big bluestem ,and Indian grass, made up about 90 per cent of the total grass production on both burned and control plots.

Burning did ater the ratio of grass to other vegetation (Table 7). Compared to the control plots, grass made up a smaller per cent of total production on all burned plots except March. The per cent of forbs and legumes was also considerably higher on April, June, and August burns than on the control.

Utilization by Wildlife

Burning apparently increased the palatability of some plants because deer utilized a higher per cent of shrubs and forbs on the burned plots than on unburned (Table 8). This increased palatability lasted

Table 7

Composition of Production—1962

	March	*April*	*June*	*August*	*Control*
Grass	71%	58%	45%	53%	76%
Forbs	15	22	27	28	14
Legumes	8	8	14	11	4
Woody	5	12	14	8	5

for only one year because utilization of plants the second year was comparable on burned and unburned plots.

Several studies by other workers have shown that burning increases palatability (Einarsen, 1946; Pearce, 1937; DeWitt and Derby, 1948; and Reynolds and Sampson, 1943).

The amount of sign observed while working on the plots indicated that other species of wildlife (turkeys, quail and rabbits) also utilized the burned areas more heavily than the unburned.

Table 8

Utilization by Deer

	1960 (Per Cent of Plants Browsed)		1961 (Per Cent of Plants Browsed)	
Wild Rose (*Rosa* sp.)	Burned 14%	Unburned 7%	Burned 1%	Unburned 1%
Sensitive Briar (*Schrankia* sp.)	22	5	0	0
Aster sp.	14	7	4	9
Spiderwort (*Tradescanthia* sp.)	62	25	8	0
Brown-eyed Susan (*Rudbeckia* sp.) (*Ratibida* sp.)	12	5	0	0
Hypericum (*H. punctatum*)	5	2	0	0
AVERAGE	16%	6%	2%	4%

Hardwood Sprout Survival

Spring burning is a common annual occurrence in the Missouri Ozarks. One reason given for this burning is to control hardwood sprouts. The spring fire season generally ends when the vegetation begins "greening up." Spring burning does not decrease sprouts. It "knocks back" the larger tree reproduction but resprouting occurs (Paulsell, 1957). Spring burning actually creates sprout stools with large root

systems which are resistant to fire (Liming and Johnston, 1944).

Results of our study indicate that occasional burning in early spring (March) increased the number of sprouts but that burning at a later date, caused some decrease in sprouts (Table 9).

Table 9

Hardwood Sprouts Survival

	North		*South*		*Total*		% Increase or Decrease
	1960	1961	1960	1961	1960	1961	
March	103	191	86	101	189	292	+ 54
April	76	91	152	108	228	199	— 13
June	110	139	138	66	248	205	— 17
August	73	117	121	44	194	161	— 17

There was a difference in sprout survival with regard to exposure of slope. Burning on north slopes increased sprouts on all treatments. Burning later in the summer reduced sprouts on the south facing slopes. This difference is probably the result of burning conditions. Fires on the south slopes tended to be hotter because of lower moisture content in the litter.

Summary

A single controlled burn improved wildlife food conditions on a non-commercial timber site in the Missouri Ozarks. Burning in summer or early fall was more effective than in spring.

Burning increased the production of forbs and legumes and reduced the proportionate amount of grass.

Production of forbs and legumes preferred by deer and turkeys was increased by burning, especially in summer or early fall. However, the early fall burn (August) cannot be recommended because of the amount of bare soil which it leaves exposed over-winter on the steep slopes of the Ozarks.

Palatability of some plants was apparently increased for at least one year following burning.

Hardwood sprout survival was reduced by burning in summer or fall but not by burning in the spring. Survival was lower on south slopes.

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