EFFECTS OF PRESCRIBED BURNING ON FORAGE AND MAST PRODUCTION IN SOUTHERN PINE FORESTS[1]

By DANIEL W. LAY
Wildlife Biologist, Texas Game and Fish Commission, Buna, Texas

Prescribed burning is a sound timber management practice in all types of southern pine forests. Its use in longleaf forests is widespread and well established. In other pine types, foresters are just beginning to use it in their management programs. It serves in the control of hardwood understory, the preparation of pine seedbeds, the reduction of fire hazard, and in the control of brown spot disease on longleaf.

Since prescribed burning is becoming accepted, the problem of game managers is to evaluate its effects and look for adjustments which will benefit wildlife without reducing forestry benefits.

One of the earliest advocates of prescribed burning for wildlife was Stoddard (1931) who found that fire was essential to quail management in the southeast. Burning which followed mechanical brush control by Blakey (1947) on the Arkansas National Refuge (Texas) attracted turkey, quail, jacksnipe, and sandhill cranes. Uncontrolled fires on moose range in Alaska (Spencer and Chatelain, 1953) and on Isle Royal (Aldous and Krefting, 1946) have had very beneficial effects on the browse supply and on the herds. Leopold (1950) noted the importance of sub-climax stages of succession for deer and suggested that prescribed burning where applicable is the cheapest tool for increasing the deer carrying capacity of some ranges.

Prescribed burns, as defined by Silker (1955), "are fires purposely set to forest land under certain weather conditions, fuel and soil moisture, and time of day that will result in the intensity of heat and rate of spread required to accomplish some specific silvicultural purpose."

Ecologists recognize that hardwoods are the climax type on most southern sites (Wells, 1928). Since there is a stronger market demand for pines, the foresters' objective is to maintain a sub-climax association in which pine can dominate. This is the primary purpose of prescribed burning in pine-hardwood types as recommended by Chapman (1942), Little (1953), Silker (1955) and many others.

STUDY AREA AND METHODS

The Texas Forest Service started a study in 1949 at the Siecke State Forest in Newton County to determine how to use fire for the control of undesirable understory hardwoods invading pine-hardwood stands and slash pine plantations. Their work (Silker, 1955) was set up in three stand condition classes, to show the effects of three seasons and two frequencies of burning.

The stand conditions studied were: Cut-over sawtimber-size pine-hardwood, pulpwood-size pine-hardwood, and pulpwood-size slash pine in plantations. The seasons studied were: Spring (March 1-30), late summer (August 1-September 15), and winter (December 15-January 30). Burns were repeated at two and three-year intervals and each treatment was replicated three times on three-acre plots.

The original understory on these plots varied considerably, depending on stand age and past cutting history. Three stand condition classes averaged from 13,000 to 38,000 hardwood stems under one inch in diameter per acre. The number of stems one to five inches in diameter, averaged about 500 to 1,000 per acre. The average height of the understory was 9.2 to 11.7 feet before the fires and 1.8 to 5.8 feet after the second fire.

The type of fire used was backfire or strip-headfire with flames three feet high or less. Selection of time and method of burning depended on the following factors: Overstory, fuel type, moisture content of upper and lower fuels, relative humidity, wind, and air temperature.

The Texas Game and Fish Commission studied most of these same plots in 1953-1955 to determine the effects of burning on wildlife foods, with primary

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emphasis on deer. The location had not been grazed by livestock, no deer were present, and there had been no fire for at last 20 years prior to the beginning of these tests. The flora was exceptionally complete and undisturbed as the result of these conditions.

Two methods were used to record the production of browse by species, and the production of herbs and grasses-sedges by groups. Plots 2 by 48 feet were clipped to determine the weight of forage. The plot size was such that grams on the plot were equal to pounds per acre, as described by Campbell (1946). Clipping standards were to remove all current-season growth not over 3/16 inch in diameter and not over six feet high. Clipping was done after July 1 each year, measurements of monthly growth on 60 plants having shown that 89.4 per cent of the season's linear growth is completed by that time.

Moisture content was determined on a large number of species at different seasons, with plans to convert all data to air-dry basis; but tests showed no significant effects of fire on moisture content so the original green weights were used.

The second method was line-point intercept plots as described by Parker (1951) and Dasmann (1951), in which a 50-foot tape was stretched and a 3/4-inch circle checked every six inches for browse canopy by species up to six feet high and for grass crown or herb stem. Records for the 100 points on each plot were used as percentages of density.

The weight plots were used in 1953 and 1954 and the intercept plots in 1955 after a comparison of 27 plots worked with both methods showed no important differences. The clipping method is slower, but the intercept method is biased in comparing browse and herbs.

To evaluate the effects of burning on mast production, a series of 69 1/10-acre circular plots was checked in October 1953 and June 1954 to determine the number of plants of mast-bearing size and the number of plants with mast. Species which do not produce mast until they reach a size too large to be affected by fire, such as pines and oaks, were not checked. The results are a measure of fire effects on understory mast production.

EFFORTS ON FORAGE

The effects of fire on forage production in a forest is obscured by such variables as timber stand density, age class, overstory and understory canopies, and soils. Basal area of stems over 3.5 inches on the burning plots averaged 96 feet as compared with 76 feet on the unburned plots. However, an attempt to correlate weights of forage with basal area on 27 plots failed to produce a satisfactory correlation. On the strength of this test, it was decided the variable of stand density could be ignored.

The data for each of three stand condition classes were segregated but no significant difference was found. No attempt was made to measure soil or canopy differences, although they appeared to be unimportant. Silker's work (1955) had shown no important difference between burning at two and three-year intervals so the burning-interval factor was eliminated.

Differences in production between late summer, winter, and spring burns when measured the following late summer or fall, were considered to be negligible, although the data were insufficient to test this.

With these variables eliminated for the reasons given, there remains the comparison of production on unburned plots with burned plots, by number of seasons since the last fire—one, two or three. These results are reported in Tables I and II.

The summary of data from intercept plots showed statistically significant differences in five of six comparisons whereas the weight plots showed none. This may be due to the fact that intercept plots were made after the plots had all been burned two or three times, whereas the weight plots were made after the first or second fires. Another factor is the range of measurements: intercept plots measurements were less than 100, whereas the weight measurements ranged up to about 4,300.

The intercept measurement of herbaceous forage is inadequate for adding to woody forage records to obtain total forage. For example, in Table I, the intercept record was 82.1 for unburned woody forage and 2.2 for herbaceous. The weights clipped were 675 pounds woody and 100 pounds herbaceous. By intercept, herbaceous forage represents only 2.6 percent of the total; whereas by weight herbaceous forage is 12.9 percent of the total. Thus the intercept records for total forage would be biased in favor of the woody part and cannot be used.

My interpretation of the results shown is that browse forage was reduced for two years, that herbaceous forage was increased for at least three years, and that there is no great change in total forage after one to three fires.

TABLE I

FORAGE PRODUCTION ON BURNED AND UNBURNED PLOTS AT SIECKE STATE FOREST SUMMARY FOR 1953, 1954 AND 1955 *
(Green Weights in Pounds Per Acre)

Type of Forage	*Method of Measure*	*First Season After Last Fire*		*Second Season After Last Fire*		*Third Season After Last Fire*	
		Unburned	*Burned*	*Unburned*	*Burned*	*Unburned*	*Burned*
Woody	Intercept	82.1	36.1	82.1	66.3	82.6	77.3
	Weight	675	524	848	743	794	606
Herbaceous	Intercept	2.2	6.7	2.2	6.4	1.9	10.7
	Weight	100	476	168	379	143	244
Total Forage	Weight	775	1,000	1,016	1,122	936	850

* The number of plots and the number of burns represented by each pair of figures are shown in Table II.

TABLE II

PERCENTAGE CHANGE IN FORAGE PRODUCTION AFTER BURNING ON PLOTS AT SIECKE STATE FOREST—SUMMARY FOR 1953, 1954 AND 1955

Type of Forage	*Method of Measure*	*First Season After Last Fire*			*Second Season After Last Fire*			*Third Season After Last Fire*		
		No. Plots	*No. Burns*	*% Change*	*No. Plots*	*No. Burns*	*% Change*	*No. Plots*	*No. Burns*	*% Change*
Woody	Intercept .	39	3	—56†	39	2–3	—19†	30	2	— 6
	Weight ..	54	2	—22	15	2	—12	21	1	—24
Herbaceous	Intercept .	39	3	205*	39	2–3	146*	30	2	463†
	Weight ..	54	2	376	15	2	126	21	1	71
Total Forage	Weight ..	54	2	29	15	2	10	21	1	— 9

* Exceeds the 5 percent level of probability.
† Exceeds the 1 percent level of probability.

TABLE III

PERCENTAGE CHANGES IN PRODUCTION BY SPECIES ONE, TWO, AND THREE SEASONS AFTER PRESCRIBED BURNING BY TWO METHODS OF MEASUREMENT

Species	*Method*	*First Season After Last Burn*			*Second Season After Last Burn*			*Third Season After Last Burn*		
		No. Plots	*No. Burns*	*% Change*	*No. Plots*	*No. Burns*	*% Change*	*No. Plots*	*No. Burns*	*% Change*
Yaupon	Intercept .	39	3	—90†	39	2–3	—82†	30	2	—70†
	Weight . .	54	2	—68†	55	2	—35	21	1	— 4
Holly	Intercept .	39	3	—97†	39	2–3	—94†	30	2	—90†
	Weight . .	54	2	—90†	55	2	—93†	21	1	—94†
French Mulberry	Intercept .	39	3	—48	39	2–3	—67	30	2	36
	Weight . .	54	2	20	15	2	179	21	1	— 5
Black Gum	Intercept .	39	3	—70	39	2–3	—91*	30	2	—93*
	Weight . .	54	2	—38	15	2	—100*	21	1	—60
Yellow Jessamine	Intercept .	36	3	—61	39	2–3	— 4	30	2	132
	Weight . .	54	2	23	15	1	—100	21	1	—57*
Viburnum molle	Intercept .	39	3	—30	39	2–3	0	30	2	—100
	Weight . .	54	2	515	55	2	280†	21	1	—100
Smilax glauca	Intercept .	39	3	211	39	2–3	1,610	30	2	500
	Weight . .	54	2	118	15	2	981*	21	1	2
Sweetleaf	Intercept .	39	3	—25	39	2–3	146	30	2	300*
	Weight . .	54	2	64	55	2	97	21	1	— 5
Wax Myrtle	Intercept .	39	3	—38	39	2–3	—10	30	2	30
	Weight . .	54	2	— 7	15	2	—52	21	1	—75
Sweetgum	Intercept .	39	3	4	39	2–3	96	30	2	39
	Weight . .	54	2	89	15	2	—85	21	1	90
Blackberry	Intercept .	39	3	100	39	2–3	231	30	2	263
	Weight . .	54	2	—10	15	2	308	21	1	130
Dogwood	Intercept .	39	3	—63	39	2–3	—68	30	3	50
	Weight . .	54	2	—77	15	2	—98	21	1	—92
Tree Huckleberry	Intercept .	39	3	—85	39	2–3	—74	30	2	—75
	Weight . .	54	2	—85	15	2	—35	21	1	—90
Herbs	Intercept .	39	3	316†	39	2–3	258*	30	2	146
	Weight . .	54	2	681	55	2	236†	21	1	146
Grasses—Sedges	Intercept .	39	3	125	39	2–3	150	30	2	750*
	Weight . .	54	2	194	15	2	32	21	1	15

* Exceeds the 5 percent level of probability.
† Exceeds the 1 percent level of probability.

Species reaction to fire was more pronounced. Table III gives the records for 13 species and herbs and grasses-sedges. The data for some of these species and for about 75 others not reported were inconclusive. Some may not be affected by fire, others were too rare for the limited number of plots.

Yaupon (*Ilex vomitoria*), black gum (*Nyssa sylvatica*), and holly (*Ilex opaca*) were reduced conclusively about 70 to 90 percent for three years. Yellow jessamine (*Gelsemium sempervirens*) showed a reduction of 57 percent the third year. *Viburnum molle* and *Smilax glauca* increased significantly by weight the second season, and sweetleaf (*Symplocos tinctoria*) increased the third season by intercept.

Herbs showed 200 to 300 percent increases the first two seasons and grasses-sedges were up as much as 750 percent by the third year.

Other records with less statistical basis which showed a fairly consistent percentage change were: Blackberry (*Rubus sp.*) up 100 to 300 percent for three years and French mulberry (*Callicarpa americana*), and sweetgum (*Styraciflua liquidambar*) up, and wax myrtle (*Myrica cerifera*), dogwood (*Cornus florida*), and tree huckleberry (*Vaccinium arboreum*), down.

DISCUSSION

The foregoing results indicate that one to three fires caused some changes in forage species composition but did not materially affect the total production. However, the long-term results of prescribed burning at short intervals to favor pines may reduce the total amount of forage in many southern pine forests. This is especially likely in stands that are poorly stocked with pine and are in early stages of hardwood invasion, because they are nearly ideal already.

The important short-term effects are changes in composition caused by fire. The gains in herbs, French mulberry, *Viburnum molle, Smilax glauca,* and blackberry all benefit deer but only the smilax is an evergreen. The deer foods which decreased after fire (holly, yaupon, yellow jessamine, dogwood, and black gum) may be more important. Gains and losses of sweetgum, wax myrtle, tree huckleberry and grass are unimportant to deer.

A study of the effects of fire on the nutrient quality of browse (Lay, unpublished) has shown that burning raises protein levels through the second winter and phosphorus levels until the first winter. Since these two nutrients are rarely adequate on southern ranges, fire improvement of forage quality must be balanced against losses in quantity of desirable species.

The effects of fire on forage quantity depend on conditions before the fire; so fire will do the most good for wildlife where the understory is least desirable. Such places are found where the understory is so dense and high that little food is available within six feet of the ground. Density of stems may be so great that movement is difficult and wildlife use is rare, as in most jungle-like formations. Had the understory succession (9 to 12 feet high) at the Siecke State Forest been more advanced, the burning would have been more beneficial in affecting forage but possibly not as beneficial in hardwood reduction.

The pattern of burning which increases the diversity of habitat as much as is practicable may be expected to benefit wildlife. Under some silvicultural conditions the season for burning is optional. In these cases spring and summer burning should be practiced in order to extend the period of nutrient quality improvement into the fall and winter when it is needed most.

EFFECTS ON MAST

Understory mast production is seriously reduced by fire. The 69 plots checked in October, 1953, showed that burning (with no segregation by stand class, burning season, interval, or number of burns) reduced the number of plants per acre of fruiting size 62 percent from 208 to 68 and the number of plants per acre with fruit 72 percent, from 50 to 14.

The same plots in June, 1954, with a few new species which could not be checked for mast in October, showed a reduction by fire of 72 percent in the number of plants per acre and 68 percent in the number of plants with fruit. All of these figures are significant at the .01 level. There was no significant difference in the percentage of plants with fruit.

The effects of fire on plants per acre with fruit by species was to reduce yaupon, holly, and sweetleaf 95 percent (each significant at .01) and *Viburnum molle* 84 percent (significant at .05). Dogwood plants per acre of fruiting size were unchanged but the percentage of these with fruit increased 83.3 percent (significant at .01) after burning. Other species records were insufficient for conclusive results, but French mulberry plants and plants with fruit seemed to be increased. Tree huckleberry appeared to be decreased in plants and fruit.

To summarize, fire reduces the production of understory mast by removing plants of mast bearing size. The percentage of plants with mast was not affected, except in the case of dogwood which was stimulated to 83 percent more production.

SUMMARY

1. Prescribed burning in southeast Texas reduced browse for two years, and increased herbaceous forage for at least three years, but caused little change in total forage production.
2. Changes in floral composition caused by burning were more pronounced than changes in quantity of forage. The species which were reduced were holly, yaupon, black gum, yellow jessamine, dogwood, wax myrtle, and tree huckleberry. The species which were increased were grasses-sedges, herbs, French mulberry, Viburnum, Smilax, blackberry, sweetgum and sweetleaf.
3. Burning reduced the number of understory plants per acre of fruiting size 62 to 72 percent and the number of plants per acre with fruit 68 to 72 percent. Dogwood fruiting was increased 83 percent.
4. The benefits to be gained for a wildlife species through prescribed burning increase as the understory succession progresses away from the conditions desired for that species.

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