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SEASON OF BURN AND HARDWOOD DEVELOPMENT IN YOUNG LONGLEAF PINE STANDS

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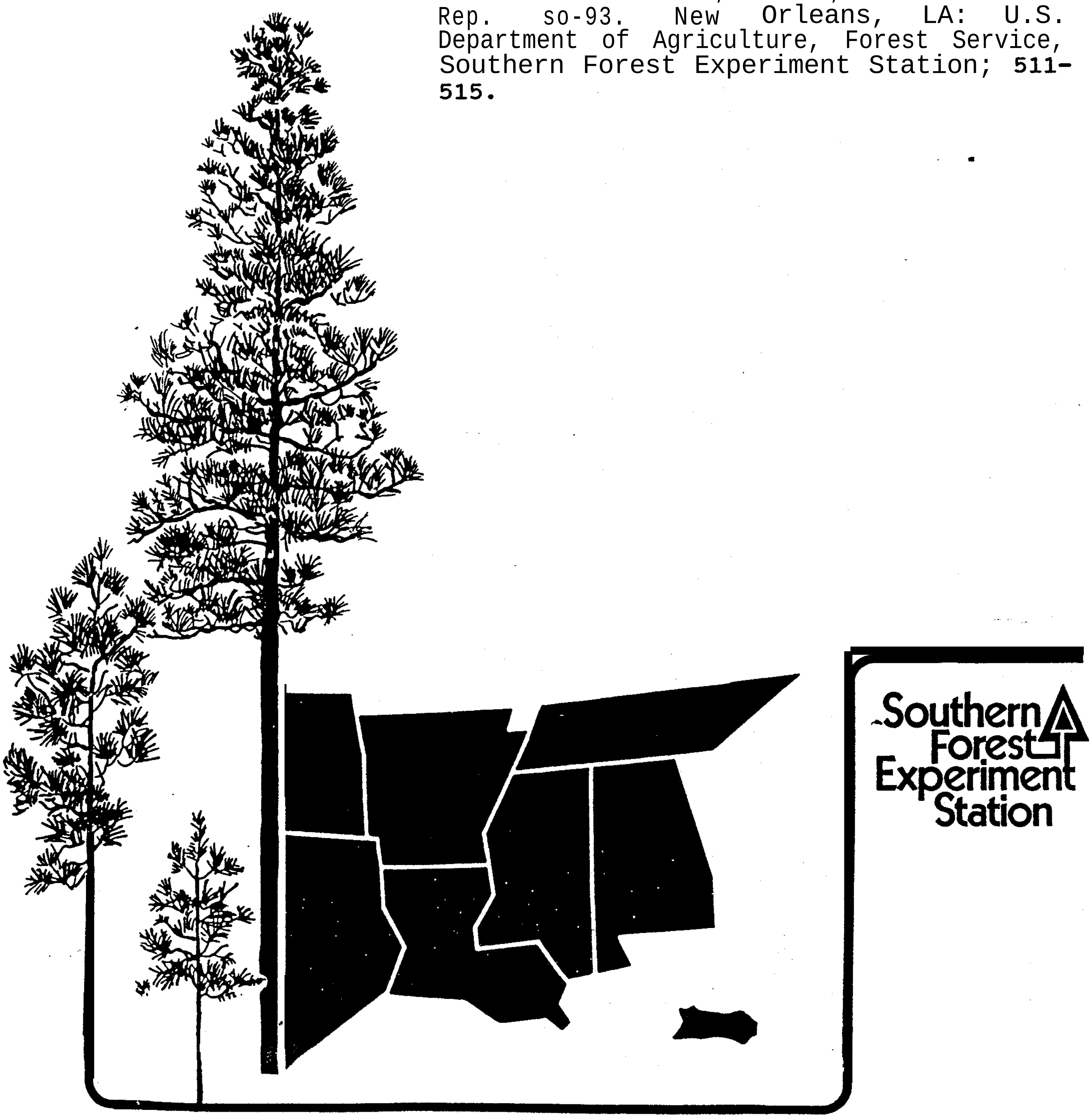

SEASON OF BURN AND HARDWOOD DEVELOPMENT IN YOUNG LONGLEAF PINE STANDS [1]

William D. Boyer [2]

Abstract. Four treatments--biennial burns in winter, spring, and summer, and a no-bum control-were applied in plots in naturally established stands of longleaf pine (*Pinus palustris* Mill.). Treatments commenced in 1974, when the pines were 15 years old, and the most recent observations were made in 1992. Midstory hardwood density increased in the absence of burning and with winter burning but decreased with spring and summer burning. The proportion of hardwood basal area to total stand basal area has remained relatively constant in both unburned and winter-burned stands. Hardwood regeneration was unaffected by burning.

Introduction

Control of understory hardwoods within young pine stands is expected to provide a number of benefits, including increased growth of overstory pine, reduced fuel loads, easier access, reduced cost of future site or seedbed preparation, and increased cover of grasses and other herbaceous vegetation.

A study to determine the long-term effects of several hardwood control treatments on understory succession and overstory growth was initiated in 1973. Combinations of fire, mechanical, and chemical treatments were applied. A major objective was to observe changes in the composition and structure of midstory and understory vegetation under the different treatmentregimes.

Effects of treatments on growth of longleaf pine (*Pinus palustris* Mill.) over the first 10 years have been reported (Boyer 1987). The effect of the single chemical treatment on the regeneration and development of woody vegetation has been reported also (Boyer 1991). Responses of hardwood tree species to 18 years of biennial dormant-season and growing-season prescribed burns and to complete fire exclusion are described here.

Methods

The study was established on a sandy upland Coastal Plain site on the Escambia Experimental Forest? in southwest Alabama in 1973. At that time, study areas supported natural stands of longleaf pine. These stands were 14 years old from seed and 12 years from time of release from a seedtree overstory. Pine stocking averaged about 700 trees per acre. The last prestudy fire on all study areas was a prescribed burn in January 1962.

Three blocks were established, each in a different 40-acre compartment. Each block consisted of 12 0.4-acre square plots. Bach plot was thinned to about 500 well-distributed dominant and codominant pines per acre. The residual pines in 0.1-acre subplots were marked and numbered, and their total height and d.b.h. were recorded. These pines averaged 22 ft. in height and 3.2 inches in d.b.h. and average basal area (BA) was 30 ft^2/acre. Average age-50 site indexes for longleaf pine on the study blocks, based on heights of dominant and codominant trees at age 33, ranged from 77 to 81 feet (Farrar 1981).

All woody stems were counted on nine systematically located 3.1-ft-square sub-subplots in each O.l-acre subplot. A lo-factor wedge prism was used to estimate hardwood BA in each subplot. Hardwood BA averaged 3.6 ft^2/acre. There were approximately 5,300 small hardwood stems per acre with d.b.h. < 1.5 inches. Eighty-six percent of these were oaks (*Quercus* spp.), 11 percent, flowering dogwood (*Cornus florida* L.), and the remainder, common persimmon (*Diospyros virginiana* L.) and sassafras [*Sassafras albidum* (Nutt.) Nees]. Woody vegetation other than tree species averaged 102,000 stems/acre. Gallberry, [*Ilex glabra* (L.) Gray blueberries and huckleberries (*Vaccinium* spp. and *Gaylussacia* spp.), and blackberries (*Rubus* spp.) made up 91 percent of thii total. Vines rooted in sample plots, averaged 14,400/acre. Seventy-two percent of these were honeysuckles (*Lonicera* spp.), and the balance greenbriars, (*Smilax* spp.).

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[3] Maintained by Southern Forest Experiment Station, USDA Forest Service, in cooperation with the T. R. Miller Mill Company.

Twelve treatment combinations were randomly assigned to the 12 plots in each block Each of four fire treatments-prescribed **fire** at *2-year* intervals in winter **(January** or February), spring (April or May), and summer **(July** or August), plus an unburned check-was **combined** with three supplemental treatments. These were: (1) injection all woody stems down to about l-inch groundline diameter with undiluted 2,4-D **amine** at time of study establishment in the spring of 1973, (2) handclearing, by cutting just above groundline, of all woody stems more than 4.5 feet in height at establishment and as needed thereafter, and (3) untreated check All plots selected for fire treatments were initially burned in January 1974. Assigned season of burn treatments were begun after that time. Spring burns were always in odd-numbered years. Since 1979, winter burns have always been in even-numbered years, and summer burns, in odd-numbered years.

Plots were first reexamined in the winter of 1980, after 7 growing seasons. At that time, all subplot hardwoods in the **2-inch** d.b.h. class and larger **(> 1.5** inches d.b.h.) were inventoried by species, and their **d.b.h.'s** were recorded. Smaller woody vegetation was again sampled on nine new systematically distributed **3.1-ft-square** sub-subplot within each subplot in the fall of 1980. All subplot and sub-subplots measurements were repeated in the **fall** and winter of 1982-83, **1985-86,** 1988-89, and 1991-92. In the last three periods, all hardwoods in the l-inch d.b.h. class were measured as part of the subplot inventory and were dropped from the sub-subplot count, which **then** included only woody stems 0.5 inches in d.b.h. or smaller.

Because supplemental hardwood control treatments had significant effects on hardwoods in the l-inch and larger d.b.h. classes, data for hardwoods in those size classes in the plots that received such treatments are not reported here. Supplemental treatments had little impact on hardwood regeneration on the forest floor, so this report deals with regeneration in all study plots.

By 1989, BA of the pine overstory on all individual plots ranged from 67 to 118 **ft²/acre** and averaged 97 **ft²/acre.** To promote optimum development of dominant residual pines and reduce natural mortality from competition, pine stands were commercially thiied in 1990 to a density of 70 **ft²/acre.** The three plots in which pine density was less than 75 **ft²/acre** were not thiied.

Results

Hardwood Midstory

The density of **midstory** hardwoods **> 1.5inches** in d.b.h. increased on unburned and winter-burned plots and generally declined on **spring-** and **summer-burned** plots (fig. 1). From 1973 to 1992, hardwood BA increased from 2.9 **ft²** to 14.6 **ft²/acre** on unburned plots. It increased **from** 3.7 **ft²** to 9.8 **ft²/acre** on winter-burned plots during the same period. Hardwood BA declined from 4.1 **ft²/acre** on spring-burned plots to 1.3 **ft²,** and from 2.2 ff to 2.1 **ft²/acre** on summer-burned plots from 1973 to 1992.

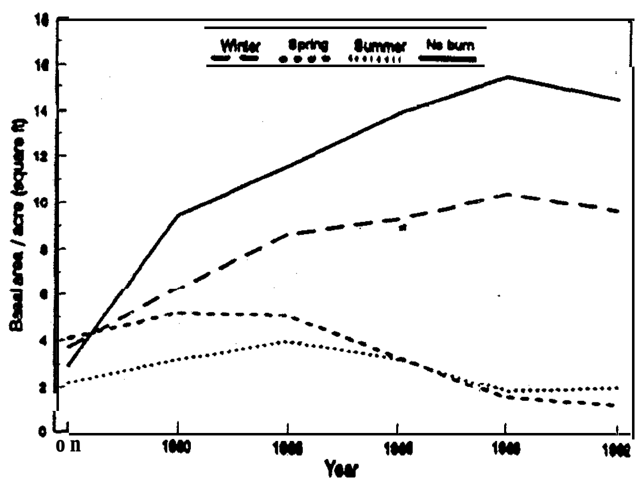

Figure 1. ***Changes* in *midstory hardwood density with* burning *treatments.***

The number of **midstory** hardwood stems per acre increased **from** 1980 to 1989 on unburned and **winter-burned** plots and declined with growing season. burns (table 1). Spring burns appear to be more effective than summer burns in reducing the number of **midstory** hardwood stems. Only one tree, an 8-inch d.b.h. oak, remains alive on the spring-burned plots.

The thinning operation in 1990 resulted in the loss of some hardwoods, especially where hardwood densities were relatively high on unburned and winter-burned plots. Only **midstory** hardwoods in the smallest **(2-inch)** d.b.h. class were lost.

The densities of **midstory** hardwoods on both unburned and winter-burned plots, while consistently increasing over time, have stabilized as percentages of total stand BA (fig. 2). **Midstory hardwoods** on unburned plots constituted 12 to 13 percent of total stand **BA from 1980 to 1989, whereas those** on winter-burned plots have constituted between 9 and 11 percent of total stand **BA since 1973.** Growing-season bums reduced the relative density of hardwoods from 12 to 14 percent of total stand BA in 1973 to 1 to 3 percent by 1989. **Thinning** removed more pine BA from unburned plots (38 **ft^2/acre)** than from all burned plots (24 **ft^2/acre).** This resulted in the greater increase in relative hardwood BA on unburned plots even though absolute hardwood BA on unburned plots declined slightly. Future measurements will reveal whether the relative hardwood density on unburned plots remains at the higher 1992 level or returns to the 1980-1989 level.

Table 1. ***Effect of fire on midstory hardwoods (>1.5 inches in d.b.h.).***

Treatment	Year 1980	1983	1986	1989	1992
	stems/acre				
Winter bum	190	237	223	220	147
Spring bum	153	113	**50**	7	3
Summer bum	**90**	97	77	43	43
No bum	287	307	317	340	**207**

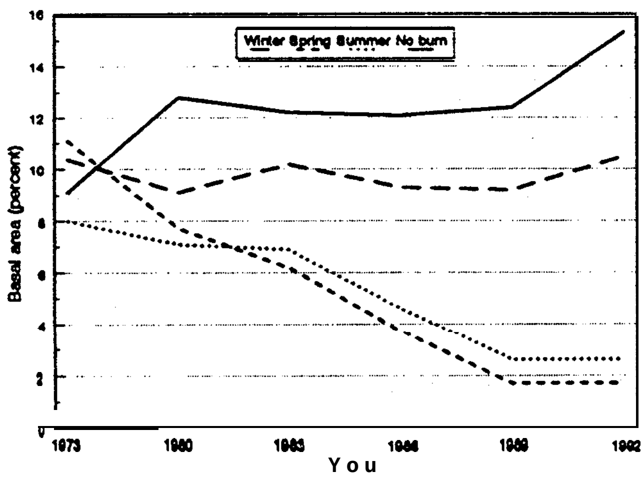

Figure 2. ***Hardwood** basal area as percent of **total** stand basal area, by burning treatment.*

Burning treatments have influenced the species composition of **midstory** hardwoods. **Only** dogwood (52 percent of surviving stems) and five oak species (48 percent of surviving stems) persisted on burned plots. Dogwoods made up 43 percent of the surviving stems on unburned plots and oaks 39 percent. Persimmon, **sassafrass,** and southern magnolia ***(Magnolia grandiflora*** L.) made up the remaining 18 percent of stems on unburned plots. **Bluejack** oak (Q. **incana** Bartr.) and water oak (Q. nigra L.) together accounted for 71 percent of all oak stems on both burned and unburned plots. However, 54 percent of all oaks on burned plots were bluejack, whereas water oaks made up 50 percent of all oaks on unburned plots.

Midstory Threshold

The immediate source for recruitment into the **midstory** is woody vegetation in the l-inch d.b.h. class (0.6 to 1.5 inches in d.b.h.). This class was tallied on entire subplots beginning in 1986. There were no woody stems in thii size class on spring-burned plots, and the number of stems **in** plots receiving the other 3 treatments has **declined** steadily since 1986 (table 2).

Table 2. *Effect of fire on woody stems in the l-inch d.b.h. class.*

Treatment	Year 1986	1989	1992
	stems/acre		
Winter bum	140	63.	**13**
Spring bum	0	0	0
Summer bum	60	10	3
No bum	317	270	123

In 1992, all woody stems in the l-inch **d.b.h.** class on burned plots were oaks (80 percent) or dogwood (20 percent). **On** unburned plots, dogwoods made up 27 percent of all stems, four species of oak, 13 percent, six other tree species **[sweetbay *(Magnolia virginiana*** L.), sassafras, magnolia, **persimmon,** American holly ***(Ilex opaca* Ait.),** and black cherry ***(Prunus serotina*** Ehr.)], 49 percent, and arborescent shrubs, 11 percent. All oaks in thii size class on burned plots were **bluejack** and post oaks ***(Q. stellata*** Wangenh.). On unburned plots, 60 percent of the oaks were water oak and southern red oak ***(Q. falcata*** Michx.), and only 40 percent were **bluejack** and post **oaks.**

HardwooRegeneration

All woody stems with a d.b.h. of **<** 0.5 inches were tallied on sub-subplots to obtain estimates of numbers of stems by species and species groups. Tree species were only a small fraction of the total number of woody stems on the forest floor. **Over** the course of the six examinations, the average number of tree stems, over all four treatments, ranged from 5,300 to **13,200/acre.** Numbers of shrubs and other woody plants (excluding vines) ranged from 58,000 to 208,000 stems/acre.

Hardwood tree regeneration on the ground grows into the midstory whenever an opportunity arises. Biennial prescribed fires over a period of 18 years have so far failed to significantly affect the amount of hardwood regeneration on the forest floor (fig. 3).

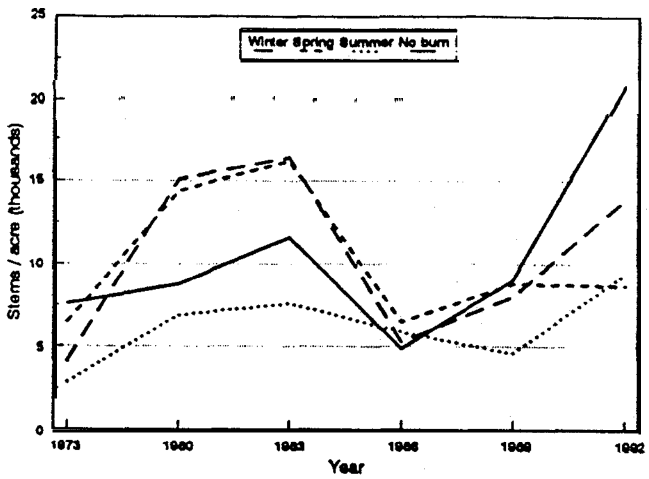

Figure 3. *Changes in hardwood regeneration with time and burning treatments.*

Examinations through 1983 treated as regeneration all stems 1.5 inches in d.b.h. or less, whereas 1986 and later examinations treated as regeneration only stems 0.5 inches in d.b.h. or smaller. However, numbers in the l-inch d.b.h. class, as recorded beginning in 1986 (table 2), are too few to affect values recorded for all regeneration from 1973 to 1983.

Counts of hardwood regeneration (< 0.5 inch in d.b.h.) on all sub-subplots in the last three examinations were combined to show treatment effects on species composition. Burning tended to favor oak. regeneration; 69 percent of all stems on burned plots were oaks, and 15 percent were dogwood. On unburned plots, 52 percent of the stems were oaks, and 40 percent were dogwood. The effect of fire on oak species composition was less pronounced in the case of regeneration than in the case of larger stems. Post and bluejack oaks made up 76 percent of oak regeneration on burned plots and 69 percent on unburned plots. Water and southern red oaks made up 20 percent of all oaks on burned plots and 31 percent on unburned plots. Season of bum did not appear to affect composition of the regeneration.

Discussion and Conclusions

Biennial prescribed fires over a period of 18 years have influenced hardwood development in young, naturally established, longleaf pine stands- Density of midstory hardwoods > 1.5 inches in d.b.h. increased steadily in the absence of fire and also with biennial winter fires while declining slowly with spring and summer burns.

The proportion of hardwood BA to total stand BA has remained relatively constant in both unburned and winter-burned stands over 19 years, averaging 12.3 percent without fire and 9.8 percent with winter fires. The proportion of hardwood BA to total stand BA in loblolly pine (P. taeda L.) plantations remained relatively constant from stand age 11 to stand age 24 (Burkhart and Sprinz 1984, Glover and Dickens 1985). Likewise, hardwood BA has remained at about 35 percent of total stand BA over 46 years in an unmanaged mixed pine-hardwood stand in Arkansas (Cain 1989). Other reports suggest that the proportion of hardwood BA in southern pine stands will reach a low point between stand ages 15 and 25 and then increase with time (Ruark and Bechtold 1989, Smith and others 1989). In the present study, no decline in percent hardwood BA was observed even though pine BA growth culminated between pine ages 21 and 27.

Biennial spring fires have virtually eliminated midstory hardwoods, and biennial summer fires have substantially reduced the number of stems. Hardwoods in the l-inch d.b.h. class have been entirely eliminated on spring-burned plots, almost eliminated on summer-burned plots, and sharply reduced in number on winter-burned plots.

The burning treatments have not affected hardwood regeneration on the forest floor, which has increased from an average 5,300 stems/acre in 1973 to 13,200 stems/acre in 1992. Hardwood regeneration in 1992 ranged from a high of 20,900 stems/acre on unburned plots to 8,700 stems/acre on spring-burned plots, but the by-treatment differences were not significant at the 0.05 level.

Although periodic growing-season burns may eventually topkill hardwood stems up to about 4 inches in d.b.h., they apparently have little impact on rootstocks, which resprout after each fire. Biennial summer fires over a period of 26 years reduced numbers of hardwood rootstocks by less than 50 percent, although annual summer burning over a period of 20 years eliminated nearly all hardwood sprouts in a stand of loblolly pine on the Atlantic Coastal Plain stand (Waldrop and Lloyd 1991). Annual winter fires led to an increase in sprouts. Eleven annual summer fires were required to reduce the number of hardwood rootstocks by 85 percent in an Arkansas loblolly-shortleaf pine stand (Grano 1970). Annual growing-season fires over a long period of time may be needed to eliminate most hardwood rootstocks within pine stands.

Differences between mixes of surviving hardwoods in burned and unburned stands were notable. Burning favored bluejack and post oaks at the expense of water and southern red oaks at ail levels from midstory to regeneration. Dogwood remained a significant component of the midstory, including the 1 inch d.b.h. class in both the burned and unburned stands. Dogwood regeneration in burned stands, however, was only about one-thiid as numerous as that in unburned stands.

Future observations should reveal the compositions and structures of the plant communities that eventually stabilize under the three biennial burning regimes, and with fire exclusion., on this Coastal Plain site. Another long-term prescribed fire study in young longleaf pine stands was established to determine the effects of 3- and 5-year as well as 2-year burning cycles.

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