EFFECTS OF FIRE ON DEER HABITAT IN THE SOUTHEAST

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Abstract: Based on the literature on cattle range as well as that on deer habitat, it appears that burning temporarily increases the crude protein and P contents and the palatability of most plants. It temporarily decreases quantity and fruiting of understory shrubs. All changes are influenced by the season of burning. The many site and stand conditions which exist in southern forests leave considerable room for further research, particularly in the Piedmont and Mountains where few studies have been conducted.

Key Words: prescribed fire, white-tailed deer, forage, nutrition

Burning in southern forests is generally credited with increasing quality and eventually quantity of forage for white-tailed deer *(Odocoileus virginianus)*. Our purpose in the literature review presented here was to ascertain the need for further research on the effects of burning on deer habitat. We find that responses of deer to the changes in habitat brought about by burning have seldom been documented or thoroughly analyzed. Furthermore, since southern sites and forest types vary widely, it is difficult and risky to make any comprehensive statements about effects of burning on deer habitat.

About half the number of the papers reviewed in this report deal with effects of burning on deer. The other half give effects of burning on cattle forage and cattle. Because reports dealing with cattle were not published in wildlife oriented journals, many may have escaped the notice of wildlife biologists.

Recent studies of deer diets in the South support the idea of reviewing papers on cattle forage. Because deer were considered primarily a browsing herbivore, wildlife scientists often ignored burning effects on grasses and forbs. Recent studies, however, have revealed that forbs and grasses constitute a large portion of the diet of southern deer in some seasons. For example, Pearson (1980) found that cattle and deer on the same range in Louisiana eat many of the same grass and grass-like plants during the summer. Dunkeson (1955) found that herbaceous plants made up the largest single class of deer food in the Missouri Ozarks, and that grass was often a major food item. In the Radford Arsenal near Dublin, Virginia where grass was the main food available to deer, Sandt (1969) found that deer rumen samples were 98% grass in November and 86% grass in March. Sotala and Kirkpatrick (1972) analyzed 132 rumen samples of deer from southern Indiana and found that grass was one of the most important food items in late winter. Vansant (1973) found that grasses were important for white-tailed deer on Blackbeard Island, Georgia, during August and November and that green forbs were preferred to other vegetation during the spring and early summer.

EFFECTS OF FIRE ON THE QUALITY OF VEGETATION

In most studies of the influence of fire on browse and forage quality, crude protein, P and Ca contents have been reported. The ruminant needs protein both for its own growth and maintenance and for the rumen micro-organisms which digest and metabolize carbohydrates and fats (Dietz 1970). A crude protein content of 7% is suggested by various researchers to be minimal for deer, and contents of 13 to 16% are regarded as optimal for growth (French *et al.* 1955, Magruder *et al.* 1957). P is necessary for transfer of energy and is an essential part of the skeleton. In nutritional studies of penned deer, Magruder *et al.* (1957) concluded that 0.25% P was the minimum for the survival of bucks. P is deficient in many forage species on southern ranges during the winter (Dietz 1970). A wide Ca-P ratio or a deficiency of P may retard growth and create a high feed requirement for cattle (Maynard and Loosli 1956).

In the South, fast-growing vegetation quickly hardens and becomes less palatable as lignin content increases. Newly formed tissues are more digestible than mature tissues (Short *et al.* 1972) and the nutritional value of the forage decreases after growth stops (Halls *et al.* 1957). Both nutrient content and palatability must be considered when assessing the influence of fire on forage quality.

Range studies in the South show that crude protein may be 2 to 3 times higher in the new growth of herbage (grasses and forbs) shortly after winter burning compared to herbage from unburned range. The percent crude protein varied from 4 to 6% on the unburned range and up to 13% on burned range (Greene 1935, Wahlenberg *et al.* 1939, Leukel and Stokes 1940, Halls *et al.* 1952, Shepherd 1953, Shepherd *et al.* 1953, Campbell *et al.* 1954, Hilmon and Lewis 1962, Duvall and Whitaker 1964). Effects of burning gradually decreased as the growing season progressed, and within 2 to 3 months they were no longer apparent. Several studies have shown that the crude protein content of woody plants was also increased by burning. In the spring after a winter burn in east Texas, crude protein contents of 10 browse species averaged 15.21% on burned plots and 12.31% on unburned plots (Lay 1957). In another area in east Texas, Stransky and Halls (1978a) found that 4 selected browse species had an average crude protein content of 16.68% on unburned plots and 19.99% on burned plots. In eastern Maryland the crude protein content of 4 browse species averaged 12.36% on unburned plots and 14.21% on burned plots (DeWitt and Derby 1955). The studies all show similar increases in crude protein content of plants in response to burning.

Unlike that of forbs and grasses, the spring crude protein content of woody plants fell within the optimum growth range for deer on both burned and unburned areas. By late summer and fall the increase in content attributable to winter burning was halved, and by winter the average crude protein contents of plants from burned and unburned areas were almost identical. Dills (1970) found after 3 successive years of investigation in the Cumberland Plateau of Tennessee, that the crude protein contents of red maple *(Acer rubrum)*, sassafras *(Sassafras albidum)* and sourwood *(Oxydendron arboreum)* were highest in June following a March burn, averaging 33, 62 and 17% more crude protein for the respective species, than on unburned sites. By September the protein contents of the browse plants were similar on the burned and unburned sites.

As with crude protein, the P content of the new growth of winter-burned herbage was higher than it was in mature herbage. Hilmon and Lewis (1962) and Hilmon and Hughes (1965) found in studies in south Florida that young sprouts of understory herbage contained 0.14% P. The chemical content decreased rapidly from this peak to 0.04% 3 months after the fire, and remained near or below this level throughout the 2-year study period. On the 2-year roughs none of the species or groups of species sampled contained more than 0.02%. Shepherd (1953) and Shepherd *et al.* (1953) in a study of the Georgia Coastal Plain reported that the P content of important grasses was 0.05% on unburned winter range but 0.12% on burned range during the early leaf-stage of growth. After the grasses reached full leaf (usually in June) forages from burned and unburned range were similar in P concentrations. In early studies, Greene (1935) and Wahlenberg *et al.* (1939) found P contents of grasses to be 0.31% on burned range and 0.26% on unburned range. These increases lasted only about 3 months in spring. Burning also increased P content of browse plants. Stransky and Halls (1978a) documented an average increase of 30% in P in the leaves of 4 species of browse plants with concentrations of 0.20% on unburned and 0.26% on burned plots. These increases quickly disappeared; by fall and winter differences attributable to burning were inconsequential. In a study of winter burning, Lay (1957) found an average increase of 43% in P content of 10 plant species during the spring with values of 0.35% on unburned and 0.50% on burned plots.

Reported increases in crude protein and P content vary considerably among plant species following burning; some species exhibit little or no change. We found no range or wildlife study, however, which indicated that burning had a deleterious effect on the crude protein or P content of plants.

Not all plants show an increase in crude protein and P content after burning. For example, deer's tongue *(Trilisa odoratissima)*, a forb heavily utilized by deer in central Florida (Harlow 1961), was found to have the same crude protein and P contents on burned and unburned ranges (Halls *et al.* 1952).

Winter burning increased Ca content from 0.06 to 0.12% for a short time in the new growth

of forages (Hilmon and Lewis 1962, Hilmon and Hughes 1965). In 10 species of browse plants analyzed in all 4 seasons, however, Lay (1957) reported an average Ca content of 1.00% on unburned plots and 0.85% on burned plots. The Ca contents of plants on unburned areas were higher than those on burned areas in all seasons. In another study, Stransky and Halls (1978a) found that after an early March burn selected plants tested in April did not differ significantly in Ca content as a result of burning. By September, however, the Ca content of browse was significantly higher on burned plots (0.71%) than on the control plots (0.67%). Because the results of these studies were inconclusive and conflicting, further research on the effect of burning on the Ca content of plants is in order. We need to know how burning affects Ca content and the Ca-P ratio in plants. Conflicting results in published studies may be attributable to site conditions, period of burning, or species of plant.

Although most of the studies reviewed showed that the crude protein and P contents of vegetation were higher on burned than on unburned areas, there is still speculation that fresh succulent spring growth of vegetation from unburned plots would be as high. Most of the papers we reviewed indicated that vegetation taken from unburned plots for nutrient testing in the spring was collected during the time when the spring growth flush should have started. Only Campbell *et al.* (1954) were explicit. They reported that in grasses the average crude protein content of the young leaf stage was significantly higher on recently burned areas than on unburned areas. The differences in crude protein content between burned and unburned range for the full-leaf and mature green stages were too small to be significant but were slightly higher on the burned range.

In most studies on effects of fire on forage quality in the South, only crude protein, Ca and P contents of plants have been measured because these nutrients are the most clearly deficient in native forages (Shepherd *et al.* 1953). A few papers have included information on crude fiber and/or the lignin content of the foliage (DeWitt and Derby 1955, Lay 1957, Hilmon and Lewis 1962, and Dills 1970). All studies indicated a decrease in crude fiber and lignin content shortly after burning, and then a rather rapid increase during the first few months of vegetative growth after burning.

Because of the early emerging, succulent and nutritious vegetation available on burned sites, cattle spend more time grazing there and gain more weight on burned than on unburned areas (Halls *et al.* 1952, Shepherd 1953, Hilmon and Hughes 1965). Some authors caution that burns may be overgrazed because of the desirable forage available there (Greene 1935, Wahlenberg *et al.* 1939, Halls *et al.* 1952, Cooper 1971, Komarek 1974). Even some plant species that formerly received little browsing become palatable and are utilized for a short period after burning (Warren 1980).

EFFECTS OF FIRE ON THE QUANTITY OF VEGETATION

Many investigations have explored the kinds and quantities of forage available on burned sites. Some authors stated that species composition did not appear to be influenced by burning (Duvall and Linnartz 1967, Grelen 1975). While plant composition several years after burning may be similar on burned and unburned areas, the abundance of fire-tolerant herbaceous species (e.g. *Lactuca canadensis*) on newly burned areas in east Texas makes those plant communities strikingly different from unburned forest communities (Stransky *et al.* 1974). Species composition of woody plants does not change greatly, though some fire-sensitive vines like rattan *(Berchemia scandens)* are greatly reduced in numbers even by winter fires. Cushwa *et al.* (1969), Stransky and Halls (1978b) and Stransky and Halls (1979) have also noted that vines decrease with burning.

Several workers reported that quantities of available herbage and browse are similar on burned and unburned areas (Lay 1956, Grelen 1975, Stransky and Halls 1978b, Moore and Terry 1980). However, burning appears to change the proportion of herbage to browse. More herbage than browse grows on frequently burned sites, while more browse occurs on unburned areas (Garren 1943, Lemon 1949, Duvall and Whitaker 1964, Hilmon and Lewis 1962, Hough 1965, Cushwa and Redd 1966, Cushwa *et al.* 1966, Cushwa *et al.* 1969, Stransky *et al.* 1974, Stransky and Halls 1978b, Moore and Terry 1980).

When browse increases after winter burning, it is mostly through sprouting of trees, shrubs and vines from roots and basal buds. Vegetation higher than the 1.5 m reach of deer becomes available again as fire kills the above-ground stems and encourages growth of nutritious coppice shoots (Halls *et al.* 1960, Hughes and Knox 1964, Lay 1967, Dills 1970, Perkins 1971, Stransky and Halls 1978b, Stransky and Halls 1979).

Summer burns, especially when repeated for several years, eventually kill the roots of nearly all browse plants (Garren 1943, Shepherd *et al.* 1951, Chaiken 1952, Lotti 1955, Lotti 1959, Hodgkins 1958, Harrington and Stephenson 1955, Lay 1956, Ferguson 1957, Devet and Hopkins 1968, Trousdell 1970, Grano 1970, Yocom 1972, Brender 1973, Grelen 1975, Lewis and Harshbarger 1976). Thus, repetitive summer fires should be avoided if browse production is the objective of burning. Not only are numbers of stems reduced, but some highly preferred plants, such as eastern baccharis *(Baccharis halimifolia)*, eastern red cedar *(Juniperus virginiana)*, greenbriers *(Smilax* spp.*)*, and oaks *(Quercus* spp.*)* and other mast producers, are eliminated (Lay 1957, Lotti 1959, Trousdell 1970, Grelen 1975). Only if the objective is to create a park-like timber stand, devoid of a woody understory, are repeated summer fires appropriate.

Summer fires may also reduce the number of legumes (Devet and Hopkins 1968), while winter fires seem to favor them (Greene 1935, Wahlenberg *et al.* 1939, Garren 1943, Lewis *et al.* 1967, Perkins 1973, Vogl 1974, Buckner *et al.* 1979). Some sources reported large increases in legume populations after intensely hot headfires (Cushwa *et al.* 1966).

On clearcut areas that are planted to pines immediately after burning, the greatest variety and growth of plants occurs during the first growing season after burning (Harlow and Bielling 1961, Stransky *et al.* 1974, Stransky and Halls 1978b). As the pine canopy begins to close, herbage production drops rapidly (Stransky and Halls 1978b) regardless of the frequency of burning (Garren 1943, Grelen 1976).

Hurst *et al.* (1980) studied the effects of a February burn on total deer forage (grass, forb, vine, woody) in an 8- to 9-year old loblolly pine plantation in Mississippi (Kemper County). They sampled for deer forage productivity in August and February 1 and 2 growing seasons after treatment. Treatments included no burning or thinning, thinning and burning, and burning but no thinning. Deer forage was significantly more plentiful on the burned-unthinned (481 kg/ha) and burned-thinned (554 kg/ha) than on unburned plots (141 kg/ha) 1 growing season after burning. Forage productivity on the burned-unthinned plots measured in August and February declined by 52% and 50% respectively after the second growing season since treatment. The decline was only 18% and 24% over the same time frame on the burned-thinned plots.

In Charlotte County, Florida, Hilmon and Lewis (1962) and Hilmon and Hughes (1965) found that total herbage increased from around 73 kg/ha (moisture free) 3 weeks after burning to 2242 kg/ha after 1 year, and 3924 kg/ha after 2 years. Harlow and Bielling (1961) in a study in longleaf pine-turkey oak *(Pinus palustris-Quercus laevis)* habitat in central Florida compared the effects of winter burns on forage production the following spring and on 2-, 3-, and 4-year old burns. No tests of significance were applied, but the measurements indicated that forbs were the greatest in quantity the first year after burning and consistently declined each year thereafter. Grasses, in contrast, were lowest the first year after burning and steadily increased, reaching their greatest productivity level on areas unburned for 3 years.

Japanese honeysuckle *(Lonicera japonica)*, one of the most important deer foods in the South (Harlow and Hooper 1972), contained lower amounts but more nutritious foliage on burned than on unburned areas. Fire successfully restricted honeysuckle to planted food patches (Stransky *et al.* 1976).

Month of burning also seems to affect forage production. Lewis (1964) found that forage yields were higher after burns in March or May than after October, November or January burns in south Florida. He went on to state: "The advantage of spring burning for optimum cattle forage must be balanced against the increased hazard of burning in the spring, potential damage to tree overstory, and loss of ground-nesting birds."

EFFECTS OF FIRE ON FRUIT PRODUCTION OF WOODY PLANTS

In 16- to 30-year old slash pine *(P. elliottii)* plantations in southeastern Georgia, only 0.5g/100m^2 of fruit were found the first growing season after burning (Johnson and Landers 1978). By the third growing season fruit yields increased to 448.4g/100m^2. Gallberry *(Ilex glabra)*, huckleberry *(Gaylussacia frondosa)* and blueberry *(Vaccinium myrsinites)* accounted for 89% of this increase. In plantations 1- to 10-years old the highest fruit yield the first year after burning was in the 4-year age class (708.4g/100m^2) and the lowest yield in the 1-year age class (120.4g/100m^2). Ninety percent of these fruit yields were gallberry and blackberry *(Rubus cuneifolius)*. Runner oak *(Quercus pumila)* acorns were most abundant in 6- to 10-year old stands 2 years after burning. Chokeberry *(Aronia* spp.*)* responded very little to burning.

Stransky and Richardson (1977) found in pine plantations in east Texas that 3 years after treatment the burned plots ranked highest in browse-fruit production with 120 kg/ha. This value, however, was not significantly higher than the 74 kg/ha on control plots. Sixty-seven percent of the fruit yield on burned plots was blackberry and American beautyberry *(Callicarpa americana)*. Three other shrubs, sebastian bush *(Sebastiana fruticosa)*, muscadine grape *(Vitis rotundifolia)* and southern wax-myrtle *(Myrica cerifera)* yielded 21% of the fruit on burned plots. Stransky and Halls (1980) reported a continuation and enlargement of the above study to include 3 separate sites in the loblolly-shortleaf pine-hardwood forest type in east Texas. Again, they found no significant differences between control plots (89 kg/ha) and burned plots (91 kg/ha).

Hilmon and Hughes (1965) reported that in south Florida gallberry plants killed back by fire neither flower nor fruit until the second year when they bear profusely. Burned palmettos, on the other hand, bloom and produce a few fruits the first year after fire. On areas burned every other year for a long period, however, full palmetto fruit production is not restored until after 8 to 10 years of fire protection (Hough 1965).

Lay (1956) in an earlier study in pine-hardwood stands in east Texas found that understory mast was seriously reduced by fire. With no segregation by stand class or season, interval or number of burns, he found that the number of plants of fruiting size was reduced by 62% and the number of plants with fruit by 72% after burning. Plants reduced included yaupon *(Ilex vomitoria)*, sweet leaf *(Symplocos tinctoria)* and

viburnum *(Viburnum* spp.). The number of dogwood plants of fruiting size was unchanged, but the percentage of these with fruit increased by 83.3% after burning. Numbers of French mulberry plants and plants with fruit seemed to have increased; tree huckleberry appeared to have decreased. Stransky and Halls (1979) also found that fruit production of flowering dogwood *(Cornus florida)* was increased by a single winter burn under dense pine-hardwood canopies.

Williams (1977a) reported that dwarf live oak *(Q. minima)* annually attains maximum acorn production in north Florida pine flatwood stands, if the stands are burned in August. If burned later than October, they fail to produce acorns the next summer. In the Coastal Plain of South Carolina on ridges dominated by longleaf pine, Devet and Hopkins (1968) found that runner oak *(Q. pumila)* appeared to survive prescribed burning and retain its vigor. The acorn crop was lost for 1 growing season, but acorns were produced with increased vigor by the fire-pruned oak the second growing season after the burn. Williams (1977b) also concluded that runner oak fruits heavily 1 year after a summer burn. Neither of these studies included a quantitative assessment of acorn production on burned versus unburned plots, so the observations must be interpreted with a great deal of caution.

Among the limited number of fruit-producing woody species studied, fruit production of some, such as flowering dogwood, increased after burning. Production of many others appears to decrease in the short or long run.

SUMMARY

Winter burns, both frequent and infrequent, cause (1) temporary increases in crude protein and P in forage, (2) increases in abundance of fire-tolerant woody plant stems, forbs, grasses and legumes for up to 3 years after burning, and (3) a temporary decrease in production of fruits the first year after burning.

Infrequent summer burning (1) temporarily increases nutrient content of forage, (2) slightly decreases the number of woody plants, and (3) increases the abundance and kinds of herbaceous vegetation. In comparison, frequent summer burns (1) eventually eliminate woody plants, many forb species, and some grasses, and (2) lead to site domination by certain fire-tolerant grasses and forbs.

RECOMMENDATIONS FOR FUTURE RESEARCH

Studies are needed on the response of vegetation to early and late winter burning and on the response of deer to these vegetative changes. Though observations from elsewhere may be useful for understanding southeastern conditions, they are no substitute for local experiments showing season, timing and forage utilization on burned lands.

The shape, size and distribution of burns for obtaining maximum benefits for deer within a forest management unit should be explored. The forage yield of burned regeneration areas and of pole and sawtimber stands should be measured and incorporated in ascertaining the potential carrying capacity of deer management units.

According to current trends, more softwood fiber is expected to be grown on short rotations. It is important to explore the effects of burning in young pine plantations on kind and quantity of forage, fruits and fungi produced.

Evergreens like yellow jessamine *(Gelsemium sempervirens)* and yaupon are important components in a white-tailed deer's winter diet. Studies are needed to determine the effects of fire on these broadleaf evergreens.

Most studies about fire effects on the fruiting habits of woody plants originated in the loblolly-shortleaf pine-hardwood forest type. Studies of fruiting plants from other forest types are also needed.

Most data about the fruiting of browse plants have been obtained from clearcuts. Additional studies are needed about burning effects on understory plants in pine pole and sawtimber stands, and in stands under other harvesting systems. Also, the effects of burning on fruit production need to be evaluated in terms of total net production over time.

Repeated burning affects the number, kind, quantity and nutrient value of woody and herbaceous vegetation in a manner different from a single burn. Studies are needed to document the long-term effects of repeated fires on browse plants in various southeastern forest types and on permanent food plots established for deer.

A possible further advantage of burning to deer may be the reduction of deer ectoparasites such as ticks and mites (Stoddard 1935, Lyon *et al.* 1978). Further research is needed on the effects of fire on these parasites because they may occur in numbers that create a year-round nuisance, lowering the physical condition and disease resistance of deer.

The southeastern and southern Coastal Plain have received more attention in fire-effect studies than the Piedmont and the Mountains combined. Thus, it would be advisable to conduct burning studies in the latter areas as forest resources there become more intensively utilized.

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