ever, that the production of broods in the wild is not enough to assure us that a new species will become established in its introduced range. It merely means that the first requisite has been met. We shall be highly interested in developments in the next few years. In this case, the tide is "in"; we shall await the scene left when the tide goes out!

The problem of managing and controlling exotic nutria has cropped up in several Southeastern States in recent years. Nutria have not only been destructive to crops, particularly rice and sugarcane, but have also seriously competed with muskrats and waterfowl in some places where they have become established. Areas of Louisiana are the most seriously affected, but nutria are also a problem in Mississippi, Texas, Florida, North Carolina, and even to some extent in Maryland and Virginia and other States. The Bureau of Sport Fisheries and Wildlife has funds this year for employment of a man to work with State organizations in the South to develop control methods. He will soon be hired and stationed in Louisiana. He will concentrate on that area, but will in time be available to other South Atlantic and Gulf locations. There seems to be no quick and easy answer to this problem, but it will be vigorously attacked.

The Bureau of Sport Fisheries and Wildlife has proposed the establishment of the Eufaula National Wildlife Refuge at the Walter F. George Project of the Corps of Engineers. The Corps of Engineers is now constructing this project on the Chattahoochee River for navigation, hydroelectric power and other purposes. The reservoir will have a surface area of about 46,000 acres.

The Chief of Engineers has approved our recommendation for modification of the Walter F. George Project to permit acquisition of an essential acreage for development of a refuge. The Chief of Engineers' report is being reviewed and we expect it to be transmitted to the Congress for its consideration early in the next session. A bill has been introduced in Congress which would authorize the proposed project modification.

The proposed refuge will be about 10,755 acres in extent. A major portion will lie in Alabama, with important acreages in Georgia. Part of the surface of the reservoir will make up a large part of the refuge but a moderate acreage will be acquired to supplement food production areas.

Perhaps the tide can be as we make it. It will come in and go out today, tomorrow and for all tomorrows to come. Let us remember—the high tide of today may be the low tide of tomorrow. We cannot stop it but we can control that which it leaves behind. We have chosen so many times to so conduct ourselves that WHEN THE TIDE WENT OUT there was debris, rubbish, filth, and stench of our own making. Thank God, there were other times WHEN THE TIDE CAME IN that we found clean water, green fields, good fishing and fine hunting. The tides of tomorrow will reflect our actions of today. In plain, old-fashioned Missouri language, "Boys, it's our move."

CONTROLLED BURNING STUDIES IN LONGLEAF PINE-TURKEY OAK ASSOCIATION ON THE OCALA NATIONAL FOREST

BY RICHARD F. HARLOW[1] AND PAUL BIELLING[2]

This study measures the effects of one, two, three, and four-year-old burns, and burning three years in succession in longleaf pine-turkey oak association. Its main objective is to demonstrate the advantages of burning as a tool in deer and quail management.

The Ocala National Forest is located in central Florida, 15 miles east of Ocala, Marion county, and comprises 440,000 acres. Although the predominant vegetative type is the sand pine-scrub oak association (*Pinus clausa-Quercus* spp.), the longleaf pine-turkey oak (*Pinus palustris-Quercus laevis*) vegetation constitutes an appreciable proportion of the total area (12 percent), Strode (1954), as well as of the State of

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occupies a large portion of the State's land area, but it also maintains one of the most densely populated deer herds, the Citrus Wildlife Management Area in Citrus county. The abundance of legumes growing in this Florida (29 percent), Harlow (1959). Longleaf pine land not only vegetation type contribute to its value as quail habitat. Therefore, land use practices affecting this type of vegetation influence important quail and deer habitat.

This vegetative association is characterized by longleaf-pine and turkey-oak as the predominant species. Several other trees are locally abundant, namely blue-jack oak (*Quercus Cinerea*), live-oak (*Q. virginiana*), post-oak (*Q. stellata*), and, when burning has been infrequent, persimmon (*Diospyros virginiana*). Ground vegetation consists primarily of wiregrass (*Aristida* spp.), gopher-apple (*Geobalanus oblongifolius*), dog-fennel (*Eupatorium* spp.) and Leguminosae. Laessle (1943:30) states that "the proportion of the association occupied by each of the dominants seems to depend primarily on the severity of the cutting and the length of time that has elapsed since lumbering operations. Fire is also an important factor. Lumbering, of course mitigates in favor of the turkey-oak, while fire favors the dominance of the more fire resistant pine."

Lay (1956) reports that prescribed burning in southeast Texas (pine-oak lands) reduces woody plants for two years, and increases forbs for at least three years. Arata (1959) in his study on the effects of a mid-winter burn on vegetation in a longleaf pine-turkey oak association in north-central Florida observed that composites, dog-fennel, and partridge-pea (*Chamaecrista* spp.) were more common in the burned portion of the study area.

On the Ocala area the longleaf-pine lands are being managed primarily for pine. Land use practices presently in effect are selective timber cutting, controlled burning, and timber stand improvement. Controlled burning has been conducted on the longleaf-pine islands in the Ocala area for a number of years to control understory hardwoods, to reduce fire hazard, to control brown spot disease on longleaf, and in the preparation of pine seedbeds. Many of the land use practices mentioned above are also important for game.

Cattle have been excluded from the Ocala area for a number of years and the deer herd, based on the 1961 summer track census, is estimated at approximately 1 deer per 38 acres.

PROCEDURES

Methods used to evaluate habitat changes and measure the utilization of herbs and grasses following burning are described by Campbell and Cassady (1957). A quadrat 3.1 feet square was used as the unit of measurement. Plots were spaced 20 paces apart, and located in straight lines approximately perpendicular to the type boundary. Utilization of woody plants involved counting the number of browsed and unbrowsed twigs on each plant. The ration of browsed twigs to the total (i.e. browsed and unbrowsed twigs) expressed as a percentage was used to indicate the degree of utilization. The number of sample plots used during any one season ranged from 20 to 50 depending upon the variability in the ground cover. Range inventories were conducted on the study areas during spring (May), fall (September), and winter (January). The same burns were sampled during each study period. Lines and plot locations were randomly located in each year age class burn. The limited number of plots taken and the lack of uniformity in the growth pattern of shrubs, compared to forbs and grasses, prevents an accurate comparison of the quantity of shrubs present in the various burns.

All study areas had been subjected to controlled burning by Forest Service, U. S. Department of Agriculture personnel. The longleaf pine islands vary in shape and size, however, the burned areas were separated by firelanes ¼ mile apart. An attempted burning rotation of five to six years has been the practice. The burning procedure is setting back fires from the firelanes during late November and December.

Overstory composition was determined in the various burns by the plotless timber crusing method. Overstory densities are as follows:

Age of Burn	Average Basal Area Per Acre (Sq. Ft.)	
	Pine	*Hardwood*
1	63	2
2	36	3
3	41	0
4	36	3
Burned 3 yrs. in succession	6	9

Utilization and occurrence of vegetation in the sample plots were rated as follows:

Item	*Amount (%)*	*Descriptive Category*
Utilization	20 +	Heavy
	5-19	Moderate
	0.1-4	Light
Occurrence	25+	Abundant
	10-24	Moderate
	less than 10	Scarce

The botanical names of the plant species contained in this paper are taken from Small (1933) and Robinson and Fernald (1908).

RESULTS

Data from the spring study indicate that the one-year burn contained the greatest quantity and number of different species of forbs and legumes (Table 1) and smaller quantities of grasses than the two, three, or four-year-old burns. The two-year-old area contained the second greatest number and quantity of forbs and legumes, while the four-year-old burned area was third and the three-year-old burned area contained the smallest quantity and number of different species. During the third year after a burn wiregrass reached its peak in abundance. Heaviest utilization occurred on all plants during the first year after a burn followed closely by the two-year-old burn.

Table 2 compares the quantities and species of plants present on one, two, three, and four-year-old burns on longleaf pine-turkey oak association during the fall.

A considerably greater quantity and number of different species of forbs and legumes, and quantity of grasses appeared in the fall plant cover compared to the spring vegetation on the one, two, and three-year-old burns. The area burned four years previous to the study, however, showed an appreciable increase in the fall mainly in quantity of wiregrass. The one-year-old burned area revealed the greatest margin of increase in both quantity and number of different species of forbs and legumes over the spring vegetation than either the two or three-year-old burned areas.

Table 3 compares the effect of controlled burning on one, two, three, and four-year-old burns on longleaf pine-turkey oak association during the winter.

Forbs, legumes and grasses decreased in quantity and number of plant species in the longleaf pine-turkey oak association markedly on all burns. Winter frosts killed nearly all herbaceous vegetation and, with the exception of the one-year-old burn, considerably reduced the quantity of wiregrass although it still remained the dominant plant cover. The plant *Opuntia* sp., which was present in only one plot, contributed 73 percent of the forbs in the one-year-old burn. If this plant had not been present the quantity of forbs in the one-year-old burn would not be greater than in the other study areas. The age of the burn has little effect on the quantity and number of forbs and legumes which will occur during the winter season. All plants are drastically reduced. Note that Basidiomycetes occurred most frequently in the four-year-old burn followed by the three-year-old burn.

Table 4 lists those plants receiving heavy utilization followed by their degree of occurrence while table 5 lists those plants occurring abundantly followed by their degree of utilization.

TABLE 1.

OCCURRENCE AND UTILIZATION OF PLANTS AS RELATED TO AGE OF BURN IN LONGLEAF PINE-TURKEY OAK ASSOCIATION. OCALA NATIONAL FOREST, SPRING STUDY.

	AGE OF BURN											
	1 (40)*			2 (30)			3 (30)			4 (20)		
Plant Species	*Amount Lbs./Ac.*	*Occur. (%)*	*Util. (%)*	*Amount Lbs./Ac.*	*Occur. (%)*	*Util. (%)*	*Amount Lbs./Ac.*	*Occur. (%)*	*Util. (%)*	*Amount Lbs./Ac.*	*Occur. (%)*	*Util. (%)*
Woody Plants												
Geobalanus oblongifolius	37.0	35.0	6.4	24.0	50.0	5.3	14.0	30.0	10.0	8.0	40.0	6.2
Ceanothus microphyllus	1.0	7.5	26.6	6.0	10.0	3.3	2.0	6.6	5.0	2.0	15.0	3.3
Asimina sp.	1.0	7.5	6.6	...	..	..	1.0	3.3	0	1.0	5.0	0
Smilax sp.	1.0	2.5	90.0	...	..	..	..	..	..	..	..	..
Quercus virginiana	16.0	15.0	5.0	6.0	6.6	15.0	5.0	6.6	5.0	2.0	5.0	20.0
Quercus laevis	3.0	15.0	0	1.0	6.6	0	1.0	10.0	0	1.0	5.0	10.0
Diospyros virginiana	1.0	2.5	0	2.0	3.3	0	1.0	3.3	0	..	..	..
Pinus palustris	1.0	2.5	0	...	..	..	..	..	..	..	..	..
Sub-Total	61.0	...	26.9	39.0	..	7.8	24.0	..	6.6	14.0	..	9.8
Forbs												
Berlandiera subacaulis	1.0	5.0	0	2.0	13.3	5.0	1.0	3.3	0	1.0	5.0	0
Eupatorium aromaticum	3.0	25.0	0	3.0	13.3	0	6.0	30.0	0	3.0	40.0	1.2
Eriogonum tomentosum	10.0	22.5	0	3.0	20.0	0	3.0	16.6	0	3.0	30.0	0
Stillingia sp.	3.0	17.5	0	5.0	20.0	8.3	1.0	6.6	0	1.0	5.0	10.0
Diodia teres	1.0	12.5	0	4.0	33.3	1.0	1.0	23.3	0	1.0	10.0	0
Chrysopsis aspera	6.0	32.5	3.8	7.0	46.6	5.0	4.0	23.3	2.8	2.0	10.0	0
Asclepias sp.	1.0	2.5	0	1.0	3.3	0	..	..	..	..	..	..
Hieracium venosum	3.0	27.5	0	5.0	20.0	0	..	..	..	2.0	10.0	0
Eupatorium capillifolium	1.0	2.5	0	3.0	6.6	0	3.0	3.3	0	1.0	10.0	0
Pterocaulon undulatum	3.0	10.0	0	..	..	..	3.0	10.0	0	..	..	..
Bivonia stimulosus	3.0	5.0	0	1.0	10.0	0	1.0	3.3	0	1.0	10.0	0
Miscellaneous herbs	4.0	30.0	1.7	5.0	46.6	0	4.0	40.0	0	6.0	80.0	0.5
Commelina angustifolia	1.0	2.5	0	..	..	..	..	..	..	..	..	..
Cirsium horridulum	1.0	2.5	0	..	..	..	..	..	..	..	..	..
Solidago Chapmanii	1.0	5.0	5.0	..	..	..	..	..	..	1.0	5.0	0
Solanum gracile	..	..	..	3.0	6.6	0	..	..	..	..	..	..
Croton Argyranthemus	2.0	15.0	0	1.0	16.6	0	2.0	6.6	0	3.0	35.0	2.8
Sub-Total	44.0	...	3.5	43.0	..	4.8	29.0	..	2.8	25.0	..	3.6

TABLE I (Cont.)

Plant Species	1 (40)* Amount Lbs./Ac.	1 (40)* Occur. (%)	1 (40)* Util. (%)	2 (30) Amount Lbs./Ac.	2 (30) Occur. (%)	2 (30) Util. (%)	3 (30) Amount Lbs./Ac.	3 (30) Occur. (%)	3 (30) Util. (%)	4 (20) Amount Lbs./Ac.	4 (20) Occur. (%)	4 (20) Util. (%)
Legumes												
Galactia spp.	10.0	67.5	4.4	7.0	33.3	4.0	4.0	53.3	1.8	2.0	40.0	0
Acanthus montanus	2.0	32.5	0	3.0	43.3	0	2.0	23.3	0	2.0	40.0	0
Meibomia Chapmanii	1.0	7.5	0	..	..	..	..	..	..	..	..	..
Unidentified Legumes	4.0	30.0	3.3	2.0	26.6	3.7	3.0	16.6	4.0	2.0	15.0	0
Rynchosia simplicifolia	1.0	12.5	2.0	..	..	..	1.0	6.6	20.0	1.0	5.0	0
Chamaecrista brachiata	1.0	17.5	0	1.0	10.0	3.3	1.0	3.3	0	..	..	..
Bradburya sp.	1.0	7.5	0	..	..	..	..	..	..	..	..	..
Psoralea canescens	1.0	2.5	50.0	..	..	..	..	..	..	3.0	10.0	5.0
Stylosanthus biflora	1.0	7.5	0	..	..	..	..	..	..	..	..	..
Cracca spp.	1.0	2.5	0	2.0	20.0	1.6	..	..	..	3.0	15.0	0
Clitoria mariana	..	..	..	1.0	3.3	0	..	..	..	..	..	..
Baptisia sp.	..	..	..	..	..	..	..	..	..	1.0	5.0	0
Chapmania floridana	..	..	..	..	..	..	..	..	..	1.0	5.0	10.0
Lespedeza sp.	9.0	12.5	0	1.0	6.6	0	1.0	3.3	0	1.0	25.0	2.0
Crotalaria rotundifolia	1.0	10.0	0	8.0	53.3	0.6	..	..	..	1.0	10.0	0
Sub-Total	33.0	..	14.9	25.0	..	2.6	12.0	..	8.6	17.0	..	5.7
Grasses and Sedges												
Aristida sp.	86.0	87.5	0.2	355.0	100.0	0.3	398.0	100.0	0	323.0	100.0	0.5
Andropogon sp.	6.0	50.0	1.5	43.0	76.6	0	23.0	53.3	0.6	12.0	75.0	0
Panicum spp.	7.0	50.0	0.5	15.0	53.3	1.5	4.0	43.3	0.8	11.0	65.0	1.5
Paspalum sp.	2.0	12.5	2.0	..	..	..	..	..	..	..	..	..
Rynchospora Grayi	2.0	17.5	0	3.0	30.0	0	2.0	10.0	0	1.0	10.0	0
Sub-Total	103.0	..	1.0	416.0	..	0.9	427.0	..	0.7	347.0	..	1.0
TOTALS	241.0	..	11.5	523.0	..	4.0	492.0	..	4.6	403.0	..	4.9

*Number of plots.

TABLE 2.

OCCURRENCE AND UTILIZATION OF PLANTS AS RELATED TO AGE OF BURN IN LONGLEAF PINE-TURKEY OAK ASSOCIATION. OCALA NATIONAL FOREST, FALL STUDY.

	AGE OF BURN											
	1 (50)*			2 (40)			3 (40)			4 (32)		
Plant Species	*Amount Lbs./Ac.*	*Occur. (%)*	*Util. (%)*	*Amount Lbs./Ac.*	*Occur. (%)*	*Util. (%)*	*Amount Lbs./Ac.*	*Occur. (%)*	*Util. (%)*	*Amount Lbs./Ac.*	*Occur. (%)*	*Util. (%)*
Woody Plants												
Quercus virginiana	34.2	26.0	14.0	11.0	12.5	16.0	..	..	..	78.8	6.2	0
Quercus laevis	0.6	2.0	10.0	2.4	2.5	0	0.4	7.5	0	..	..	..
Diospyros virginiana	..	..	..	..	..	..	..	..	..	0.3	3.1	0
Geobalanus oblongifolius	34.8	44.0	6.8	12.8	47.5	11.5	2.2	17.5	2.8	37.8	53.1	2.9
Ceanothus microphyllus	9.0	24.0	8.3	0.3	2.5	30.0	3.5	12.5	0	..	..	..
Pinus palustris	..	..	..	..	..	..	7.5	2.5	0	..	..	..
Asimina sp.	0.3	4.0	5.0	..	..	..	..	..	..	..	..	..
Vaccinium Myrsinites	13.2	2.0	10.0	..	..	..	..	..	..	..	..	..
Sub-Total	92.1	..	9.0	26.5	..	19.1	13.6	..	2.8	116.9	..	2.9
Forbs												
Berlandiera subacaulis	0.2	2.0	0	0.6	7.5	20.0	2.0	12.5	2.0	..	..	..
Eupatorium aromaticum	0.6	8.0	0	0.6	5.0	5.0	2.6	15.0	21.6	2.6	18.7	0
Eriogonum tomentosum	9.1	18.0	1.1	..	..	..	2.9	20.0	0	0.6	9.3	2.0
Stillingia spathulata	0.8	8.0	2.5	4.1	22.5	10.0	5.2	15.0	1.6	2.0	15.6	2.0
Diodia teres	0.3	4.0	0	2.2	20.0	3.7	1.7	20.0	0	1.9	37.5	6.6
Chrysopsis aspera	16.6	44.0	0.9	16.8	37.5	0	6.2	22.5	0	11.0	43.7	0
Eupatorium capilifolium	0.2	2.0	0	5.0	5.0	0	1.9	5.0	0	..	..	..
Pterocaulon undulatum	3.5	8.0	0	0.7	7.5	0	1.4	10.0	0	0.4	6.2	0
Bivonia stimulosus	..	..	..	..	..	..	..	..	..	0.4	6.2	0
Miscellaneous Herbs	4.3	20.0	21.2	..	..	..	2.7	22.5	0	5.6	56.1	2.6
Cirsium horridulum	..	..	..	..	..	..	0.7	2.5	0	..	..	..
Solidago Chapmanii	1.8	8.0	0	..	..	..	2.2	12.5	0	0.3	3.1	0
Solanum Gracile	..	..	..	0.3	5.0	0	..	..	..	0.3	3.1	0
Galium sp.	0.2	2.0	0	..	..	..	..	..	..	..	..	..
Elephantopus tomentosus	6.1	20.0	1.0	..	..	..	4.7	17.5	0	3.8	18.7	0

Pteris latisculata	0.4	2.0	0	..	..	..	..	..	..	..	..	..
Pluchea sp.	9.8	4.0	0	..	..	..	..	..	..	..	..	..
Hieracium Gronovii	1.5	16.0	0	0.2	5.0	0	0.9	10.0	0	0.2	3.1	0
Gaura angustifolia	7.7	6.0	10.0	0.7	7.5	13.0	..	..	..	..	..	..
Polygonella gracile	1.8	14.0	12.8	2.3	12.5	14.0	0.1	2.5	0	0.3	6.2	0
Liatris sp.	3.1	10.0	0	..	..	..	..	..	..	..	..	..
Croton Argyranthemus	3.1	8.0	0	3.5	17.5	1.4	2.3	12.5	10.0	0.7	12.5	0
Scutellaria integrifolia	1.2	4.0	40.0	0.3	7.5	46.6	..	..	..	..	..	..
Ruellia	0.2	4.0	0	0.4	7.5	0	..	..	..	..	..	..
Atinospermum angustifolia	1.7	4.0	0	..	..	..	..	..	..	2.2	6.2	12.5
Helianthemum carolinianum	0.1	2.0	0	..	..	..	..	..	..	..	..	..
Euphorbia sp.	..	..	..	1.1	17.5	1.4	..	..	..	..	..	..
Composite	..	..	..	1.4	5.0	30.0	..	..	..	..	..	..
Selaginella	..	..	..	0.4	5.0	0	..	..	..	..	..	..
Erigeron sp.	..	..	..	0.3	2.5	0	..	..	..	..	..	..
Garberia fruiticosa	..	..	..	..	..	..	..	..	..	0.3	3.1	0
Sub-Total	74.3	..	12.6	40.5	..	14.5	37.5	..	8.8	32.6	..	5.9
Legumes												
Galactia spp.	21.7	76.0	4.2	4.5	60.0	10.0	6.2	50.0	5.5	5.7	62.5	2.0
Acanthus montanus	4.9	28.0	7.1	0.6	5.0	15.0	0.4	7.5	0	..	..	..
Meibomea Chapmanii	6.1	16.0	11.2	1.8	7.5	20.0	0.1	2.5	0	..	..	..
Unidentified Legumes	18.2	10.0	31.6	0.3	2.5	50.0	2.4	17.5	10.0	..	..	..
Rynchosia simplicifolia	1.9	14.0	0	1.8	22.5	17.7	1.4	7.5	6.6	0.3	3.1	0
Chamaecrista brachiata	10.4	22.0	5.4	2.7	10.0	5.0	6.2	20.0	5.0	1.0	9.3	0
Stylosanthus biflora	0.7	16.0	12.5	..	..	..	0.1	2.5	0	..	..	..
Cracca spp.	7.4	12.0	6.6	3.0	17.5	7.1	1.1	7.5	0	1.9	18.7	1.6
Clitoria mariana	..	..	..	..	..	..	..	..	..	12.1	6.2	5.2
Lespedeza sp.	0.9	4.0	5.0	0.1	2.5	0	..	..	..	0.4	6.2	0
Crotalaria rotundifolia	5.3	34.0	4.7	8.1	60.0	7.1	2.8	3.3	7.5	2.1	34.3	1.8
Indigofera caroliniana	14.1	10.0	2.0	2.6	15.0	10.0	2.5	10.0	5.0	0.8	6.2	15.0
Bradburya sp.	3.5	20.0	4.0	..	..	..	..	..	..	..	..	..
Martiusia mariana	..	..	..	..	..	..	..	..	..	0.6	3.1	0
Sagotia triflora	..	..	..	0.3	5.0	10.0	..	..	..	..	..	..
Secula viscidula	..	..	..	0.4	2.5	0	..	..	..	0.3	3.1	0
Psoralea canescens	0.7	4.0	25.0	..	..	..	..	..	..	..	..	..
Sub-Total	95.8	..	9.9	26.2	..	15.2	23.2	..	6.6	25.2	..	5.1

TABLE 2 (Continued)

Plant Species	1 (50)* Amount Lbs./Ac.	Occur. (%)	Util. (%)	2 (40) Amount Lbs./Ac.	Occur. (%)	Util. (%)	3 (40) Amount Lbs./Ac.	Occur. (%)	Util. (%)	4 (32) Amount Lbs./Ac.	Occur. (%)	Util. (%)
Forbs (cont.)												
Grasses and Sedges												
Aristida spp.	341.0	98.0	0	714.0	100.0	0	743.0	100.0	0	573.0	100.0	0
Andropogon spp.	17.4	46.0	0	27.0	47.5	0	11.4	52.5	0	26.8	56.0	0
Panicum spp.	9.1	38.0	1.0	8.1	52.5	2.8	18.5	45.0	0	3.5	31.2	1.0
Paspalum spp.	2.9	8.0	0	..	..	..	4.1	10.0	0	3.3	6.2	0
Sorghastrum secundum	..	..	..	4.4	10.0	0	3.3	2.5	0	4.0	9.3	0
Rynchospora Grayii	4.4	34.0	2.4	2.1	17.5	0	0.9	12.5	0	0.9	18.7	0
Cyperus sp.	0.1	2.0	0	..	..	..	0.1	2.5	0	..	..	..
Sub-Total	374.9	..	1.2	755.6	..	2.8	781.3	..	0	611.5	..	1.0
TOTALS	637.1	..	8.2	848.8	..	13.2	855.6	..	5.9	786.2	..	3.7

*Number of plots.

TABLE 3.

OCCURRENCE AND UTILIZATION OF PLANTS AS RELATED TO AGE OF BURN IN LONGLEAF PINE-TURKEY OAK ASSOCIATION. OCALA NATIONAL FOREST, WINTER STUDY.

AGE OF BURN

Plant Species	1 (44)* Amount Lbs./Ac.	Occur. (%)	Util. (%)	2 (43) Amount Lbs./Ac.	Occur. (%)	Util. (%)	3 (43) Amount Lbs./Ac.	Occur. (%)	Util. (%)	4 (43) Amount Lbs./Ac.	Occur. (%)	Util. (%)
Woody Plants												
Quercus virginiana	13.2	13.6	36.0	18.0	23.2	11.0	..	..	..	25.4	11.6	10.0
Geobalanus oblongifolius	4.3	18.1	13.0	3.3	27.9	9.2	2.0	9.3	0	1.2	11.6	20.0
Smilax sp.	0.2	2.2	30.0	..	..	..	..	..	..	..	..	..
Ceanothus microphyllus	6.5	11.3	6.0	0.5	4.6	0	3.4	2.3	0	..	..	..
Vaccinium Myrsinites	..	..	..	3.5	2.3	0	..	..	..	..	..	..

Quercus myrtifolia	..	..	..	0.1	2.3	0	3.5	2.3	10.0	..	..	..
Yucca filamentosa	..	..	..	..	..	..	5.3	4.6	0	..	..	..
Rubus sp.	..	..	..	..	..	..	4.9	2.3	20.0	..	..	..
Pinus pawstris	..	..	..	..	..	..	1.5	2.3	0	..	..	..
Prunus sp.	..	..	..	..	..	..	0.2	2.3	0	..	..	..
Serenoa repens	0.1	2.3	0	..	..	..	..	..	..	..	..	..
Sub-Total	24.3	..	21.2	25.4	..	10.1	20.8	..	15.0	26.6	..	15.0
Forbs												
Miscellaneous Herbs	1.9	11.3	0	0.8	23.2	0	3.5	41.3	0	1.0	18.6	0
Chrysopsis aspera	4.9	27.2	9.2	0.4	2.3	0	2.4	16.2	0	2.0	37.2	3.1
Hieracium venosum	0.3	2.2	0	..	..	..	0.2	2.3	0	..	..	..
Eriogonum tomentosum	0.7	6.8	0	1.2	13.9	0	1.9	13.9	3.3	2.0	16.2	0
Stillingia sp.	0.2	2.2	50.0	..	..	..	0.4	4.6	15.0	0.2	2.3	0
Opuntia	23.5	2.2	0	..	..	..	..	..	..	2.1	2.3	0
Cladium	0.1	2.2	0	0.7	2.3	0	0.3	2.3	0	0.1	2.3	0
Selaginella	0.2	2.2	50.0	..	..	..	..	..	..	..	..	..
Berlandiera subacaulis	..	..	..	0.2	2.3	30.0	..	..	..	..	..	..
Basidiomycetes	..	..	..	2.7	2.3	0	2.5	4.6	0	1.3	11.6	0
Sub-Total	31.8	..	36.4	6.0	..	30.0	11.2	..	11.1	8.7	..	3.1
Legumes												
Unidentified Legume	0.3	6.8	30.0	..	..	..	..	..	..	..	..	..
Stylosanthus biflora	..	..	..	0.1	2.3	0	..	..	..	..	..	..
Galactia sp.	..	..	..	0.1	2.3	0	..	..	..	..	..	..
Rhnchosia symplicifolia	..	..	..	..	..	..	..	..	..	0.1	2.3	0
Sub-Total	0.3	..	30.0	0.2	..	0	..	..	..	0.1	..	0
Grasses and Sedges												
Aristida spp.	251.1	100.0	0	299.5	100.0	0	395.6	97.6	0	307.0	97.6	0
Panicum spp.	3.2	18.1	0	2.4	20.9	0	6.7	48.8	0	2.3	44.1	1.5
Andropogon spp.	2.3	15.9	1.4	1.5	16.2	1.4	5.4	32.5	0	5.1	55.8	2.9
Rynchospora Grayii	1.2	13.6	0	0.7	18.6	0	0.2	4.6	0	0.4	6.9	0
Sub-Total	257.8	..	1.4	304.1	..	1.4	407.9	..	0	314.8	..	2.2
TOTALS	314.2	..	22.2	335.7	..	13.8	439.9	..	13.0	350.2	..	6.7

*Number of Plots.

TABLE 4

PLANTS SHOWING HEAVY UTILIZATION (20%+) ACCORDING TO AGE OF BURN AND SEASON.

Heavy Utilization	*Age*	*Occurrence*
Spring	*Burn*	*(Av. all burns)*
Ceanothus microphyllus	1	Light
Smilax sp.	1	Light
Psoralia canescens	1	Light
Rynchosia simplicifolia	3	Light
Quercus virginiana	4	Light
Fall		
Miscellaneous herbaceous	1	Heavy
Psoralia canescens	1	Light
Scutellaria integrifolia	1,2	Light
Unidentified Legumes	1,2	Moderate
Ceanothus microphyllus	2	Moderate
Berlandiera subacaulis	2	Light
Compositae	2	Light
Meibomea Chapmanii	2	Light
Eupatorium aromaticum	3	Moderate
Winter		
Quercus virginiana	1	Moderate
Smilax sp.	1	Light
Stillingia sp.	1	Light
Selaginella	1	Light
Unidentified Legumes	1	Light
Berlandiera subacaulis	2	Light
Rubus sp.	3	Light
Geobalanus oblongifolius	4	Moderate

The greatest number of plants receiving heavy utilization occurred in the fall. Most of the plants receiving heavy utilization during the spring, fall and winter occurred in the first year burn and next in the two year old burn.

TABLE 5

PLANTS OCCURRING ABUNDANTLY (25%+) ACCORDING TO AGE OF BURN AND SEASON.

Abundant Occurrence		*Utilization*
Spring	*Age Burn*	*(Av. all burns)*
Geobalanus oblongifolius	1,2,3,4	Moderate
Eupatorium aromaticum	1,3,4	Light
Chrysopsis aspera	1,2	Light
Hieracium venosum	1	None
Miscellaneous herbaceous	1,2,3,4	Light
Galactia spp.	1,2,3,4	Light
Acanthus montanus	1,2,4	Light
Unidentified Legumes	1,2	Light
Aristida sp.	1,2,3,4	Light
Andropogon sp.	1,2,3,4	Light
Panicum sp.	1,2,3,4	Light
Diodia teres	2	Light
Rynchospora Grayi	2	None
Eriogonum tomentosum	4	None
Croton argyranthemus	4	Light
Lespedeza spp.	4	Light
Fall		
Quercus virginiana	1	Moderate
Geobalanus oblongifolius	1,2,4	Moderate
Chrysopsis aspera	1,2,4	Light
Galactia spp.	1,2,3,4	Moderate
Acanthus montanus	1	Moderate
Crotalaria rotundifolia	1,2,4	Moderate
Aristida sp.	1,2,3,4	None
Andropogon sp.	1,2,3,4	None
Panicum spp.	1,2,3,4	Light
Rynchospora Grayi	1	Light

TABLE 5 (Continued)

Diodia teres	4	Light
Miscellaneous herbaceous	4	Moderate
Winter		
Chrysopsis aspera	1,4	Moderate
Aristida spp.	1,2,3,4	None
Geobalanus oblongifolius	2	Moderate
Miscellaneous herbaceous	3	None
Panicum spp.	3,4	Light
Andropogon spp.	3,4	Light

The degree of utilization was light on the majority of those plants occurring abundantly.

The frequency which the same area should undergo controlled burning to benefit wildlife and not be destructive to soil composition or pine regeneration is an important consideration. To obtain information on the effect of repeated burning an inventory of the vegetation was taken on an area which was burned three years in succession.

Table six illustrates the effects of repeated burning (three years in succession) on the same area in longleaf pine-turkey oak association during the spring.

TABLE 6.

EFFECTS OF REPEATED BURNING (THREE YEARS IN SUCCESSION) ON LONG-LEAF PING-TURKEY OAK ASSOCIATION DURING THE SPRING.

Species	*Av. lbs. per Acre*	*% Occurr.*	*Utiliz.*
Woody Plants			
Kalmiella hirsuta	2.0	27.7	5.5
Quercus virginiana	2.4	5.7	0
Quercus laevis	0.5	11.4	0
Geobalanus oblongifolius	24.0	51.7	3.8
Pinus palustris*	0.6	8.5	0
Ceanothus microphyllus	0.5	2.8	10.0
Subtotal	30.0		6.4
Forbs			
Diodia teres	0.7	14.2	0
Pterocaulon undulatum	2.7	8.5	0
Stillingia sp.	2.4	14.2	0
Euphorbia sp.	0.5	8.5	3.0
Selaginella	1.6	22.8	0
Miscellaneous herbaceous	1.3	22.8	0
Chrysopsis aspera	12.1	57.5	6.0
Elephantopus tomentosus	0.2	2.8	0
Eriogonum tomentosum	1.3	11.4	0
Berlandiera subacaulis	0.2	5.7	60.0
Eupatorium capillifolium	1.8	2.8	0
Ruellia sp.	0.6	11.4	0
Bivonia stimulosus	0.2	5.7	0
Solanum sp.	0.3	5.7	0
Lygodesmia aphylla	0.3	2.8	50.0
Hieracium tomentosa	0.1	2.8	0
Commelina sp.	0.5	11.4	0
Subtotal	26.8		29.7
Legumes			
Crotalaria rotundifolia	3.0	37.2	15.0
Galactia spp.	8.0	63.3	3.9
Psoralea sp.	2.0	14.2	15.0
Chamaecrista brachiata	0.1	2.8	0
Cracca spp.	4.3	28.5	5.0
Croton argyranthemus	5.8	31.4	0.9
Indigofera caroliniana	3.7	20.0	23.3
Unidentified Legumes	0.4	8.5	0
Rynchosia simplicifolia	1.4	17.1	0
Stylosanthus biflora	0.3	8.5	0
Subtotal	29.0		10.0
Grasses and Sedges			
Aristida sp.	145.8	95.2	0
Andropogon sp.	22.0	54.6	0
Panicum spp.	1.4	28.5	1.0
Rynchospora sp.	3.6	31.4	3.6
Subtotal	172.8		2.3
Total	258.6		12.1

*Planted one year previous to the study.

This association continues to maintain a considerable number of species of forbs, legumes and grasses in spite of repeated burning. The quantities of plants however, declined below that of the one-year-old burned area with the exception of *Chrysopsis aspera, Geobalanus oblongifolius, Galactia* spp., *Croton argyranthemus, Aristida* sp., and *Andropogon* sp. So little vegetation remained in some sections after the second successive burn that these sections failed to ignite during the third burn causing a patchy effect. A fourth burn would be difficult to achieve. Deleterious effects from the standpoint of deer browse was the dying off of runner oak sprouts and the disappearance of *Vaccinium Myrsinites.*

TABLE 7.

BURNING STUDY TOTALS.

AGE OF BURN

FORBS

Season	Average Pounds Per Acre					Number of Plant Species					Utilization				
	1	2	3	4	3 yrs. in succ.	1	2	3	4	3 yrs. in succ.	1	2	3	4	3 yrs. in succ.
Spring	44.0	43.0	29.0	30.0	26.3	16	13	11	12	16	3.5	4.8	2.8	3.6	29.7
Fall	74.3	40.5	37.5	32.6	...	23	18	15	13	..	12.6	14.5	8.8	5.9	...
Winter	31.8	6.0	11.2	8.7	...	8	6	7	7	..	36.4	30.0	11.1	3.1	...
LEGUMES															
Spring	33.0	25.0	12.0	17.0	29.5	12	8	6	9	11	14.9	2.6	8.6	5.7	10.0
Fall	95.8	26.2	23.2	25.2	...	13	12	10	10	..	9.9	15.2	6.6	5.1	...
Winter	0.3	0.2	...	0.1	...	1	2	..	1	..	30.0	0	..	0	...
GRASSES AND SEDGES															
Spring	103.0	416.0	427.0	347.0	172.8	5	4	4	4	4	1.0	0.9	0.7	1.0	2.3
Fall	374.9	755.6	781.3	611.5	...	6	5	7	6	..	1.2	2.8	0	1.0	...
Winter	257.8	304.1	407.9	314.8	...	4	4	4	4	..	1.4	1.4	0	2.2	...
WOODY PLANTS															
Spring	61.0	39.0	24.0	14.0	30.0	8	5	6	5	6	26.9	7.8	6.6	9.8	6.4
Fall	92.1	26.5	13.6	116.9	...	6	4	4	3	..	9.0	19.1	2.8	2.9	...
Winter	24.3	25.4	20.8	26.6	...	5	5	7	2	..	21.2	10.1	15.0	15.0	...

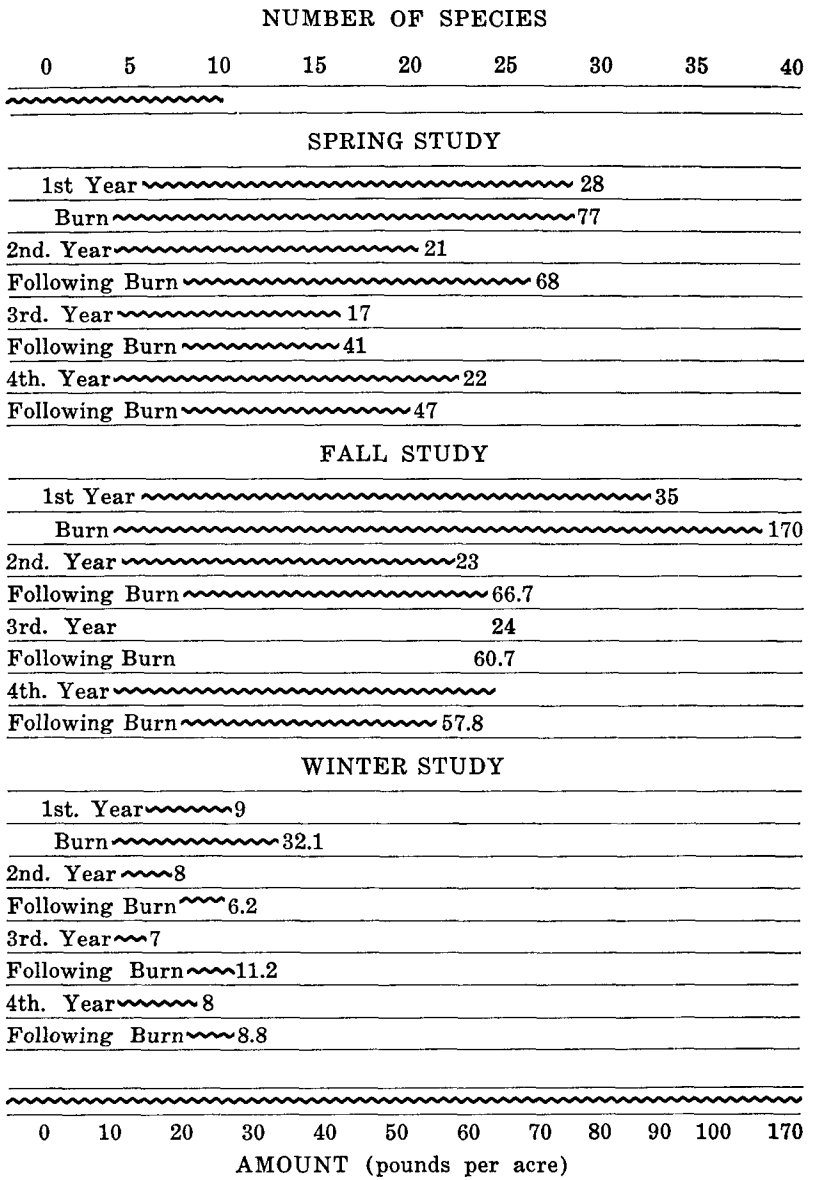

FIGURE 1. The amount and total number of species of forbs and legumes present as related to age of burn and season of the year.

RECOMMENDATIONS FOR CONTROLLED BURNING

Control burning longleaf pine-turkey oak association annually is too hard on pine seedlings largely because it prevents retention of needles through the second year. Fire causes mortality before development of the secondary needles. According to Wahlenburn (1946) the surface of frequently burned-over longleaf soils is often much harder than that of unburned soils. This allows greater run-off of precipitation. Micro-fuana and macro-fuana in the soil are reduced by repeated burning. This reduces adequate aeration. Also, annual burning on the dry, sandy, well-

drained longleaf pine lands on the Ocala National Forest would be difficult to accomplish after the third annual burning. The area subjected to burning for three successive years demonstrated this point by the patchy growth of the ground cover and its thin, sparse density. After pine has advanced into the grass stage then burning may be carried out every two years. A two-year burning program would be most beneficial from the standpoint of food for quail since legumes are most abundant during the first year following a burn. However, as pointed out by Rosene (1956), ground cover that is too sparse (where no unburned grass remains) produces unsatisfactory breeding conditions for quail.

Control burning the same area every third year would maintain forbs and legumes at high levels of production, produce a more complete burn than the two-year schedule and prevent an excessive accumulation of duff. Also, nesting conditions for quail would be preserved.

Burning once every four to six years would be most beneficial for understory hardwood growth, mast production, and soil structure. Basidiomycetes, a choice fall and winter deer food, occurred more abundantly in the three and four-year-old burns during the winter study than in the one or two-year-old burns. The thick accumulation of wiregrass in the older aged burns evidently presented more suitable environmental conditions for the production of Basidiomycetes than the one or two-year-old burns. Burning the same area once every four years would be less desirable for quail than once every two or three years since legumes become considerably reduced in number and quantity by the third year after a burn. Lay (1956) found that burning seriously reduced understory mast production by removing plants of mast bearing size. An interval of three years or more between burns would undoubtedly favor mast species and be a more desirable rotation for deer than the two or three-year-old burning program.

Burning not only serves the purpose of increasing the abundance and variety of forage plants available to wildlife but also it has been found by Halls, Southwell, and Knox (1952), and Lay (1957) to materially increase the protein and phosphoric acid content of plants. The loss of some of the more desirable mast species by burning is offset to some extent by the increase in protein and phosphoric acid levels. According to Lay (op. cit.) these two nutrients are rarely adequate on southern ranges.

The most beneficial burning program when soil, wildlife, and pine growth are given equal consideration, on the longleaf pine-turkey oak association on the Ocala National Forest, would be the three-year-old rotation, (burning every third year).

SUMMARY

Studies of changes in seasonal plant growth, species composition, utilization by deer, and food production were conducted, using the 100 percent clipping method, on one, two, three, and four-year-old burns, and controlled burning in the same area three years in succession on longleaf pine-turkey oak association. These studies were conducted on the Ocala National Forest in Marion County, Florida during the spring (May), fall (September), and winter (January) months.

The one-year burn contained greater quantities (average pounds per acre) and number of different plant species (forbs and legumes) than the two, three, or four-year-old burns during the three seasons (spring, fall, winter). The area burned annually for a three-year period supported approximately the same number of different species of forbs and legumes as the one-year burn but the quantities of these plants were less.

The two-year study area contained the second greatest abundance and variety of forbs and legumes during the spring and fall surveys.

Herbaceous material nearly disappeared on all burns during the winter. Wiregrass declined in quantity nearly to the spring level on two, three, and four-year-old burns, while wiregrass on the one-year-old burn declined to approximately one-half the spring and fall levels.

Forbs, legumes, and grasses increased both in quantity and variety on the four different aged burns during the fall.

The amount of wiregrass was lowest on the one-year-old burn during all seasonal checks, second lowest in the area burned annually for three

years (spring study), and highest in the three-year-old burned area during all three study periods.

On the area burned three-years in succession the *quantity* of forbs was less than in the other burns (spring study). This burned area, however, contained the greatest variety of forbs.

Degree of utilization on forbs, legumes, and woody plants was heaviest in the one and two-year old burns and in the area burned three years in succession. Utilization on grasses and sedges was negligible during all seasons. Utilization on all other plants except grasses and sedges was greatest during the winter.

The most beneficial burning program when soil, wildlife, and pine growth are given equal consideration on the longleaf pine-turkey oak association on the Ocala National Forest is a three-year rotation. Forbs and legumes are maintained at their highest levels of production on this type of burning program.

LITERATURE CITED

Arata, Andrew A. 1959. Effects of burning on vegetation and rodent populations in a longleaf pine-turkey-oak association in north central Florida. Quart. Journ. of the Fla. Acad. of Sci. 22 (2): 94-104.

Campbell, R. S. and Cassady, J. T. 1951. Instructions for forage weight method of range inventory for use on southern national forests. U.S. Forest Serv., South. Forest Expt. Sta. 12 pp.

Halls, L. K., F. E. Knox, V. A. Lazar. 1952. Burning and grazing in coastal plain forest; a study of vegetation and cattle responses to burning frequency in longleaf-slash pine forests of Georgia. Ga. Coastal Plain. Expt. Sta. Bul. 51. 33 pp.

Harlow, Richard F. 1959. An evaluation of white-tailed deer habitat in Florida. Tech. Bull. No. 5, 64 pp.

Laessle, Albert M. 1942. The plant communities of the Welaka Area. Univ. Fla. Publ. Biol. Sci. Ser. 4(1) pp. 1-143.

Lay, Daniel W. 1956. Effects of prescribed burning on forage and mast production in southern pine forests. Proc. Southeast. Assoc. Game and Fish Comm., 9 (1955): 50-57.

———————. 1957. Browse quality and the effects of prescribed burning in southern pine forests. Reprinted from Journ. of Forestry. 55 (5): 342-347.

Robinson, B. J. and M. L. Fernald. 1908. Gray's new manual of botany 7th. Edition—Illustrated. American Book Company 926 pp.

Rosene, Walter, Jr. 1956. Management techniques which encourage bobwhite quail to nest. Proc. Southeast. Assoc. Game and Fish Comm., 9 (1955): 126-128.

Small, J. Kunkel. 1933. Manual of the southeastern flora. The Univ. of North Carolina Press; Chapel Hill, N. C. Illustrated. 1,553 pp.

Strode, Donald D. 1954. The Ocala deer herd. Fla. Game and Fresh Water Fish Comm. Game Publ. No. 1. 42 pp.

Wahlenburg, W. G. 1946. Longleaf pine. First Edition. Publ. by Charles Lathrop Pack Forestry Foundation, Wash. D. C. in cooperation with Forest Service, U.S. Department of Agri. 429 pp.

GROWTH AND USAGE OF PERMANENT FORAGE BY DEER AND TURKEYS

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INTRODUCTION

In recent years, through trial and error, the development, seeding and maintenance of permanent openings and food plots in the game management areas of Northern Georgia, have evolved, in most cases to permanent pasture. The justification for these openings and food plots was an attempt by the Georgia Game and Fish Commission to increase the numbers of wild turkeys (Meleagris gallopovo silvestris) on the game management areas to huntable populations. In the spring of 1954, a program of development was started with the wild turkey in mind, on