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WILDLIFE - A SECONDARY CROP ON FOREST LAND MANAGED PRIMARILY FOR TIMBER PRODUCTION

Bryant A. Bateman

1949

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in the University of Michigan

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Figure Page

(Quail foods grown in plots)

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WILDLIFE - A SECONDARY CROP OF FOREST LAND MANAGED PRIMARILY FOR TIMBER PRODUCTION

Introduction

The forests of Louisiana and the nation are and should be maintained primarily for timber production; yet wildlife as a secondary crop warrants special consideration. The wild dwellers of the forest play an important part in the economy and well-being of the nation; therefore, their perpetuation in reasonable numbers should be the concern of all who are interested in the public welfare. Multiple use of forests is practical even when the land is privately owned and the chief objective is the production of merchantable timber.

The states bordering the Gulf of Mexico have climatic conditions and vegetative cover so similar that forest and wildlife management practices suitable for a particular species in a given location can usually be applied with minor changes throughout the area. Thus, although the study reported herein was limited to Louisiana, nevertheless, it has a much wider application.

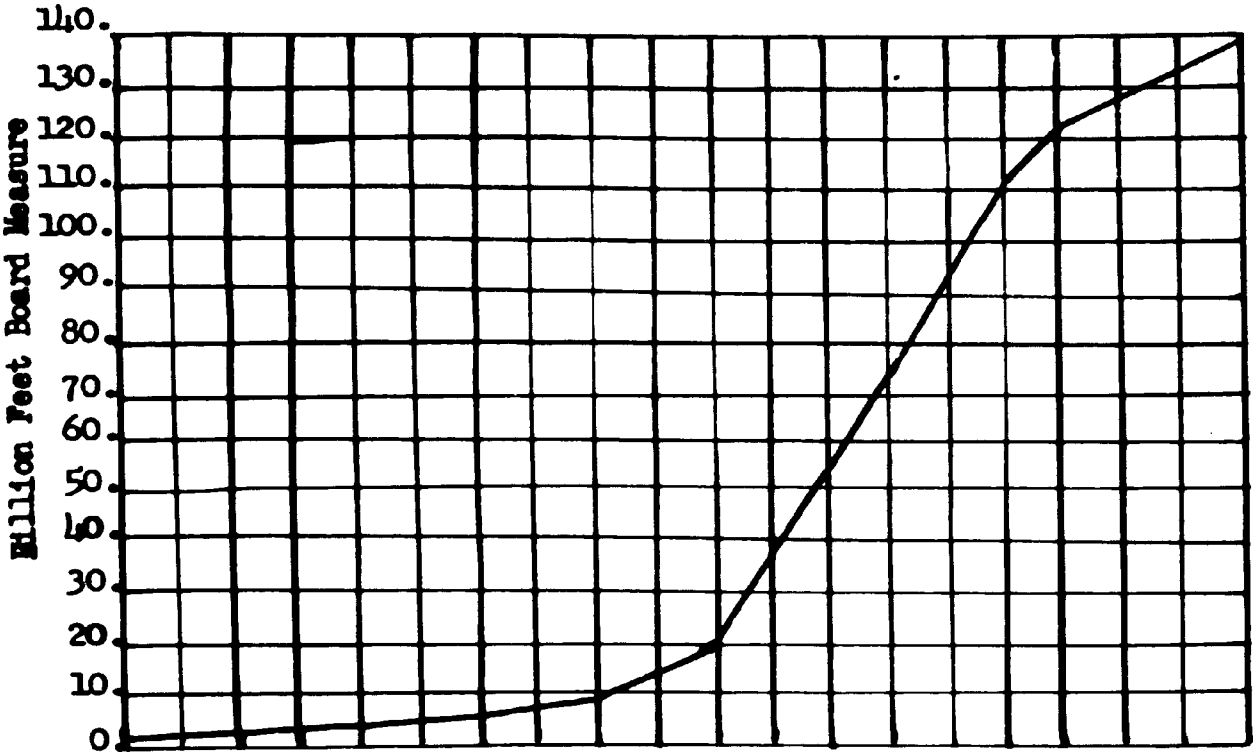
The forest wildlife habitat of the South has undergone many changes since the white man put in his appearance. The last fifty

years have seen millions of acres of virgin forest give way to farm crops, pasture and second growth forest. Left in the wake of these changes and scattered throughout the area are cutover lands so badly denuded that planting will be necessary if they are to produce timber of economic value within any reasonable period of time. Such areas need attention but they are only a part of the picture and should not be over emphasized when southern forests as a whole are considered. Land bearing timber that was restocked naturally is far more extensive than the denuded land, although admittedly some of it is understocked and some carries a high proportion of the less valuable species.

The cutting of the forest and the varied and changed use of the land has greatly modified its value as wildlife habitats. Some species of wildlife, and more particularly some species of game have benefitted, while others have suffered.

On the whole, changes have benefitted wild animals and gradually people are beginning to accept the statements of Gabrielson (11) and others that wide unbroken virgin forests are usually poor habitats for most wildlife species. On the other hand, the logging of extensive areas with skidders has often had a deleterious effect and has destroyed the habitat for deer (Odocoileus virginianus), squirrel (Sciurus spp.), turkey (Meleagris galopavo) and some other wildlife species. Quail (Colinus virginianus) and rabbit (Sylvilagus floridanus), on the other hand, have often benefitted.

Figure 1 (2) illustrates the modifications that have taken



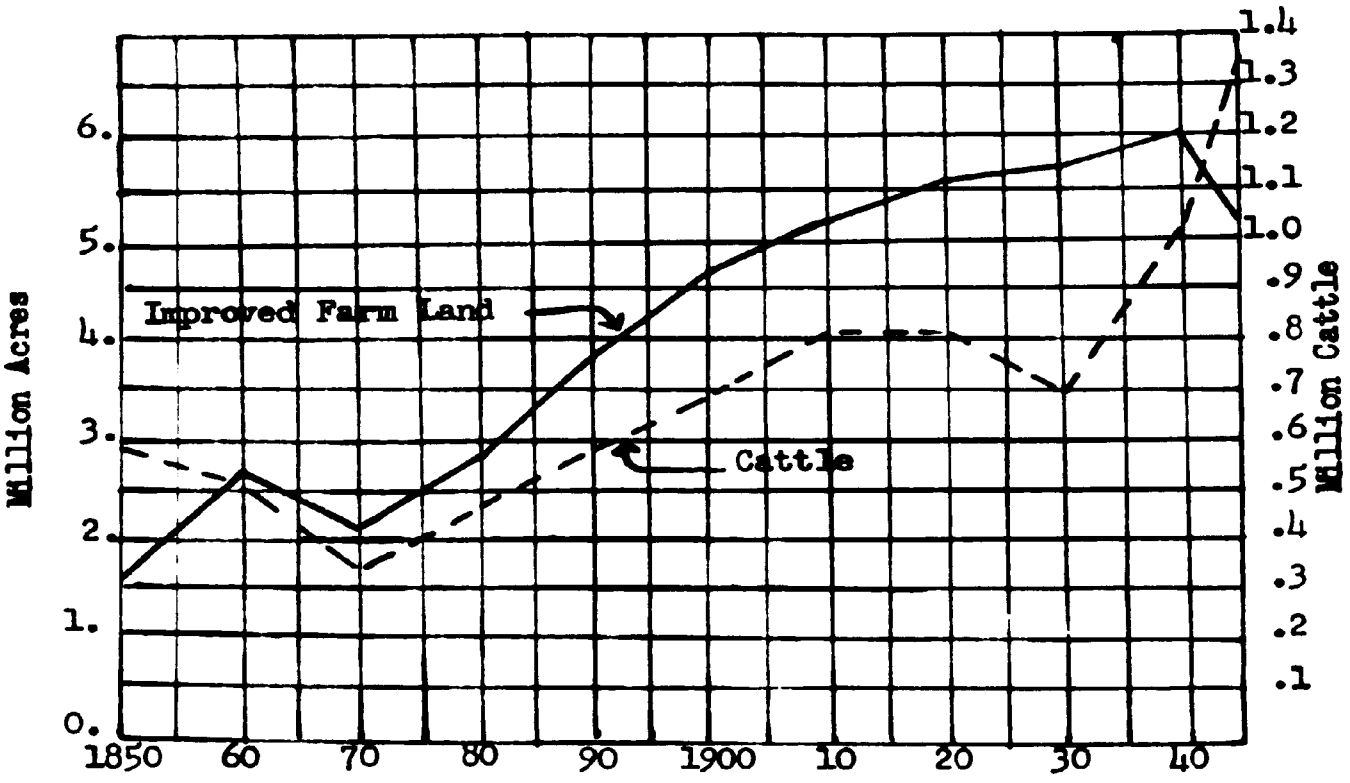


Fig. 1 (Above) Cumulative volume of sawtimber cut in Louisiana from 1850 to 1945.

(Below) Area of improved farm land and number of cattle in Louisiana from 1850 to 1945.

place in land use, with its resultant influence on vegetation and cover. Approximately 146 billion board feet of sawtimber alone has been cut. To this must be added undetermined billions of board feet removed in the form of fuel, piling, poles, and pulpwood, not to mention the vast volume that was cut, piled and burned in earlier days to provide land for agricultural crops.

More recently, in the Gulf States the production of cattle is fast becoming a leading industry. Increases in the number of cattle (2) from 1940 to 1945 were: In Louisiana - 40%, Mississippi - 45%, Alabama - 44% and Florida - 54%. Cattle (27) (28) injure or destroy many plants which provide food and cover for quail, turkey, dove (Zenaidura macroura) and rabbit. From our studies it appears that they also are harmful to deer as some of the more desirable winter deer browse plants are readily eaten. Because the nutritive value of many browse plants for cattle is low and will not alone maintain them, whereas deer thrive on them, the wisdom of running cattle on land covered with browse plants may be reasonably doubted. Cattle (5) eat browse plants during winter and early spring only as a supplement to the grasses. In addition, cattle should be fed concentrated proteins during this period, therefore, browse species evidently furnish only a small part of their required food. Thus some of civilization's changes have benefitted wild animals whereas others have been deleterious. Some of the effects are understood whereas others are not.

A better understanding of the ecological relations existing in cut-over lands is needed if mistakes are to be avoided.

Efforts have been made to maintain certain species of game in forests that are no longer suited to them, always with disappointing results. This is especially true where artificially produced quail have been released in forests where the habitat is unsuited to them. The objective of the studies reported in this dissertation has been to determine conditions that favor the various species of wild animals and conditions that are unfavorable for them so that some of the errors of the past may be avoided in the future.

The investigations described in this dissertation were made in the northern portion of Louisiana that lies east of the Mississippi River, known as the Florida Parishes. Work began in 1938 and was continued until 1948 with the exception of three war-years. It rests upon a background of twenty years of experience in this locality. Much of the land in Washington, St. Tammany, Tangipahoa, Livingston, St. Helena, and East Feleciana Parishes has been examined in considerable detail while the writer has been type mapping, estimating timber, surveying land, and making forest or game management plans. (See Fig. 2.) This experience has been especially useful in providing an overall view of the problems of forest wildlife and has been included with the more intensive investigations.

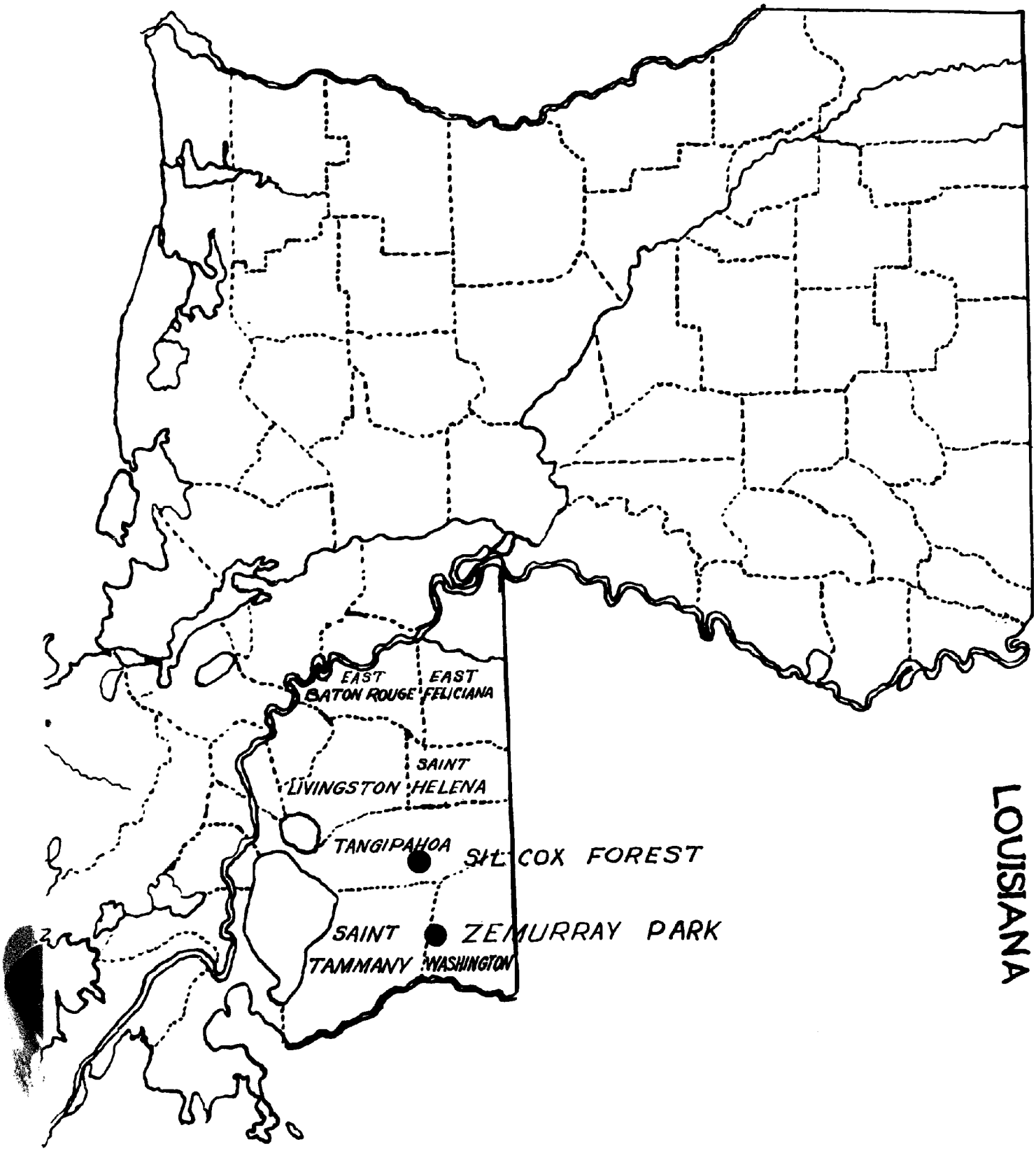


Fig. 2. Location of study areas.

Quail were studied intensively in the Silcox Forest in Washington Parish, Zemurray Park in Tangipahoa Parish, and in the northern portion of St. Helena Parish. Deer were studied both on their natural range in Zemurray Park and in controlled feeding experiments in northwest St. Helena Parish. In addition, a short study of browse was made in Natchitoches Parish. Squirrel investigations were concentrated in central Washington Parish, Zemurray Park, and St. Helena Parish, whereas turkey and rabbits have been observed throughout the northern part of the Florida Parishes.

The Silcox Forest and Zemurray Park were type mapped, based on ecological succession as first outlined by Wight (35) and later modified by Graham (13). These maps were very useful in analyzing the habitat but contain too much detail to be included here. They are introduced later in a simplified form.

In the following pages the more important game species will be discussed in the light of investigations made in this study. Since deer were stressed most, they will be discussed first followed by squirrel and quail.

DEER

Deer are the most important big game mammals in the South. Because of this fact and the small amount of scientific information regarding them available in the Gulf States, much time was allotted to this species, to determine the habitat and food requirements.

In order to determine the most productive habitats and the preferred and staple foods, two separate investigations were inaugurated, one a feeding experiment under controlled conditions to check seasonal and annual preferences for the various browse species, and the other a field study of deer range. The first was set up in northwestern St. Helena Parish, because of the great number of native plant species and because reliable personnel could be secured there to assist in the study. The second was carried out in Zemurray Park where a large deer population was confined on approximately 5,000 acres. This area was especially suited for such a study as it contained three of the more common timber types, namely, hardwoods, shortleaf-loblolly pine and longleaf pine.

After the deer feeding experiments and the habitat studies have been outlined, other factors influencing deer and their management will be discussed. These are based on general observations made in connection with other work.

Deer Feeding Experiment

The deer feeding experiments were designed to determine the browse species that were preferred by deer during the different seasons of the year. This preference could, of course, apply only to those species composing the various vegetative types of northwest St. Helena Parish. Creek and river bottom hardwoods in addition to large areas of shortleaf-loblolly-hardwood forest provided a source of numerous food materials for the experiments. In order to determine seasonal changes in diet, the experiments were in operation throughout one year.

The general procedures developed by A. A. Nichol (19) of Arizona were followed in setting up the study. To hold the experimental animals, an area approximately 100 feet square was fenced with eight foot boards placed in an upright position. (See Fig. 3.) Narrow boards were placed over the cracks to lessen outside disturbances. Included within the corral was one large red cedar (Juniperus virginiana) and several loblolly pines (Pinus taeda), ranging in diameter from 8 to 12 inches. Within the enclosure, a feeding shed was built with supporting posts so placed that they did not interfere with the free movement of the deer. (See Fig. 4.) Between the posts down the center of the shed a trough was constructed containing a double

Fig. 3. Deer within the corral.

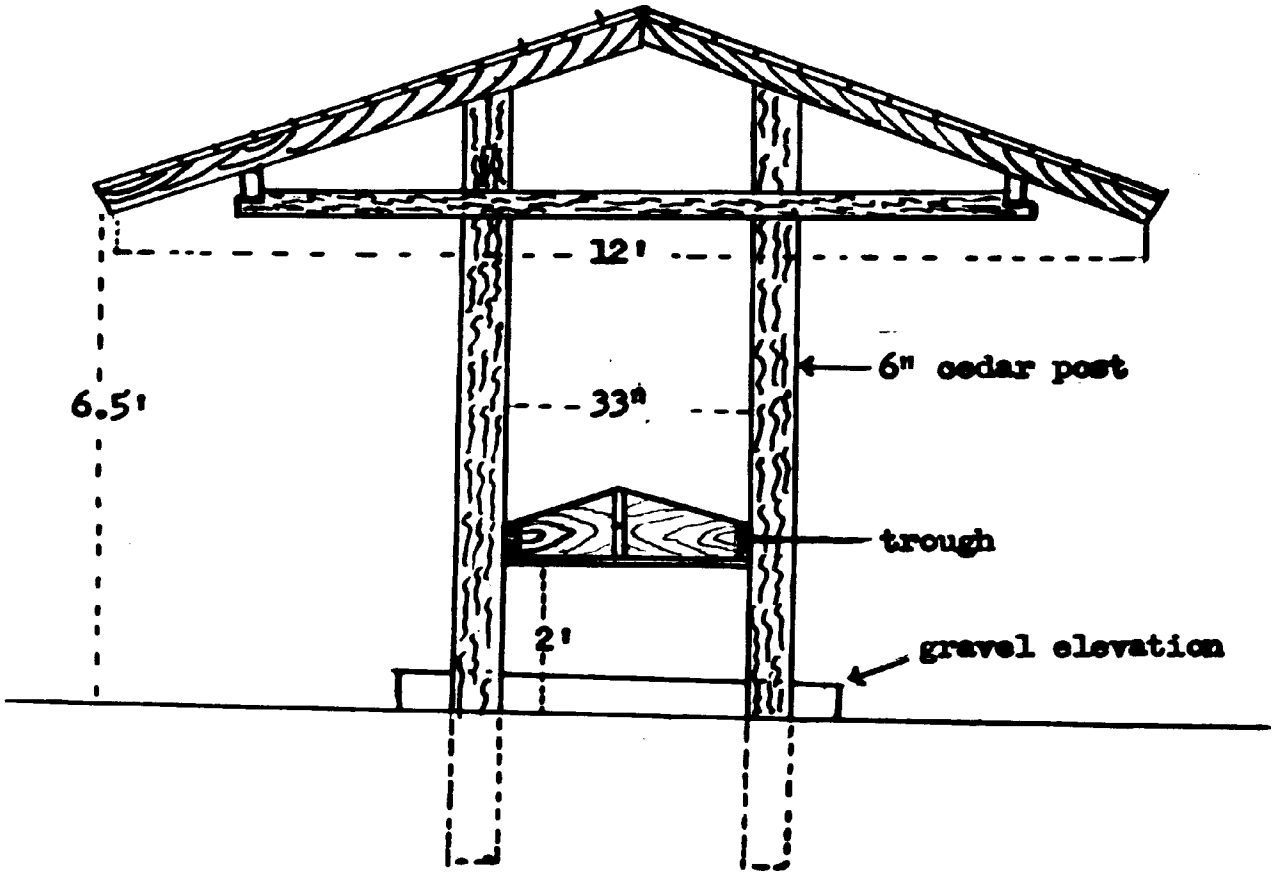


Fig. 4. End view of feeding shed.

row of feeding trays, sixteen on each side or a total of thirty-two. Two by fours were placed on the ground 12 inches beyond the edges of the trough on both sides and the space between filled with sandy gravel, so that the deer in feeding had their front feet slightly elevated, since Nichol had found that deer under such conditions stood more quietly and wasted less food than if they stood on the level beside a feeding trough. The arrangement proved entirely satisfactory and very little food was dropped on the ground by the animals while feeding.

Three deer were obtained from the Louisiana Department of Conservation on January 22, 1942; one buck weighing 62 pounds, a doe weighing 58 pounds, and a stunted, sickly doe weighing 38 pounds. The last one died shortly and contributed nothing to the experiments. These deer had been picked up as fawns during a flood the previous spring. Later, one buck was trapped in Zemurray Park on March 25, 1942. He was evidently a two year old and was rather thin, weighing only 116 pounds.

Several different kinds of green food were offered daily. No effort was made to determine a daily required ration, but sufficient food was presented to permit selection by the deer and, therefore, some of the less palatable would be left uneaten. All food was weighed to the nearest hundredth of a pound when placed in the racks and uneaten food was gathered up and weighed. All

food was gathered during each afternoon and kept in heavy cloth bags until placed in the feeding trays just before night. As the deer did most of their feeding in late afternoon and early morning, only small quantities of preferred food remained during the day, therefore, the loss in weight due to drying was small. Since those species that were eaten sparingly or not at all were offered in small amounts, their total loss in weight from drying was also small. There are two gaps in the weight records of food eaten: one due to mechanical failure of the scales and one due to serious sickness of the man responsible for the deer feeding. During these periods the deer were fed native vegetation but no weights were taken.

The material fed from woody vegetation was mostly leaves. Some smaller twigs were included but constituted only a small portion of the bulk. Small twigs of yaupon bearing the leaves were sometimes cut. Leaves were usually stripped from such vines as Japanese honeysuckle (Lonicera japonica), yellow jessamine (Gelsemius sempervirens), and smilax (Smilax spp). Great masses of yellow jessamine and honeysuckle were fed when the caretaker was sick. The deer did not eat the vines but all leaves were picked off and eaten.

Early in the feeding experiment small portions of many species of browse were fed. But under this practice the deer did not

seem to thrive. The captured buck failed to grow new antlers although new antlers were seen on wild bucks. A changed feeding procedure was then started in which a much larger proportion of one or more of the more palatable foods was fed. Soon after this practice was adopted, the deer began to add flesh and antlers appeared on the older buck. Well formed antlers with three prongs each were produced. All velvet was shed within a three day period during the week of October 25.

Table No. 1 lists the plant species fed in the course of these tests and indicates their relative palatability by three month periods. Some items may have been eaten in the enclosure that might not have been touched under natural conditions, because the deer seldom had as much of the more palatable foods as they would have consumed. Perhaps five or six species would have made up all food eaten if they had been available in sufficient quantities. As an example, red mulberry (Morus rubra) or honeysuckle would be fairly well cleaned up before the deer would start on other foods.

Palatability was rated as high, medium, or low based on the order of choice and amount of each species eaten. Foods that were eaten during the first 12 hours were rated as high; foods that were nearly all eaten during a 36 hour period but not eaten first were rated medium, and those foods eaten only in part were rated as

having a low palatability.

During early spring the palatability of most species is higher than it is later in the year, although some exceptions to this were found. Conditions restricted the area from which food could be collected. As a result, there are many palatable deer foods that could not be tested in this study. Some of these are found in Zemurray Park and are discussed later.

Species

Table 1 Species of Native Vegetation Fed, Indicating Their Relative Palatability*

Species	Dec. Jan. Feb.	March April May	June July Aug.	Sept. Oct. Nov.
Alder (Alnus rugosa)	O	L	O	O
Ash (Fraxinus spp.)	O	L	M	L
Bay, sweet (Magnolia virginiana)	H	L	M	M
Beech (Fagus grandifolia)	O	H	M	M
Blackhaw (Viburnum rufidulum)	O	H	H	M
Buttonbush (Cephalanthus occidentalis)	O	M	M	L
Birch (Betula nigra)	O	M	R	O
Buckeye (Aesculus pavia)	O	L	R	O
Catalpa (Catalpa bignonioides)	O	M	M	M
Cedar (Juniperus virginiana)	R	R	R	R
Cherry, black (Prunus serotina)	H	M	M	M
Chinatree (Melia azedarach)	M	M	M	M
Chinquapin (Castanea pumila)	O	M	L	L
Cottonwood (Populus deltoides)	O	O	M	O

* Palatability: H-high, M-Medium, L-low, R-refused, O-not fed.

Species	Dec. Jan. Feb.	March April May	June July Aug.	Sept. Oct. Nov.
Crabapple (Malus spp.)	O	H	H	O
Crapemyrtle (Lagerstroemia idica)	O	M	M	M
Cypress, bald (Taxodium distichum)	O	M	O	O
Dogwood, flowering (Cornus florida)	O	H	M	M
Dogwood, roughleaf (Cornus asperifolia)	O	O	H	H
Elderberry (Sambucus canadensis)	O	M	M	L
Elm (Elmus spp.)	O	H	M	M
Gum, black (Nyssa sylvatica)	O	H	M	M
Gum, red (Liquidambar styraciflua)	O	M	L	M
Hickory (Carya spp.)	O	M	M	O
Holly, American (Ilex opaca)	L	L	O	O
Holly, deciduous (Ilex decidua)	H	H	H	H
Hornbeam (Carpinus caroliniana)	O	H	M	O
Hophornbeam (Ostrya virginiana	O	M	L	L
Huckleberry, summer (Gaylussacia spp.)	H	H	M	M
Huckleberry, winter (Vaccinium arboreum)	M	H	R	M
Linden (Tilia americana)	O	H	M	O
Locust, honey (Gleditsia triacanthos)	O	H	H	M
Magnolia, American (Magnolia grandiflora)	H	M	L	L

Species	Dec. Jan. Feb.	March April May	June July Aug.	Sept. Oct. Nov.
Maple, red (Acer rubrum)	O	M	M	M
Mimosa (Albizzia julibrissin)	O	H	H	H
Mulberry, red (Morus rubra)	O	H	H	H
Mulberry, French (Callicarpa americana)	O	H	M	H
Oak, red & black (Quercus spp.)	O	M	L	L
Oak, water (Quercus nigra)	M	M	M	M
Oak, white (Quercus alba)	O	M	L	L
Osage-orange (Malcura pomifera)	O	H	H	H
Pecan (Carya pecan)	O	L	L	L
Persimmon (Diospyros virginiana)	O	M	L	L
Pine, loblolly (Pinus taeda)	R	R	R	R
Pine, shortleaf (Pinus echinata)	R	R	R	L
Pine, spruce (Pinus glabra)	L	R	R	R
Plum (Prunus spp.)	O	H	H	M
Poplar, yellow (Liriodendron tulipifera)	O	H	M	M
Prickly ash (Xanthoxylum clava - herculis)	O	H	H	H
Redbud (Cercis canadensis)	O	O	M	O
Sassafras (Sassafras albidum)	O	H	H	M
Serviceberry (Amelanchier canadensis)	O	M	L	O

Species	Dec. Jan. Feb.	March April May	June July Aug.	Sept. Oct. Nov.
Silverbell (*Halesia diptera*)	O	M	L	L
Sourwood (*Oxydendrum arboreum*)	O	M	L	L
Sumac, drawf (*Rhus copallina*)	O	M	M	M
Sweetleaf (*Symplocos tinctoria*)	M	M	L	L
Sycamore (*Platanus occidentalis*)	O	O	M	O
Waxmyrtle (*Myrica cerifera*)	M	M	R	R
Willow (*Salix nigra*)	O	H	M	O
Witch-hazel (*Hamamelis virginiana*)	O	M	L	L
Wild azalea (*Rhododendron canescens*)	O	H	H	M
Yaupon (*Ilex vomitoria*)	H	H	H	H
Forbs				
Beggarweed (*Meibomia* spp.)	O	H	H	L
Blackberry (*Rubus* spp.)	M	M	L	L
Cherokee rose (*Rosa laevigata*)	O	O	H	M
Cocklebur (*Xanthium* spp.)	O	O	R	O
Fern, bracken (*Pteridium aquilinum*)	O	H	M	R

Species	Dec. Jan. Feb.	March April May	June July Aug.	Sept. Oct. Nov.
Grape, wild (Vitis spp.)	O	H	H	M
Honeysuckle, Japanese (Lonicera japonica)	H	H	H	H
Lespedeza, bush (Lespedeza spp.)	O	L	M	M
Lespedeza, common (Lespedeza striata)	O	O	M	H
Mexican clover (Richardia scabra)	O	O	M	M
Muscadine (Vitis spp.)	O	M	M	O
Partridge pea (Chamaecrista spp.)	O	M	M	O
Poor joe (Diodia teres)	O	O	O	M
Potato vine, sweet (Ipomea batatas)	O	O	H	H
Ragweed, small (Ambrosia elatior)	O	M	M	O
Rattan vine (Berchemia scandens)	O	H	H	H
Smilax (Smilax spp.)	H	H	H	H
Soybean (Soja max)	O	O	H	H
Switch cane (Arundinaria tecta)	M	O	O	O
Tea weed (Sida spp.)	O	O	H	M
Tie vine (Thyella tamnifolia)	O	O	M	M
Yankee weed (Eupatorium capillifolium)	O	O	R	R
Yellow jessamine (Gelsemium sempervirens)	H	H	H	H

Species	Dec. Jan. Feb.	March April May	June July Aug.	Sept. Oct. Nov.
		Fruits		
Acorns (*Quercus* spp.)	H	O	O	H
Corn (*Zea mays*)	H	O	O	H
Crabapple (*Malus* spp.)	O	O	O	H
Mulberry, French (*Callicarpa americana*)	O	O	O	H
Rose hips (*Rosa* spp.)	H	O	O	H

The palatability rating of the various browse species listed in Table 1 is relative rather than absolute. The total food eaten was probably affected by the palatability of the foods offered the deer at a given time, and consumption, no doubt, dropped when preferred foods were fed in small amounts or not at all. Therefore, the amounts shown in the following data are probably lower than would be eaten in the field where desirable foods would be available in adequate quantities. They are nevertheless indications of the seasonal quantitative requirements.

The average monthly consumption by seasons, estimated weights being interpolated for the periods when actual records were lacking, are presented in Table 2.

Table 2

Amount of Browse Consumed by Seasons in Pounds

Season	Total average monthly consumption	Average daily consumption per deer
December January February	460	5.1
March April May	510	5.4
June July August	807	8.9
September October November	770	8.5

During August, 397 pounds of red mulberry were fed. This is the most palatable of all species during August and September and doubtless stimulated food consumption. During September, 269 pounds of red mulberry and 114 pounds of French mulberry were eaten. The fruit of the French mulberry is especially relished by deer. They will greedily eat stems and leaves in order to get the fruit more quickly.

Yaupon, wax myrtle, Japanese honeysuckle, yellow jessamine, and smilax made up the bulk of the winter and early spring food. These evergreens seem to have a much lower water content than the deciduous browse preferred during late spring, summer and fall.

Deer Food Studies in Zemurray Park

Field studies of native deer food were made in Zemurray Park to supplement and check the results obtained in the deer feeding experiments previously described. This park is a privately owned estate, available and convenient for this study. It is composed of some 5,000 acres, enclosed by a deer-proof fence and contains a good population of deer. The timber types are representative of vast areas of this and other southern states,

consisting of mixed stands of shortleaf-loblolly pines and hardwoods, pure stands of longleaf pine (Pinus palustris), and hardwood bottomlands along the creeks. (See Figure 5.)

As one of these types merges into another there are many combinations of species. In making a 10 percent timber estimate one-fifth acre plots were tallied on separate sheets. The mixed character of the forest was emphasized by the fact that on a single plot there were often three different pines and six to eight different hardwoods. The timber ranged in size from reproduction to mature stands of loblolly and shortleaf pine and bottomland hardwoods. Actually, the hardwood type has never been cut and contains many large beech and magnolias, the climax species for this area. In addition, many kinds of brush and non-merchantable trees intermingle with the merchantable forest species. No other location is available in this part of the state that supports so many timber types with as great a number of browse species and having, in addition, a deer population heavy enough to create marked browsing signs.

Many days have been spent in Zemurray Park since 1940. It has been used for research and as a laboratory for students in both timber and game management. During each season for several

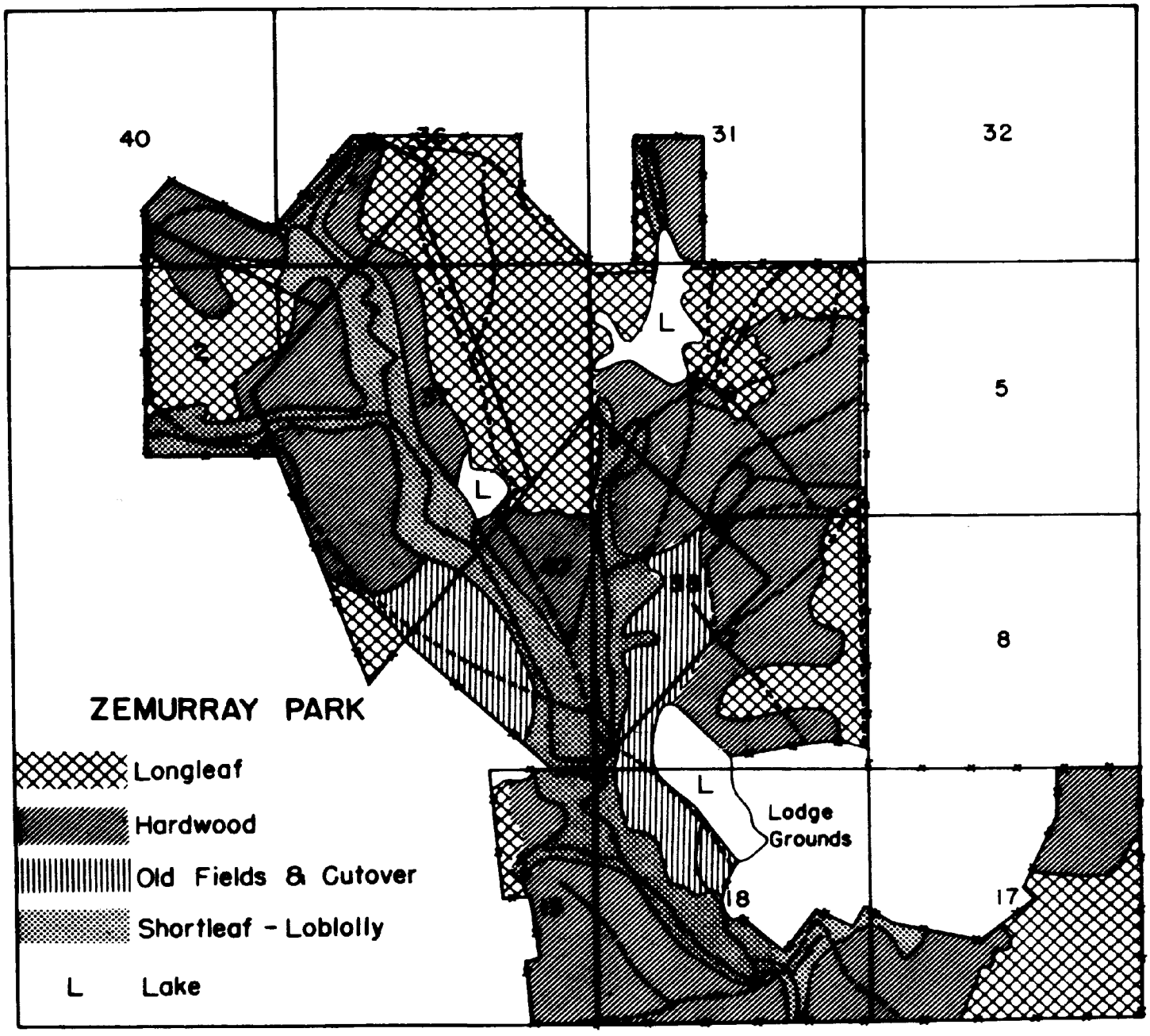


Fig. 5. Principal timber types in Zemurray Park.

years, random strips have been run in the various vegetative types and all plants listed with the amount of browsing on each shown.

The degree of utilization was divided into four classes: heavy, medium, light and none. Heavy browsing occurred when most of the leaves and often small stems were stripped up to a height of five feet. Medium browsing showed definite use on most plants but only part of the leaves were stripped while light browsing showed some use of scattered plants. Table 3 lists the species with the degree of browse shown by each.

Table 3 Species with the Degree Browse Shown by Each

Species	High	Medium	Low	None
Alder (Alnus rugosa)				X
Arrow-wood (Viburnum dentatum)	X			
Ash (Fraxinus spp.)			X	
Buttonbush (Cephalanthus occidentalis)		X		
Dogwood, flowering (Cornus florida)		X		
Gallberry (Ilex glabra)		X		
Gum, black (Nyssa sylvatica)		X		
Gum, red (Liquidambar styraciflua)			X	
Holly, American (Ilex opaca)			X	
Holly, deciduous (Ilex decidua)	X			
Hophornbeam (Carpinus caroliniana)			X	
Huckleberry, ground (Gaylussacia dumosa)			X	
Huckleberry, summer (Gaylussacia spp.)		X		
Huckleberry, winter (Vaccinium arboreum)		X		
Maple, red (Acer rubrum)		X		
Mulberry, French (Callicarpa americana)	X			
Oak, blackjack (Quercus marilandica)			X	
Oak, live (Quercus virginiana)	X			
Oak, red (Quercus falcata)			X	
Oak, water (Quercus nigra)		X		
Oak, white (Quercus albra)			X	
Pine (Pinus spp.)				X
Smilax (Smilax spp.)	X			
Stinkbush (Illicium floridanum)				X
Sweetleaf (Symplocos tinctoria)		X		
Titi (Cyrilla racemiflora)	X			
Tung (Aleurites tordi)				X
Waxmyrtle (Myrica cerifera)			X	
Willow (Salix nigra)		X		
Wild azalea (Rhododendron canescens)	X			
Yaupon (Ilex vomitoria)	X			

Using the visible browsing signs as a basis, the relative palatability of the different species of plants in Zemurray Park was determined. Heading the list of preferred deer food plants were arrow-wood, deciduous holly, French mulberry, smilax, titi, wild azalea and yaupon. Of these, smilax and yaupon are evergreen and, therefore, would be used throughout the year. Titi is a semi-evergreen and is available part of the winter. Buttonbush, flowering dogwood, gallberry, summer and winter huckleberry, maple, water oak and sweetleaf form the next group in order of preference. The group having the lowest relative palatability included red gum, American holly, hophornbeam, ground huckleberry, blackjack oak, red and white oaks and waxmyrtle. Included in these last two groups are gallberry and waxmyrtle which are evergreen. Although the latter is not used in summer it is important as a source of winter food. Oak sprouts were not browsed following a summer fire, although nearly all other species showed heavy use.

Deer were observed browsing on forbs but their relative importance was not determined. Among those showing browse signs were common lespedeza, bush lespedeza, beggarweed, partridge pea and goldenrod (Solidago spp.).

In order to give a more complete picture of the deer feeding habits in Zemurray Park certain additional observations

were made. The deer population in the early 1940's was high, probably reaching one deer to each fifteen acres. While working in the park, observers recorded the number and location of all deer seen on small maps carried for that purpose. The cumulative data on these maps added to information furnished by employees of the park indicated a population of about 300 deer.

This large number of deer was creating a distinct browse line on the more palatable food plants. Due to higher populations or lower carrying capacity certain areas were browsed heavier than on others. But everywhere the most palatable species showed marked browsing signs, while the less palatable plants were used only sporadically. Two thickets of gallberry, each about twenty feet in diameter, and growing approximately one hundred yards apart, in the same ravine, illustrate the unequal use of such plants by deer. One of these had been browsed until only scattered leaves remained on the almost bare stems while the other was dense and bright green with hardly a browsing sign. The only explanation for this difference in use is that a well-used path bordered the browsed plants, whereas the other was not in such a position.

The studies of vegetation naturally used by deer and the feeding experiments indicated that only evergreen browse was used in

winter. Ruff (26) found this to be true in the Pisgah National Forest. In this section of Louisiana the most important palatable evergreens are yaupon, smilax, Japanese honeysuckle, sweetbay, magnolia, gallberry, sweetleaf, yellow jessamine and waxmyrtle.

Of these evergreens, sweetbay, magnolia, Japanese honeysuckle and yellow jessamine were not available in sufficient quantities to judge their use. Limited evidence of their palatability was noticed and is described here. The park employees credited magnolia with supplying much food during the severe ice storm of 1940. The weight of the ice broke many limbs and the fall shattered the ice on the leaves which were immediately consumed by the deer. During this study when large limbs were cut from magnolia trees in the afternoon, all leaves were stripped during the night by the deer.

In the uplands of the northern part of the Florida Parishes, yellow jessamine is very common. In certain localities, every bush is a springtime bouquet of yellow blooms, while in others, the ground is matted with yellow jessamine vines. This plant had not been noticed in the park until after the feeding experiment had shown that deer eat it especially in winter. Later, it was noticed but never listed as an available browse because it occurred only in the tops of

trees beyond the reach of deer. Presumably the available plants had been destroyed by browsing. Although Japanese honeysuckle is not as widespread as yellow jessamine throughout the section, it was found growing on old piles of wire and in the tops of a few trees. These vines are aggressive and spread rapidly when uncontrolled; therefore, it was assumed that the deer had eradicated all within their reach.

Of the winter browse species, yaupon seemed most important. Based on observations in the park and on the feeding experiments, it is preferred by deer above most other plants. This preference plus the fact that it is able to withstand heavy browsing explains its high rating. Fig. 6 through Fig. 16 show browse species of medium and high palatability that were heavily browsed.

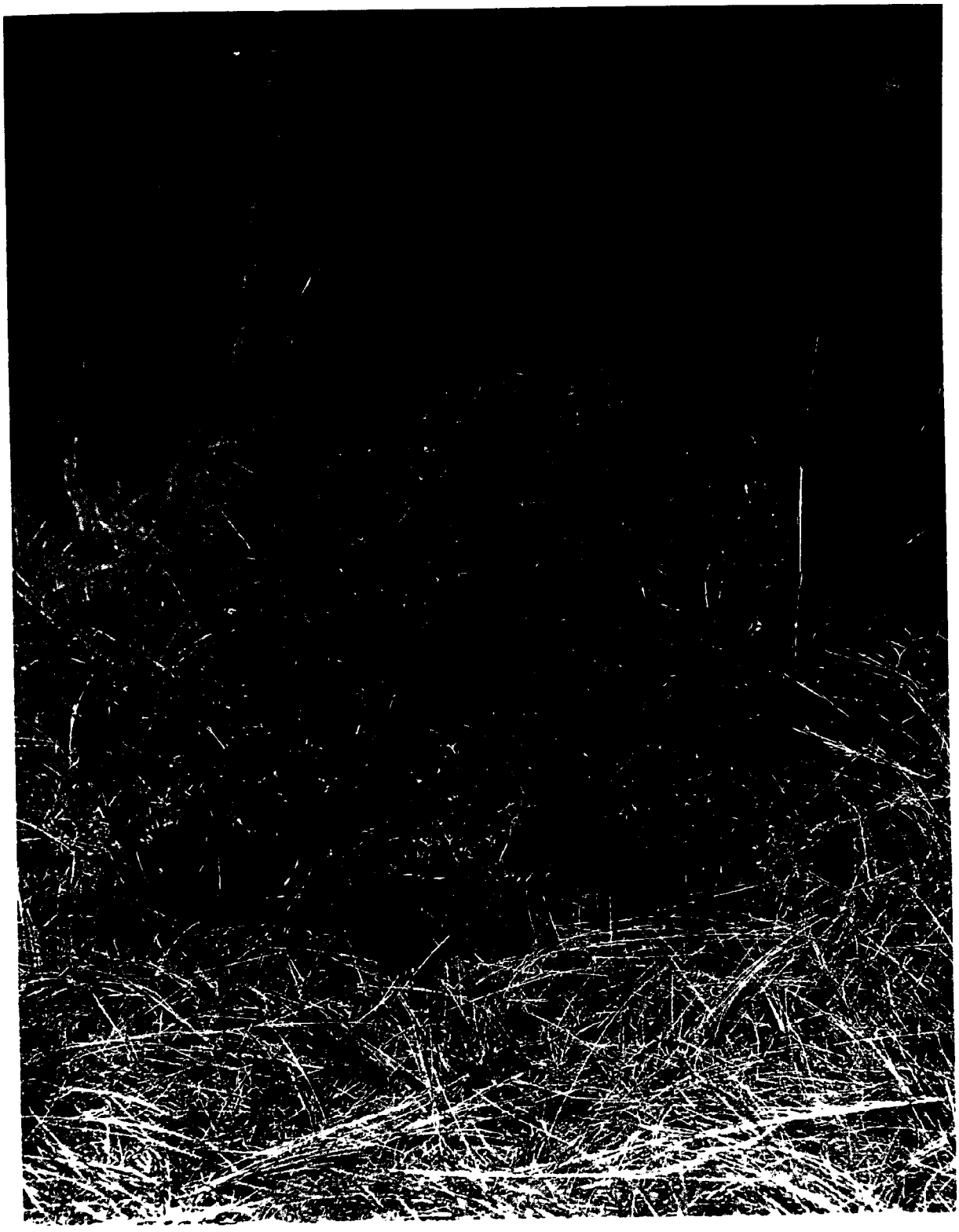


Fig. 6. Yaupon, browsed to a hedge-like condition yet still vigorous.

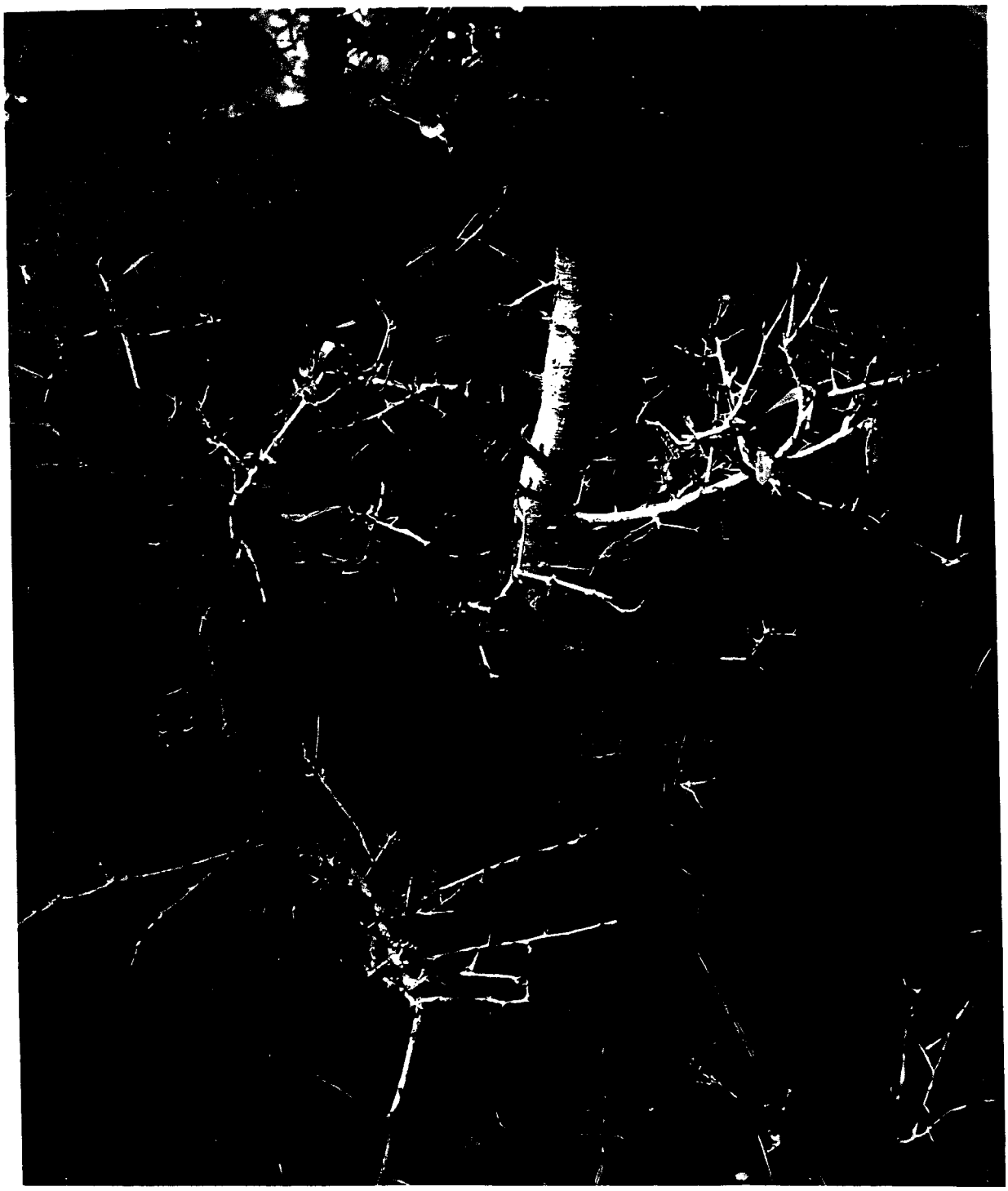


Fig. 7. Yaupon browsed to a height of five feet.

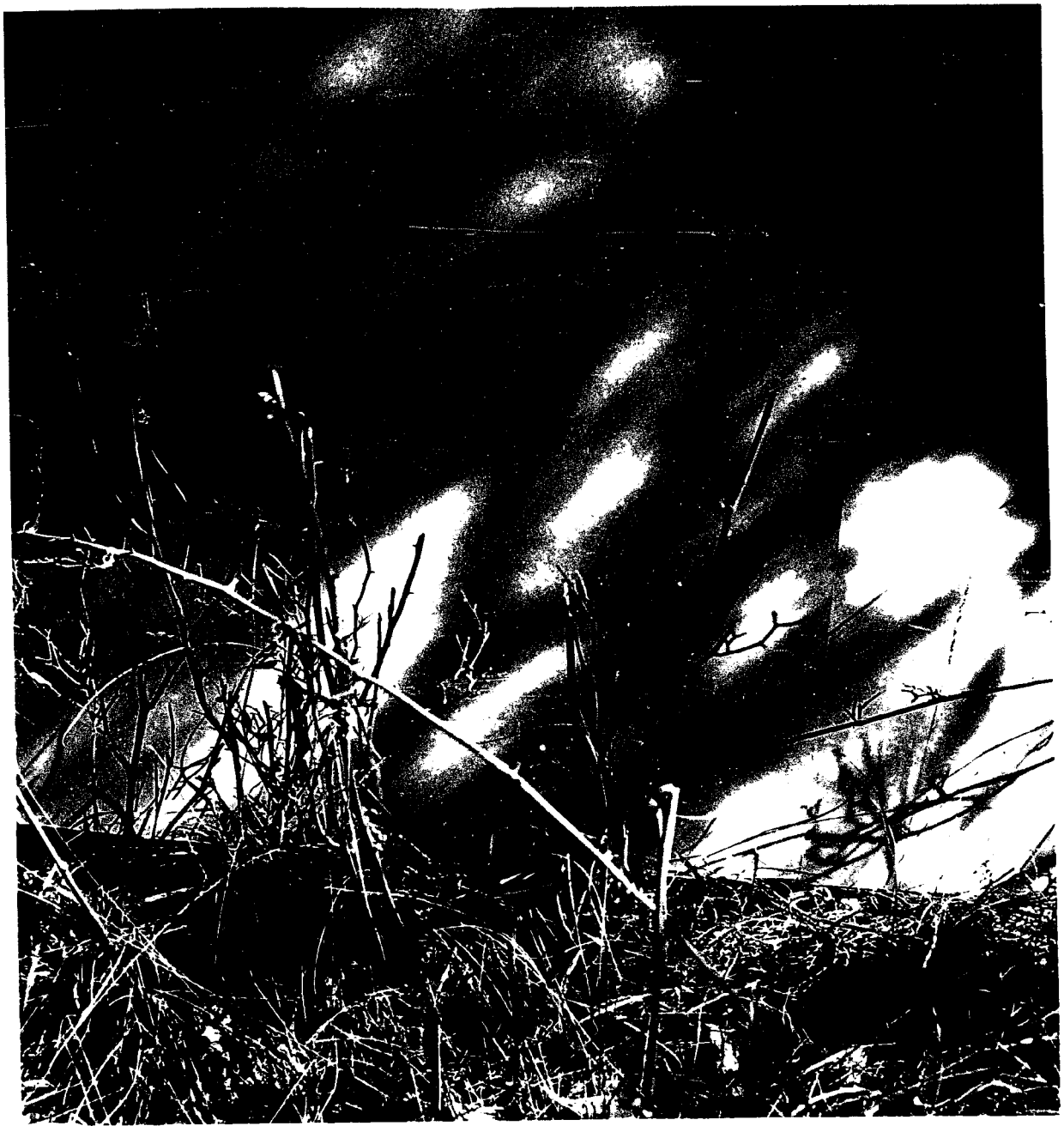


Fig. 8. Smilax.

Fig. 9. Deciduous holly in front of large oak.

Fig. 10. Winter huckleberry.

Fig. 11. Summer huckleberry

Fig. 12. Japanese honeysuckle supported and protected by a pile of old wire.

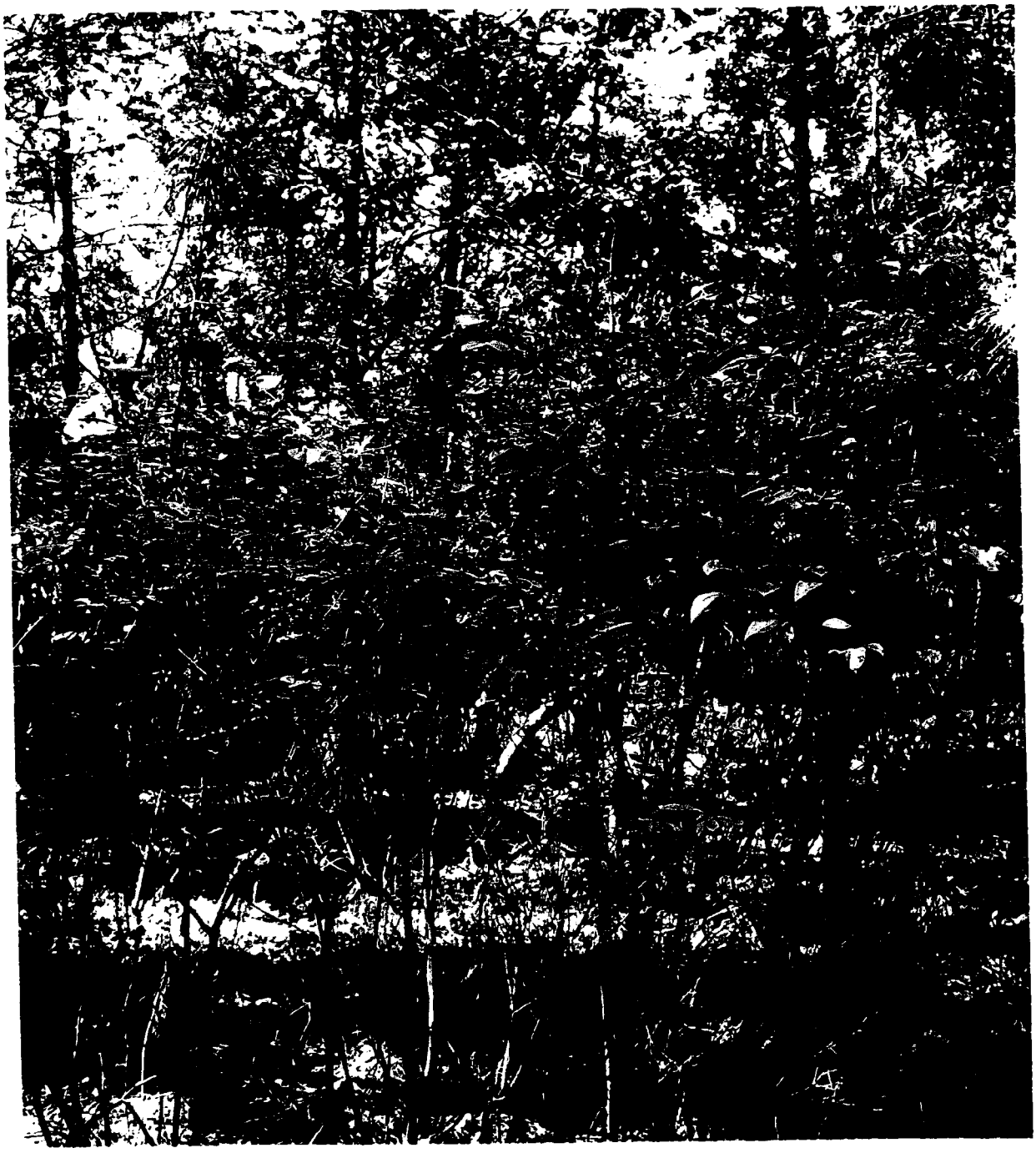


Fig. 13. Wild azalea supporting smilax.

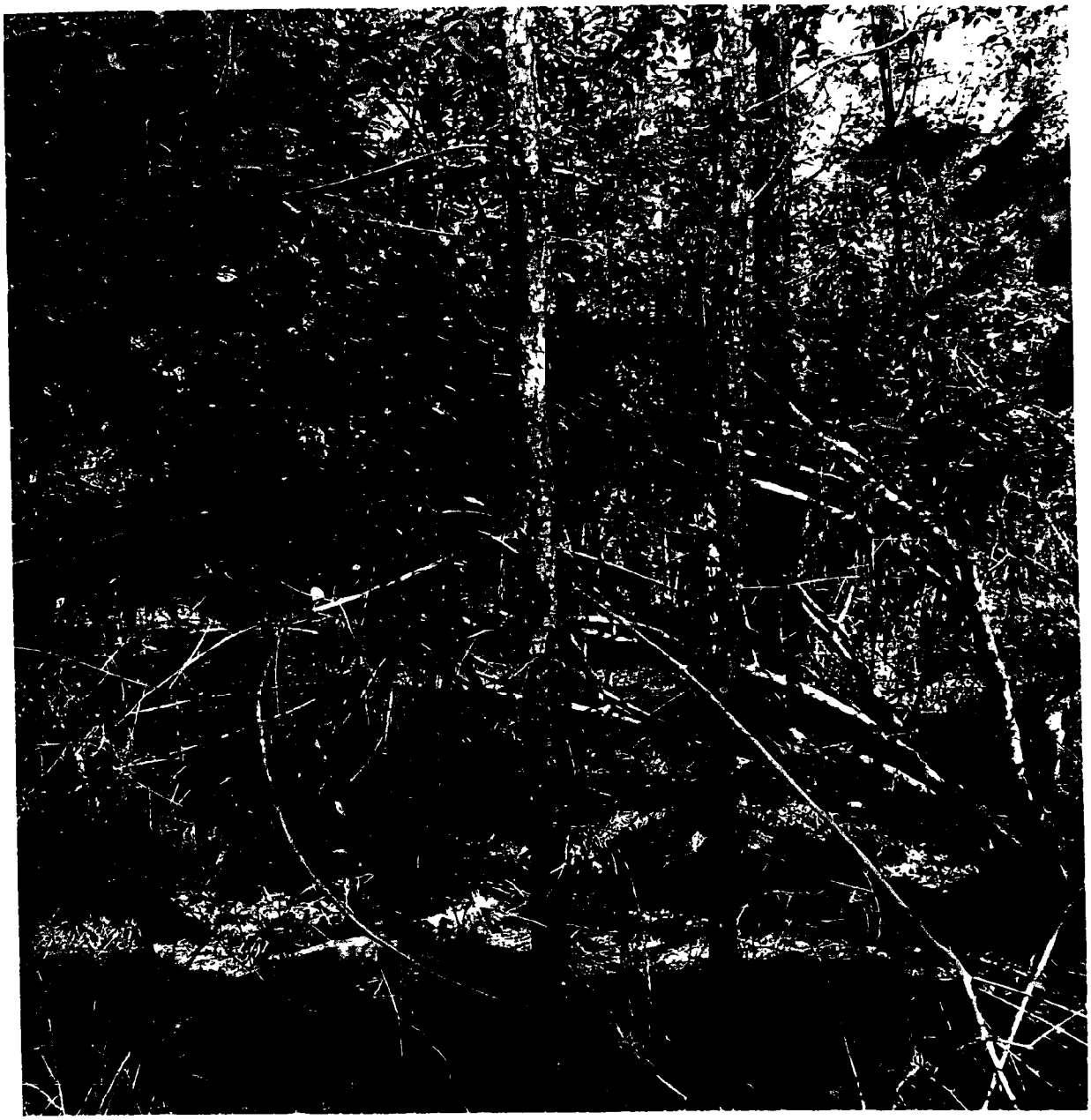


Fig. 14. Arrow-wood

Fig. 15. Flowering dogwood sprouts following killing of saplings by fire.

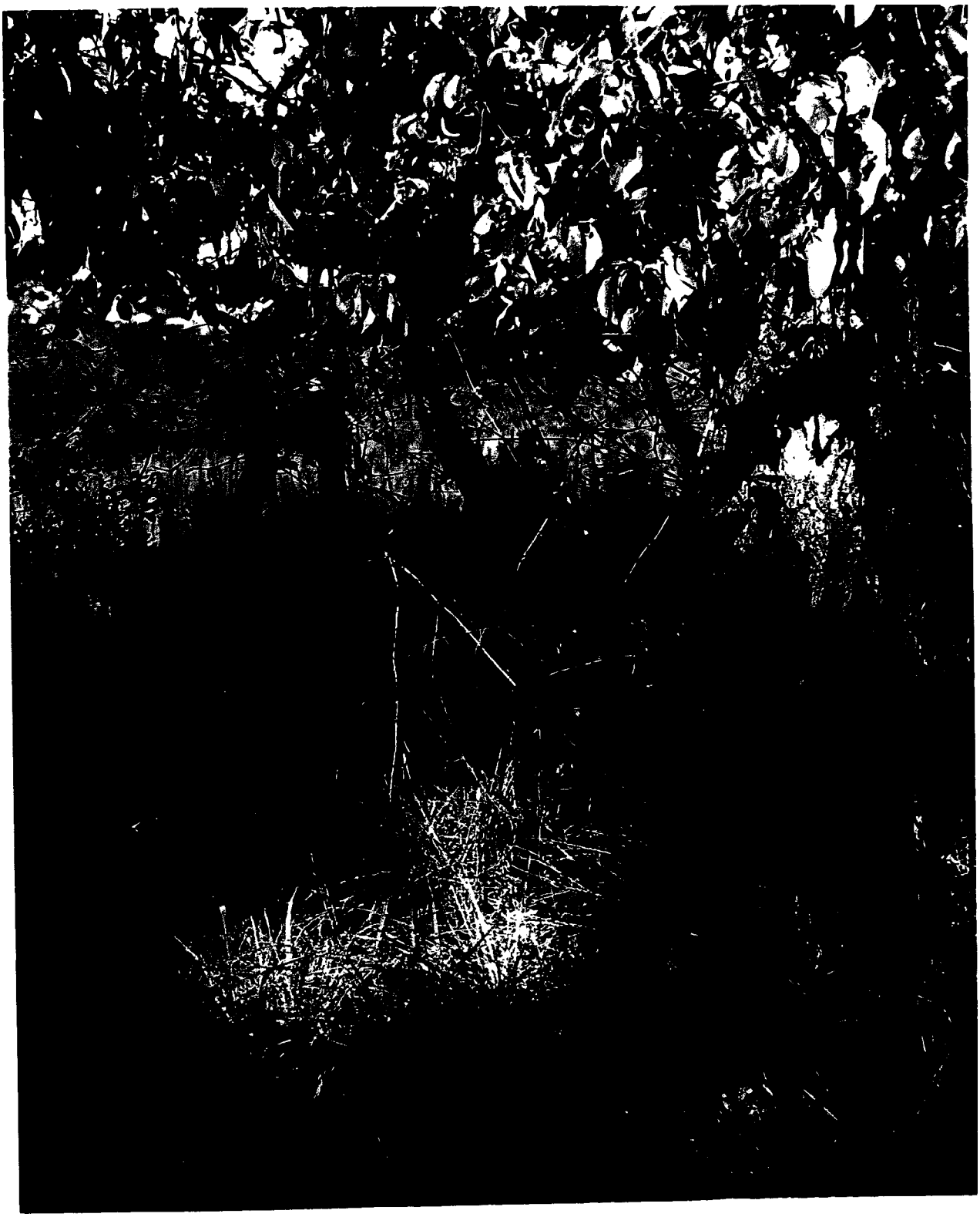


Fig. 16. Flowering dogwood shortly after being blown down.

Forest Practices and Their Relation to Deer

The habitats used by deer in Louisiana some thirty years ago were the most inaccessible swamps; yet at that time older men reported that deer were numerous in the uplands during their youth. Evidently, continuous hunting, increasing agricultural developments and timber exploitation had driven the deer into the dense, wet and undisturbed swamps. Without a knowledge of these changes in deer populations, one was apt to consider the deep swamps the optimum environment for deer.

Since fire protection was initiated about 1920, vegetation suitable for deer food and cover has increased rapidly. As a result, deer are found now in areas from which they have been absent for fifty years or more.

The degree to which uplands may be used by deer and the amount of food that such areas can produce are important questions in deer management. In order to determine the available browse in various forest types, studies were made in Zemurray Park and northwest St. Helena Parish where a direct comparison could be made between swamp and uplands. A series of fifth acre plots, located four chains apart, on lines one fourth mile apart, were laid out and the percentage of the plot covered with brush less than five feet above the ground was recorded on a form prepared especially for this purpose. (See Appendix No. 3.) Table 4 summarizes the data from the 177 plots examined on this area.

Table 4 Percent of Plots Covered by Vegetation Within Five Feet of the Ground

Species	Percent of coverage on 149 plots in upland pine or pine-hardwood types	Percent coverage of 28 plots in bottomland hardwood types
High Palatability		
Arrow-wood (*Viburnum dentatum*)	.106	.010
Crabapple (*Malus* spp.)	.003	
Haw (*Crataegus opaca*)	.004	
Honeysuckle, Japanese (*Lonicera japonica*)	.001	
Mulberry, French (*Callicarpa americana*)	.027	
Smilax (*Smilax* spp.)	.028	.057
Titi (*Cyrilla racemiflora*)	.067	
Wild azalea (*Rhododendron canescens*)	.001	.005
Yaupon (*Ilex vomitoria*)	.220	
Medium Palatability		
Beech (*Fagus grandifolia*)	.014	.051
Blackberry (*Rubus* spp.)	.092	
Cherry, black (*Prunus serotina*)	.001	
Chinquapin (*Castanea pumila*)	.003	
Dogwood, flowering (*Cornus florida*)	.170	
Elm (*Ulmus* spp.)	.004	.036
Gallberry (*Ilex glabra*)	.249	
Gum, black (*Nyssa sylvatica*)	.063	.010
Huckleberry, summer (*Gaylussacia* spp.)	1.204	.285
Huckleberry, winter (*Vaccinium arboreum*)	2.328	.643
Maple, red (*Acer rubrum*)	.014	.105
Oak, water (*Quercus nigra*)	.031	.005
Redbud (*Cercis canadensis*)	.020	
Sumac, dwarf (*Rhus copallina*)	.045	
Sweetleaf, (*Symplocos tinctoria*)	.404	.210
Low Palatability		
Gum, red (*Liquidambar styraciflua*)	.550	.321
Holly, American (*Ilex opaca*)	.013	.063

Species	Percent of coverage on 149 plots in upland pine or pine-hardwood types	Percent coverage of 28 plots in bottomland hardwood types
Hornbeam (*Carpinus caroliniana*)	.007	.089
Hophornbeam (*Ostrya virginiana*)	.081	.021
Huckleberry, ground (*Gaylussacia dumosa*)	.302	
Oak, blackjack (*Quercus marilandica*)	.511	
Oak, red (*Quercus falcata*)	.691	1.610
Oak, white (*Quercus alba*)	.055	.036
Persimmon (*Diospyros virginiana*)	.045	
Silverbell (*Halesia diptera*)	.003	.005
Sourwood (*Oxydendrum arboreum*)	.007	
Waxmyrtle (*Myrica cerifera*)	3.266	.289
Witch-hazel (*Hamamelis virginiana*)	.002	.036
Not browsed		
Pine (*Pinus spp.*)	2.132	.268
Stinkbush (*Illicium floridanum*)		17.294
Total	13.166	21.448

To supplement these data from Zemurray Park, a similar study of potential browse species was made in northwest St. Helena Parish. No deer are present in that area and the effect of deer browsing upon the vegetation was thus eliminated. Twenty one-fifth acre plots were examined, ten in the Amite River swamp and ten in the pine-hardwood hills adjoining the swamp. Table 5 shows the percentage of the plots covered by the various species.

Table 5 Percent of Plots Covered by Vegetation Within Five Feet of the Ground.

Species	Percent coverage on 10 plots in the upland pine-hardwood type	Percent coverage on 10 plots in the hardwood bottomland type
High palatability		
Holly, deciduous (*Ilex decidua*)	.16	.06
Honeysuckle, Japanese (*Lonicera japonica*)	.06	
Mulberry, French (*Callicarpa americana*)	.12	
Smilax (*Smilax* spp.)	.93	.01
Wild azalea (*Rhododendron canescens*)		.01
Yaupon (*Ilex vomitoria*)	4.84	
Medium palatability		
Beech (*Fagus grandifolia*)	.02	.02
Cherry, black (*Prunus serotina*)	.03	
Dogwood, flowering (*Cornus florida*)	3.33	.01
Elderberry (*Sambucus canadensis*)		.05
Gum, black (*Nyssa sylvatica*)	.76	
Huckleberry, summer (*Gaylussacia* spp.)	2.02	.03
Huckleberry, winter (*Vaccinium arboreum*)	.92	
Maple, red (*Acer rubrum*)	.02	
Oak, water (*Quercus nigra*)	.11	
Sweetleaf (*Symplocos tinctoria*)		.02
Yellow jessamine (*Gelsemius sempervirens*)	4.26	
Low palatability		
Gum, red (*Liquidambar styraciflua*)	2.26	
Holly, American (*Ilex opaca*)	.43	.12
Hornbeam (*Carpinus caroliniana*)	.08	.24
Oak, red (*Quercus falcata*)	.52	.01

Species	Percent coverage on 10 plots in the upland pine-hardwood type	Percent coverage on 10 plots in the hardwood bottomland type
Oak, white (Quercus albra)	.02	.02
Persimmon (Diospyros virginiana)	.07	
Silverbell (Halesia diptera)		.10
Sycamore (Platanus occidentalis)		.10
Waxmyrtle (Myrica cerifera)	12.00	.01
Not browsed		
Cedar (Juniperus virginiana)	.05	
Pine (Pinus spp.)	.05	
Stinkbush (Illicium floridanum)		12.22
Total	33.06	13.03

A casual examination of either of the areas studied might lead one to conclude that the hardwood bottomlands produced more browse than the uplands. But careful examination of the above table demonstrates that such a conclusion is erroneous. In Zemurray Park 80.6 percent of the total cover in the swamp is stinkbush, a plant that was never eaten in the feeding experiments and on which no browsing sign has been seen. Pine, another plant not browsed, covers 2.132 percent in the uplands but only 0.268 percent in the bottomlands, whereas red and white oak, species that rank low in palatability, were more abundant in the bottomlands. If the pine is deducted from the

upland browse and stinkbush from the bottomland browse, then the uplands have 11.035 percent and the bottomlands only 4.154 percent of the land covered with available browse. Waxmyrtle, yaupon, gallberry, sweetleaf and smilax, the most important winter foods, cover 4.167 percent of the uplands and only 0.556 percent of the bottomlands. (See Fig. 17.)

The data from St. Helena Parish, where there are no deer, present an even better picture of the relative browse production on upland and lowland forest types. The pine-hardwood type had 33.06 percent in vegetation under five feet in height, whereas the hardwood type had 13.03 percent, from which should be subtracted 12.22 percent of stinkbush, leaving only 0.81 percent of the land covered with usuable browse. The evergreens available for winter food include yaupon, sweetleaf, waxmyrtle, smilax, honeysuckle and yellow jessamine. Within the pine-hardwood stands these species covered 22.09 percent as against 0.04 percent in the swamp hardwood stands.

In addition to food other environmental factors differ as between swamp and upland types. The biting flies at certain seasons are by no means the least of them. In the bottomlands of Zemurray Park during May and June, mosquitoes and deer flies were very numerous. During these months, the deer moved out of the swamps into the hills, evidently to escape these pests which were far less common in the hills

Fig. 17. Old hardwood stand in Zemurray Park.

than in the swamps. The absence of tracks in the swamps during that time was striking as deer signs were plentiful during other months.

These studies indicate that the wet, mosquito-infested bottomlands rank below the better drained upland areas as deer habitats when fires are controlled. Browse, especially that used in winter, was less plentiful in the swamp. Mast is most abundant in stands of oak and beech, and least abundant in red gum stands. The pine-hardwood types, with their mixture of oak, provide considerable quantities of acorns in certain years. In the past, the deep swamps were evidently the only places to which the deer could go in order to escape man and his dogs. Repeated fires had lowered the carrying capacity of the uplands by keeping down the browse. They were found in the swamps for those reasons and not because the swamps afforded an ideal habitat. Today with efficient forest protection, there is a noticeable spread of deer into suitable upland habitats.

As a result of fire protection, marked changes have occurred in pine lands throughout the South. Invasion of shrubs and hardwoods has been greatly accelerated. In order to obtain definite information concerning these changes and the rate at which they occur, a study was made in a shortleaf-loblolly pine-hardwood area that had been logged one or two years previously. Ten forest management plots were laid out. They were located in northwest St. Helena Parish and were

each one-half acre in area. They were established with the help of forest management students from Louisiana State University in 1937-38, following a selective cut using crawler tractors. At that time, the residual basal area per acre on the plots ranged from 9.05 square feet to 59.69 square feet with an average of 35.53 square feet. On a separate map for each plot, the locations of all trees and stumps were indicated and their sizes recorded. Three continuous strips 6.6 feet wide and subdivided into mil-acre plots were examined. The number of pine seedlings in each mil-acre was determined and recorded on the map in its appropriate place. Appendix 4A is a reduced reproduction of one of these plots. Nine plots were protected from fire while the tenth was burned annually.

These plots were re-examined in the winter of 1942-43 and again in the winter of 1947-48. Appendix 4B is a tally sheet used to record the information on pine reproduction and hardwood brush growing on the mil-acre plots. In both 1942-43 and 1947-48, reproduction was tallied by size classes, while the percent of each mil-acre covered with hardwood brush was estimated. In 1937-38 tree reproduction was small, therefore, only a count of the number per plot was made, and there was no quantitative record made of hardwood brush. Table 6 gives the average number of pine seedlings and saplings per acre on data taken from nine plots. The tenth plot had burned regularly and had neither pine reproduction nor hardwood brush growing on it.

Table 6 Pine Reproduction per Acre by Numbers and Size Classes and the Percentage of Mil-acre Plots Covered by Hardwood Brush.

Year	Reproduction per acre by numbers and sizes					Percent of area in hardwood brush
	Size in height up to 5 feet, above that in d.b.h.					
	0-2'	2'-5'	5' - 1" d.b.h.	1.1"-3.0" d.b.h.	3.1"-5.0" d.b.h.	
1937-38	446					No data
1942-43	4600	675	429	238	60	24.41
1947-48	1671	1092	393	310	235	41.90

The pine reproduction secured and the increase in hardwood brush following a selection cut on the St. Helena area indicate that such a cutting was satisfactory as a forest practice and at the same time permitted the production of a great deal of deer browse. The rather low basal area left per acre was the result of understocking in the original stand and not overcutting. On the other hand, the

stand was improved by removing the larger and poorer trees, while at the same time producing satisfactory financial returns.

No estimate was made of the brush density when the plots were first laid out, but it was definitely sparse. Therefore, although the exact percentage increase during the first five years is unknown, it was considerable. Observations in 1942-43 and 1947-48 showed an increase of 17.49 percent in five years. The increase of hardwoods (9) (23) in pine stands is a serious threat to the continuous production of pine. This will be developed further in the discussion of fire.

Such stands as those in which these plots were established are far more common than fully stocked stands (3) in Louisiana and in the South, therefore, harvest cuts similar to that in St. Helena Parish must of necessity be continued for some time. The production of hardwood deer browse will follow without any special effort of the forest owner. Eventually, as the growing stock of the forest is built up, some silvicultural system that will make relatively large holes in the canopy may be necessary both to obtain tree reproduction and to maintain a good deer habitat.

Hardwood forest may suffer from browsing of deer if populations reach too high a level, because some desirable forest species are palatable. Yellow poplar, one of the better hardwood species, was

eaten, but in the feeding study, the deer did not favor this species to the extent that they seemed to show in the Pisgah National Forest. Some of the more palatable species such as red maple, dogwood and black gum are not regarded highly as forest trees in the area studied. Some of the better species such as red gum and the oaks were browsed only lightly.

If the forest is to be guarded against injury from over-browsing and if the deer are to be protected from possible starvation, some gauge is necessary to warn forest owners and wildlife technicians of approaching danger.

The selection of an indicator species by which the status of deer food could be judged was not attempted, yet the following suggestions might be of some value in that direction. Species such as smilax or red mulberry are so palatable that even small herds of deer might browse them heavily, while there is still an abundance of staple food available; therefore, these species seem to have little value as indicators. The least palatable species, such as red or white oak serve no better as most of the more palatable species would have been dangerously over-browsed before the indicators showed noticeable browsing sign. On the other hand, red gum might serve as an indicator as it was taken moderately in spring but seldom showed heavy browsing sign. In 1940, a careful inspection of browsed plants

was made with the owner of Zemurray Park. At that time no red gum browsing could be found, while in early 1948, certain areas showed considerable use. It seems that red gum is passed by when there is a good supply of the more palatable species, yet it is eaten in preference to other species that are available and are used lightly.

Waxmyrtle seems to show about the same relative palatability as red gum, therefore, it might serve as an indicator for winter food conditions. Further study will be required before indicator species can be suggested for areas where red gum and waxmyrtle are not found.

Should these assumptions prove accurate, then medium browse on red gum or waxmyrtle would indicate an approaching shortage of staple food. Deer populations could then be reduced to the point required to meet the needs of the habitat.

Deer Hunting Regulations and Their Effect on Deer

Closed and open seasons on deer are usually established and enforced for two major reasons. First - the closed season is designed to maintain good hunting by giving the deer the protection needed to reproduce and multiply. Second - the open season is designed to give all citizens an equal opportunity to harvest game.

A third function of the open hunting season is usually overlooked, namely that it provides a means by which game population may be maintained at levels within the carrying capacity of the site, that is to say, levels at which the vegetation will be preserved and perpetuated.

In Louisiana, these objectives cannot be realized under present laws. Although a season limit of two bucks is allowed, no system has as yet been established to enforce this limit. Within the dates November 15 to January 10 each parish may set a forty-five day season which is completely independent of that established by other parishes. Furthermore, all hunting seasons and bag limits are set by the Legislature, whereas the Fisheries and Wildlife Department has no power to change these regulations regardless of emergencies that may arise after the seasons have been established by legislative action.

Open seasons of a few days each week over many weeks, in effect, opens the season for the whole period. Hunting is usually concentrated on week-ends; therefore, a season that has ten week-ends gives very little more protection to game than an open season for the entire ten weeks. When the open season in a state varies, this gives those hunters who have the time and means to travel a much longer season than it gives those who cannot travel.

A legal harvest of one or two bucks per season per hunt is impossible to enforce without some sort of tag system which would enable law enforcement officers to check the game killed. There seems to be no practical way for the officer to know if the buck a licensed hunter has is his first or fifth for the season unless each deer is marked with an official tag issued by the state.

The use of dogs for deer hunting which is unlawful in many states, is allowed in the southern part of the country only. The arguments for continuing hunting with dogs are numerous and some have merit. First, it is claimed that hunters are safer if they stay on designated stands when hunting with dogs than they are when still hunting. This seems reasonable, although most hunting accidents are due to carelessness or irresponsibility. Second, in some areas, the dense swamps are difficult to hunt in. Conceivably, there are swamps in the South where dogs are essential to successful hunting, yet many other states have thick, wet swamps and still maintain a satisfactory kill without dogs. Some men claim that the chief sport of deer hunting is the chase and the baying of the hounds, but the desires of these hunters might find equal pleasure in fox or raccoon hunting, or even rabbit hunting with a pack of beagles. Thus some of the arguments used in favor of dogs for deer hunting are not too strong.

However, if deer are to be managed so as to extend their range and thereby increase the total available hunting grounds, and at the same time prevent local conditions of overpopulation, conditions that tend to concentrate them in dense jungles or wet swamps should be avoided. If dogs can be used to scatter concentration, hunting deer with hounds would have some merit but reports have been received of deer swimming the Mississippi River from the uplands of Mississippi to the swamps of East Central Louisiana when chased by dogs. In spring, during some years, high water forces deer to cross the river to the uplands, but fall hunting with dogs drives them again to the swamplands where they are less available to the hunters. It seems reasonable to expect deer to extend their range into suitable habitats more rapidly if they are not hunted with dogs on upland or relatively open areas. On the other hand, hounds might well be used in dense - wet swamps. Although the regulation of such a plan might be difficult, nevertheless it might be justified by results and deserves a trial.

In setting and enforcing hunting regulations, the authorities responsible for the development of a wildlife program should make clear the need for such controls and at the same time the necessity for future possible modifications. Some regulations may be desirable only temporarily. For instance, any locality that

establishes and enforces a buck law must eventually allow does to be taken. Continual enforcement of a buck law has invariably resulted in an unbalanced sex ratio, excessive deer populations, (32) destruction of browse plants, and eventually mass starvation (4)(18). The Fisheries and Wildlife Department should have sufficient trained personnel to maintain a constant check on the deer ranges in the state, and should have the authority to open, close or modify seasons when the condition of the game or range requires such action. Should the population become so large that the habitat is threatened, then measures should be taken to relieve the condition immediately. In any place where normal hunting cannot remove sufficient deer, the use of dogs could be authorized.

SQUIRREL

Two species, the fox squirrel (Sciurus niger) and gray squirrel (Sciurus carolinensis) are native to Louisiana. Fox squirrel prefer the uplands and formerly inhabited the virgin longleaf pine forest of the state. The gray squirrel was found more frequently in the extensive hardwood swamps. In the smaller stream bottoms both species are usually found.

As a forest game animal of Louisiana, the squirrels may be placed second to the much larger and more spectacular deer.

Yet, based on the total amount of hunting provided, the squirrels would be placed first. Because shootable populations of squirrels are found in relatively small wooded areas, they are within reach of almost any hunter and are especially favored by inexperienced youngsters. For still hunting squirrels, no equipment is needed other than some sort of firearm.

Because of their widespread distribution and popularity as a game animal, squirrels were the subject of careful observation in this study. First, an effort was made to determine the various sources from which they secured their food throughout the year. Second, the history of a newly established population was observed. Third, the reactions of squirrels to a changed food supply were determined. Fourth, a short study was made on longleaf pine seed consumption by squirrels. These points and forest-squirrel interrelations are discussed in this section.

The food habit study mentioned above consisted of careful observations on squirrels in the act of feeding and signs left by their feeding. The latter is simple, relatively accurate, and offers far more opportunities to gather data than the former. While studying forest-wildlife relationships during the recent years, 3 x 5 inch cards have been carried at all times. Each unrelated observation was noted on a separate card and later filed by subject matter. Throughout

the years, these data have accumulated and are summarized briefly in Table 7.

Table 7 Partial List of Squirrel Foods and the Period of Greatest Consumption.

Food Species	Month											
	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Beech (*Fagus grandifolia*)	———	———	———						———	———	———	———
Blackberry (*Rubus* spp.)					———	———						
Cherry (*Prunus serotina*)					———	———						
Chinquapin (*Castanea pumila*)									———	———		
Cypress (*Taxodium distichum*)									———	———	———	
Dewberries (*Rubus* spp.)				———	———							
Dogwood, flowering (*Cornus florida*)	———	———								———	———	———
Elm (buds) (*Ulmus* spp.)		———	———									
Fringetree (*Chionanthus virginicus*)						———	———	———	———			
Grape, summer (*Vitis* spp.)						———	———	———				
Grape, winter (*Vitis* spp.)									———	———		
Gum, black (*Nyssa sylvatica*)	———	———	———	———	———	———	———	———	———		———	———
Gum, red (Fruit) (*Liquidambar styraciflua*)									———	———		
Gum, red (buds) (*Liquidambar styraciflua*)			———	———								
Gum, tupelo (*Nyssa sylvatica*)	———	———	———	———	———	———	———	———	———		———	———

Food Species	Month											
	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Hickory (*Carya* spp.)	———						———	———	———	———	———	———
Hornbeam (*Carpinus caroliniana*)							———	———	———	———	———	———
Hophornbeam (*Ostyra virginiana*)							———	———	———	———	———	———
Huckleberry, summer (*Gaylussacia* spp.)					———	———						
Huckleberry, winter (*Vaccinium arboreum*)	———	———								———	———	———
Magnolia (*Magnolia grandiflora*)							———	———	———	———	———	———
Mayhaw (*Crataegus opaca*)				———	———							
Muscadine (*Vitis* spp.)							———	———				
Mulberry, red (*Morus rubra*)					———							
Oak, water (*Quercus nigra*)	———	———								———	———	———
Oak, red (acorns) (*Quercus falcata*)	———	———								———	———	———
Oak, red (buds) (*Quercus falcata*)			———									
Oak, white (*Quercus alba*)	———	———								———	———	———
Pecans (*Carya pecan*)	———	———								———	———	———
Pine (*Pinus* spp.)					———	———	———	———	———	———	———	———
Silverbell (*Halesia diptera*)								———	———	———	———	———
Sourwood (*Oxydendrum arboreum*)								———	———	———	———	———

Because most of the foods are available only seasonally, the relative importance of the various items is difficult to determine. In the fall

when the food supply is probably greatest, beech, hickory and water oak mast are preferred. Acorns from other species of oaks evidently are less palatable. Some fruits, such as silverbell, are utilized to a much greater extent during some seasons than others, indicating that they are of secondary importance when more desirable foods are available. Red mulberry and mayhaw fruits are favorites in season.

During the fall season many and varied kinds of foods are available to squirrels, although some tree seed crops are, in some years, almost complete failures due to very late spring frost, or because of periodic heavy and light yields that are characteristic of many species. Squirrels frequently begin to feed on seeds that are still green. The exact date on which seeds are first eaten in any year cannot be given as the evidence is usually seen some time after it is produced. For instance, on the Louisiana State University Campus in 1948, loblolly pine and slash pine cones were cut as early as May. In Washington Parish, slash and loblolly cones were being eaten throughout most of June, whereas in Zemurray Park, longleaf was not eaten until early in July. Generally, cutting of pine cones has stopped before the cones are ripe enough to pick for seed. At this time foods that are either more palatable or more easily secured evidently become available.

Beech, a favorite food, was being used as early as September 21, 1942, and later squirrels were seen rooting in the leaves under beech trees in search of seed. Thus these nuts provide a supply of food throughout the winter or until most available nuts have been found and eaten. Magnolia was cut before the cones opened, and hickory nuts were eaten in the late summer when still quite green as well as later when ripe. Heavy attacks were being made on green silver-bell seed by mid-August whereas no cuttings were observed in the fall or winter after the seed had dried and turned brown. Sourwood was being used in late August and red gum by the middle of September. Also by September, squirrel had turned to the water oak group, one of the most important sources of food found locally. In fact, a combination of water oak, beech and hickory produces an almost ideal habitat for squirrels.

Black and tupelo gums are a source of food over extended periods. Seeds which fall, and get mixed with leaves and litter often drift up behind logs from which they are dug out and eaten during spring and summer.

Fruit produced in the fall usually deteriorates or sprouts when temperatures begin to rise in the spring; therefore, the squirrel must then turn to other sources of food. Beginning with the

buds of such trees as red oak, red gum and elm in late February and early March, a series of plants and trees produce a fairly constant food supply. Huckleberries, mayhaws, dewberries, blackberries and mulberries ripen in about that order and bridge the gap during which staple tree fruits are scarce.

If food and cover are adequate, squirrels will move into unoccupied woodlands unless they are completely isolated from occupied habitats. Such a movement was observed in Central Washington Parish and will be described here. Some twenty years ago, gray squirrels moved into a farm woodland supporting a mixture of longleaf pine, red oak, blackjack oak and other minor species. The owner of the land guarded them carefully and they remained and multiplied. Corn and other agricultural crops from adjacent fields augmented the natural foods found in the woodland.

Although the food supply was ample, no open water was available during periods of extended drouths. This lack of water did not force the squirrels to move out of their new home, but rather the population increased and overflowed into nearby woodlands. Dew and succulent vegetation evidently were sufficient to meet the water requirements of the animals. As a result of this migration and establishment, there has been a shootable

population in this locality in recent years.

If the food supply fails, squirrel will seek new sources of food, even to the point of deserting their homes and moving into new territory. The sequence of events described in the following paragraphs illustrate this.

Prior to 1924, most of the squirrels in northwestern St. Helena Parish were to be found in creek and river bottomland hardwoods. The upland areas were burned and grazed to such an extent that the forest remained open. In that year, forest fire protection was started and thereafter the trees began to close in. Oak and pine with many minor species later created a closed canopy. Soon after the canopy closed, squirrel were found scattered throughout the uplands, yet the bottomlands still supported the greater numbers.

The results of three hunts in successive years during the month of December 1939, 1940 and 1941 illustrate how squirrels may move to seek food. In December 1939, two hunters with a dog killed eighteen squirrels by about 9:30 A.M. one morning. The following year, three hunters with the same dog covered the same territory and killed only three squirrels. These were found at the margin

of the bottomlands where they joined the hills. In the swamp, none were found and a careful search failed to locate a single track in the soft earth. An examination of the forest trees disclosed an almost complete absence of fruit; therefore, this habitat with many nest trees but without food had been abandoned. The squirrel population in the hills was greater than usual, yet it was spread fairly evenly over all suitable habitats.

In 1941, the same general route was covered using a dog. On this hunt, in approximately the same period of time, seventeen squirrels were killed. The food supply in the bottomlands was adequate and the squirrel population was again comparable to that of 1939. As this area abounds in nest trees, the squirrel evidently moved in to rear their young and found sufficient summer as well as winter food. The population in the hills was similar to that of 1939.

Reports during the early part of the 1948 hunting season indicate that the rolling lands with its mixture of pine and oak plus scattered trees of many other species are carrying more squirrels than the hardwood river bottomlands. The mixed forest, where the principal commercial tree is pine, is producing a good harvest of game.

As indicated previously, squirrels eat longleaf pine seed before the cones open, thus destroying many seed before they are scattered. Sometimes this may have an important effect upon the reproduction of forest trees. In 1942, the longleaf pine in Zemurray Park produced a light crop of cones that were being cut by squirrel. A short study was made to determine the effect of this activity. In this area, both fox and gray squirrel are present, but the fox squirrels are usually more common in the pine hills, whereas the gray squirrels are more common in the hardwoods. Although no squirrels were seen, it was assumed that fox squirrels were responsible for most of the cutting of the longleaf cones.

On August 9, 1942, using a fork in the road as a convenient starting point, all trees within two chains on each side of the road were marked. Within a distance of 21 chains there was a total of 25 cone-bearing trees and 14 trees without cones. Those with cones were numbered consecutively from one to 25 with a scribe, whereas trees without cones were marked with a zero and totaled 14 trees, one eight-inch, one ten-inch, eight twelve-inch and four fourteen-inch. Thus on 8.4 acres there were 39 trees or 4.4 trees of seed-bearing size per acre. Under such conditions natural reproduction should have been present if all other factors were favorable, and the question might well be asked whether the activities of squirrels were responsible for its absence.

On August 10, 1942, when trees were first examined, the uneaten cones that had been cut were all picked up, counted and moved at least 100 feet from the trees, and an estimate of the number of cones left on the trees was made. Because exact counts of cones on trees were very difficult, approximations were substituted. If there were some cones but no more than fifteen, the trees were listed as having a few. Others with over fifteen but under forty were listed as having a medium crop, while the one tree that still retained nearly one hundred cones was placed in the good crop class.

The following table lists data on twenty-five cone bearing trees:

Table 8 Longleaf Cones Eaten by Squirrels and the Approximate Number of Cones Remaining at the Time of the First Check, August 10.

Tree No.	d.b.h.	Number of cones eaten at first check Aug. 10,'42	Approximate number of cones left on tree Aug. 10	Additional number of cones eaten by Sept. 11,'42	Estimated number of cones that opened and dispersed seed
1	14	42	Medium	None	25
2	14	0	Few	2	5
3	12	3	None	0	0
4	10	1	Few	1	8
5	12	6	Few	0	10
6	12	0	Few	0	4
7	12	0	Few	0	3
8	14	12	None	0	0
9	10	0	Few	0	4
10	12	1	Medium	10	15
11	8	1	Medium	21	5
12	10	0	Good	1	100
13	14	104	Few	2	5
14	10	1	Medium	0	25
15	12	1	Medium	0	25
16	10	0	Few	0	8
17	12	0	Few	0	7
18	12	0	Few	0	3
19	14	42	Few	0	7
20	10	0	Few	0	8
21	18	98	None	0	0
22	8	1	Medium	0	25
23	12	1	Medium	3	20
24	12	2	Few	0	7
25	14	4	Medium	0	20
		320		40	339

Once a squirrel began to feed in a given tree, it seemed to continue feeding on that tree until most of the cones were used. Certain trees were almost completely stripped while nearby trees had hardly been touched.

The seed crop in 1942 was light but old cones indicated that there had been an excellent crop one or two years prior to this study and furthermore when the percentage loss to squirrel appeared to have been far less.

According to Wahlenberg (33), approximately 100 longleaf cones are required to fill a bushel measure which in turn will produce one pound or approximately 5,000 seed. For the study area, the loss then was 3-1/5 bushel of cones or 16,000 seeds, therefore, the loss in seed per acre was just under 2,000.

Theoretically with a 50% germination this amount of seed could have produced a fully stocked stand but actually, the obstacles to the successful regeneration of longleaf pine are so numerous and complex that such an assumption is unjustified. The presence of uneaten cones, when the seeds were disseminated, indicatesthat the food requirements of the squirrels had been met without destroying all cones of a very moderate seed crop and it may, therefore, be assumed that the loss from larger cone crops would be little if any greater. From this it would appear that

the effect of squirrels on the regeneration of longleaf pine will, over the years, be of relatively minor consequence.

Forest Practices and Their Relation to Squirrel

Forest trees are an absolute essential in the squirrel habitat, although much of its supplementary food may come from herbaceous plants and cultivated crops. Trees are very seldom grown for the sole purpose of providing living quarters for this animal, and squirrel production must almost always be secondary to some other major use, usually timber production. Therefore, it is necessary to harmonize squirrel production with this overall objective.

Squirrels prefer hollow trees in which to nest and raise their young, although nests of leaves, straw and twigs built in tree tops are often used. In most cases, trees that are suitable for dens are worthless or nearly so for timber production, although such trees may be valuable as sources of seed for natural forest restocking. Bronen and Yeager (6) suggest that four or five usuable cavities per acre should be sufficient for a staple population. Allen (1) reports staple squirrel populations in young forests where cavities for dens

were absent; however, he states that hollow trees provide a place of escape from hunters and natural enemies as well as providing a nesting place. Landowners who wish to maintain squirrel populations in their forests should leave some den trees, preferably species that will furnish high quality food also. The number and distribution of such trees will depend upon the overall carrying capacity of the habitat.

In order to produce heavy crops of fruit, trees must have ample crown space. The recommendations of Putman and Bull (24) for improvement cuttings in bottomland hardwoods of Mississippi indicate the type of hardwood forests that should produce the greatest returns in the future. In that portion of the Mississippi River Delta, the best species include bottomland red oak (Quercus nuttallii), willow oak (Quercus phellos), water oak, cherrybark oak (Quercus pagoda), cow oak (Quercus prinus), mulberry and cypress. Intermediate species include overcup oak (Quercus lyrata), hackberry (Celtis laevigata), sweet pecan, bitter pecan (Carya aquatica), hickories, honey locust and black gum. All of these trees produce squirrel food under favorable conditions. Most of these species are not considered mature until they have reached a diameter of 30 inches breast height. Although cutting recommendations require the removal of wolf trees, Putnam often leaves high quality trees over 30 inches in diameter when marking timber to be cut; therefore, the food supply should be adequate

for squirrel although den trees may be scarce.

Under certain conditions, harvest cuts in hardwoods may require the removal of most of the older trees, although such cuts will not be extensive where sustained forest production is planned. Following such a cut, a large percentage of the squirrel population will probably move to older stands of timber. However, the production of tree fruits depends on crown space to a greater extent than on age; therefore, released trees that are ten to fifteen inches in diameter should produce seed crops soon after the removal of crown competition.

In the southern pine-hardwood type, hardwoods are usually considered weed species and, in managed forests, they are being removed as fast as possible, even in national forests. In unmanaged forests, pines have been removed while the low value hardwoods, principally oaks, have been left. Under such conditions, good forest management practices require that a high percentage of these hardwoods be replaced by pine. Small owners may feel justified in leaving some of the better squirrel food and den trees in order to produce a squirrel population for their own hunting. On the other hand, under existing conditions, the large forest owner has little to gain from leaving trees useful primarily for squirrel production.

However, there should be sufficient food and den trees in the pine-hardwood types for many years. And, in addition, small stream bottoms bearing almost pure hardwood stands divide the pine-hardwood type into relatively small blocks. The better trees in these bottoms have been cut, while low quality trees have been left and will probably remain undisturbed for a long time.

FOOD PATCHES AND COVER IMPROVEMENT FOR BOBWHITE QUAIL

The bobwhite quail is by the far the most numerous and the most popular game bird of the South; therefore, it was given much time in this study although it is not usually considered to be a forest game animal (19). Three different quail projects were organized and carried on in an effort to determine methods of producing greater bobwhite populations on forest lands.

The location and purpose of these studies were as follows: (1) Silcox Forest, located some thirty miles southwest of Bogalusa, Louisiana, in Washington and St. Tammany Parishes, where food plots were established in order to supply additional food for existing quail populations; (2) Zemurray Park, approximately

fifteen miles northwest of Hammond, Louisiana, where the work included both habitat improvement and food plots; and (3) Northwestern St. Helena Parish about sixty miles northeast of Baton Rouge where the study consisted largely of food plot work in timber types of different ages and densities. The results of each of these studies are given in order.

Silcox Forest

The Silcox Forest, consisting of about ten thousand acres is bordered on the East by the Bogue Chitto River and extends west through hardwood bottoms, loblolly flats, and into the drier rolling longleaf pine hills. (See Fig. 18.)

During 1935-36, the forest was fenced and roads were constructed inside the fence and across the area so as to make the whole easily available for fire protection. Prior to that time fires had occurred in the drier portions regularly, and the vegetative cover was light except for some dense stands of blackjack oak and others of longleaf pine reproduction. On the flats, there was a mixture of hardwood brush and young loblolly pine.

Most of the quail were on the longleaf pine sites adjacent to hardwood ravines which afforded excellent escape cover. Within

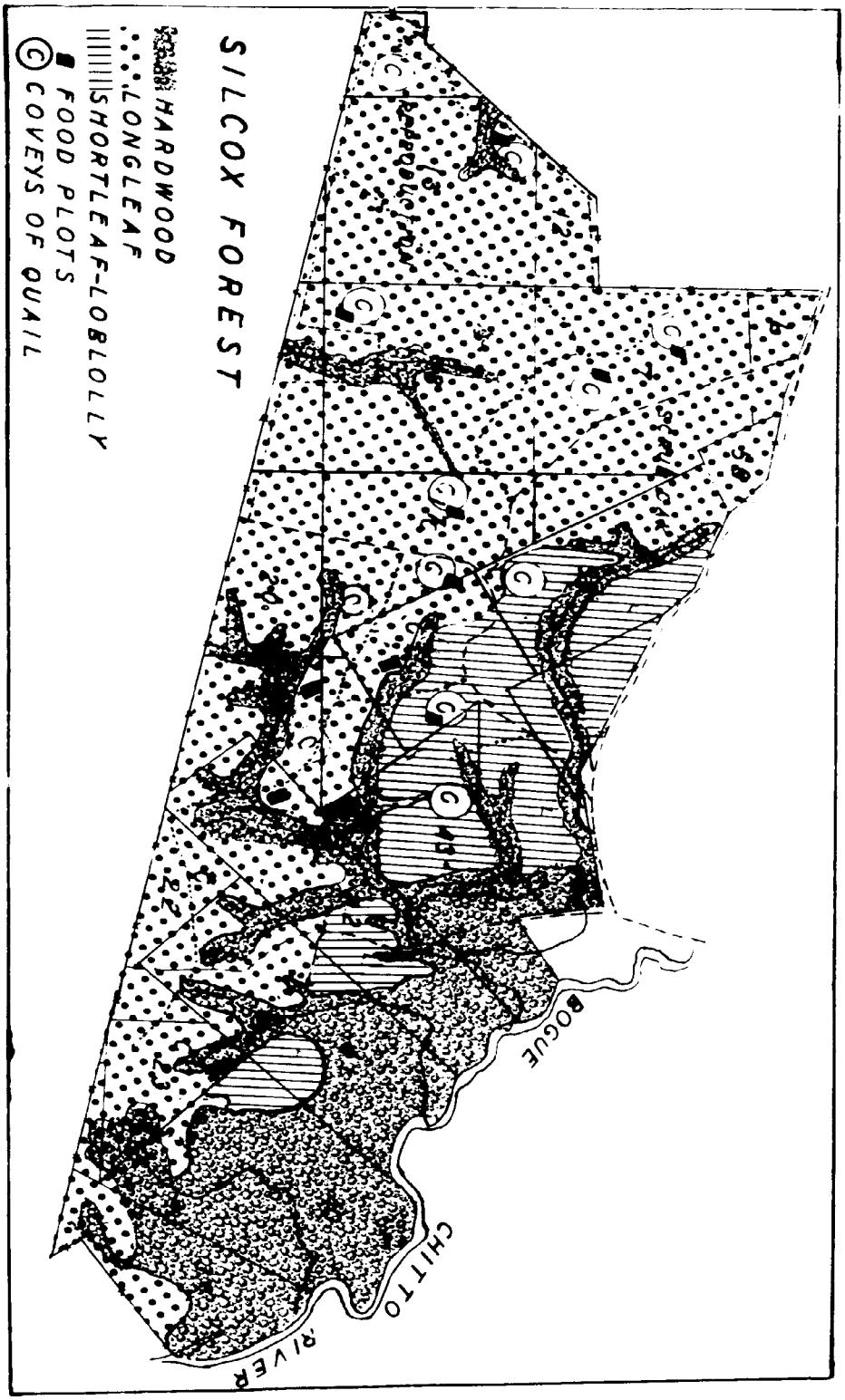


Fig. 18. Silcox Forest showing location of timber types, food plots and coveys of quail.

the range of one or more coveys of quail, one-half acre food plots were established and maintained from 1938 to 1943. (Two plots located in St. Tammany Parish were discontinued when that portion of the forest was sold).

All food species used produced satisfactory yields, yet their value as quail food varied so each will be discussed briefly.

1. Florida beggarweed (Melibomia purpurea), an annual, was a favorite food with quail from the beginning. Some volunteer plants came back once a crop had been produced but the stand was scattered and could not be relied on without replanting.

2. Sesbania (Sesbania spp.), an annual, produced very high yields that were available throughout the year. Sound seed were on old stalks in August following their production the previous year. Volunteer crops were satisfactory provided the soil was disked. In the heavy soils around Baton Rouge, good yields are produced year after year without any soil preparation. Quail did not use the seed heavily until the third year. This agrees with the results obtained by Stoddard (30) in the southeastern part of the United States.

3. Sericea lespedeza (Lespedeza sericea) produced a great deal of cover and seed, and quail used it for loafing cover in the middle of the day. Seed were only eaten late in the winter when other food was less plentiful.

4. Mungbean (Phaseolus aureus) produced many seed by early summer but they molded very quickly and were not considered satisfactory because of this characteristic.

5. Soybean produced well but the variety planted opened immediately on maturing and was available only for a short time as they decayed on wet soils. The Louisiana Agricultural Experiment Station has now produced varities that shed very slowly and are heavily used where grown.

6. Wildwinter peas (Lathyrus hirsutus) and hairy vetch (Vicia villosa) were destroyed by rabbits when planted on small areas.

7. Three grain sorghums are grouped together as the results obtained from all three were similar. Egyptian wheat (Sorghum roxburghi), red topped cane (Sorghum spp.) and amber sorghum (Sorghum vulgare) produced well but the seed did not usually last beyond early winter. During wet weather they molded and weevils were in the seed as early as September.

8. German (Chaetochloa italica) and brown topped millet (Panicum adspersum) were available in early summer thereby furnishing food when needed by young birds.

9. Buckwheat (Fagopyrum fagopyrum) was another food available by early summer.

These plots furnished sufficient supplementary food to maintain the coveys of quail that used them. With the exception of mungbean all the different foods grown were found in the crops of birds taken during the regular hunting season between the first of December and the twentieth of February. Based on the following factors, sesbania is recommended for food plots above all other quail foods grown.

1. It was eaten readily beginning the third year and often made up the entire meal toward the end of the hunting season.

2. It was easy to grow and produced high yields of seed.

3. It lasted well, shedding its seed gradually throughout the winter, spring and most of the summer.

4. It will reseed naturally in moist, heavy soils, however, some cultivation is necessary in the hill sections.

Although the habitat was deteriorating steadily, due to increasing vegetative cover, the food plots each held at least one covey in 1943 when the study was discontinued. After the forest was fenced, fires were infrequent, permitting a gradual increase in the density of the cover. Then, beginning in 1940, all understocked areas were planted to slash pine. The combined effects of these factors were detrimental to quail and all coveys not using food plots disappeared. In the early part of 1948, one day was spent with bird dogs visiting the old plots. No quail were found, and it is probable that if more time had been spent on the forest some might have been found. It is clear that the changed habitat had resulted in great reductions of the quail populations. Fig. 19 - 20 - 21 show food plots in the Silcox Forest.

Fig. 19. Sesbania in foreground, grain in the back.

Fig. 20. Sesbania.

Fig. 21. Sericea lespedeza in its third season.

Zemurray Park

The quail studies in Zemurray Park included both food and cover improvement. The owner estimated that the park carried approximately fifty coveys of birds in the early 1930's. About that time, complete fire protection was inaugurated and soon thereafter the quail population began to decline. This continued until only twelve or fifteen coveys remained in 1940.

At that time a program designed to improve the cover and increase the food supply was undertaken. To improve the cover, the longleaf pine areas, consisting of seed trees and open pole stands, were burned periodically, while food strips were used to increase the food supply. During May and June, approximately fifteen miles of strips about fifteen feet wide were cleared, fertilized with basic slag and planted to sesbania. As there was a heavy population of deer and some fifty cows in the park, sesbania was the only food plant that offered any chance of success. Stoddard (29) had found that deer and cattle ate sesbania only slightly.

An excellent stand was secured and the plants soon averaged about three feet in height with no sign of deer or cattle damage. Then approximately 250 underfed cows were purchased and

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An excellent stand was secured and the plants soon averaged about three feet in height with no sign of deer or cattle damage. Then approximately 250 underfed cows were purchased and

placed in the park. Almost overnight the entire stand was completely destroyed.

The following year, five one-half acre plots were fenced and planted. One of these had a deer proof fence, while the other four could be entered at will by deer. All food plants not browsed by deer did well and the results were similar to those obtained in the Silcox Forest. These experiments indicate what may be expected of food patches exposed to deer.

Sesbania was not browsed, however there was some evidence that the seed were being eaten. Brown topped millet, German millet and buckwheat showed no evidence of browsing and their seeds were available to quail early in July. Red topped cane, Egyptian wheat and amber sorghum foliage was undamaged but all heads were consumed as fast as they formed. Sericea lespedeza was eaten but grew and produced seed, and still persists with a vigorous stand of grass. Four of the plots were located near existing coveys of quail and were used regularly.

A burning schedule was planned and the first area was burned in the winter of 1940-41. A different area was burned during the winter of 1941-42; however, the war prevented the continuation of this program.

At the time the above areas were burned, cattle were grazing in the park. Following the burning, the cattle congregated on the burned land thereby nullifying the possible benefits to quail by consuming most seed bearing plants. This experience emphasizes the importance of careful consideration of all factors involved before investing in expensive game management practices.

St. Helena Parish

In St. Helena Parish ten one-half acre plots were established in timber of different sizes and ages. These plots were fenced, cleared and planted in the spring and early summer of 1939. The last plantings were made in the fall of 1942. They were not selected because quail were there, but rather to determine the possibility of increasing the food supply in timbered areas. Plantings were made in two fields where quail were found. All plots were fertilized with 4-12-4 at the rate of about 300 pounds per acre.

Plots No. 1 - 2- 3 & 4 were in shortleaf-loblolly fifteen to twenty-five years of age and dense enough to need thinning. Plot No. 5 was in longleaf pine about twenty-five years of age and in need of thinning. Plot No. 6 was in an old field loblolly stand,

which was twenty-five years of age and fairly dense with a basal area of approximately seventy sq. ft. per acre. Plot No. 7 was established in an old field loblolly stand that was forty years old with a basal area of approximately sixty sq. ft. per acre. The land had suffered from sheet erosion and the top soil was very thin. Plot No. 8 was in a sixty year old stand of loblolly which had a basal area of approximately sixty sq. ft. per acre with trees up to twenty-six inches in diameter. Plots 9 and 10 were located on areas that had been selectively cut in 1935 and 1936. Each one-half acre plot had ten to twelve trees whose diameters ranged from ten to sixteen inches. Fig. 22 shows the location of these plots on air maps, while Fig. 23 shows the location of each plot in Northwest St. Helena Parish.

Table 9 summarizes results obtained in the various plots. Exact measurements were not made but rather the yield was compared with yields in plots that were not in timber. Those crops listed as good were estimated to be producing from 67 to 100% as much as plots in the open. Those listed as fair were producing 33 to 66% and those listed as poor were producing some seed but less than 33% as much as plots in the open. Those with very scattered or no production were listed as failures.

Fig. 22. Cover conditions on quail food plots. (See Fig. 23 for geographic location)

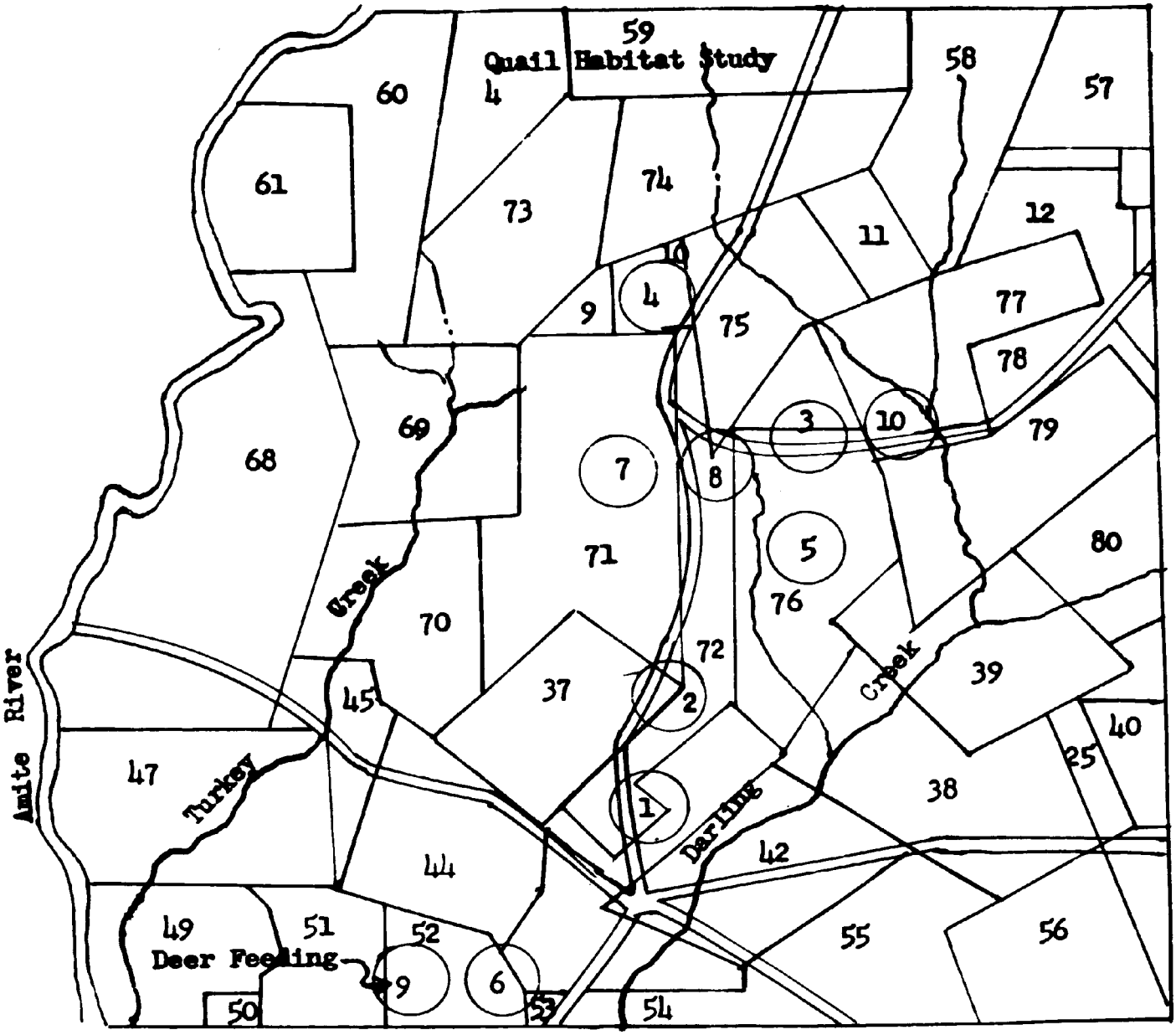


Fig. 23. Township 1 South - Range 4 East in northwest St. Helena Parish showing the location of quail food plots, deer feeding experiment, and quail habitat study.

Table 9 Foods Planted and their Production in Different Timber Types of St. Helena Parish

Timber Types and Plot Numbers

Food	Year	Dense stands of loblolly & shortleaf pine fifteen to twenty-five years old				Dense long-leaf pine	Old field lob-lolly twenty-five years old	Old field lob-lolly forty years old	Sixty year old lob-lolly	Lob-lolly selec-tively cut	
		1	2	3	4	5	6	7	8	9	10
Common lespedeza (Lespedeza striata)	1940	Poor				Fail	Fail		Poor	Good	
	41						Poor		Fair	Good	Fair
	42							Fair			
Kobe lespedeza (Lespedeza striata)	1940	Fair					Fair	Good	Poor	Good	
	41						Poor		Fair	Good	Fair
	42							Good			
Serecia lespedeza (Lespedeza serecia)	1940	Fair	Fair	Poor		Fair**	Good	Fair	Poor	Fair	
	41				Fair		Fair	Good	Fair	Fair	Fair
	42						Good	Good	Fair	Good	
Sesbania (Sesbania spp.)	1940	Poor				Fail	Fair		Fair**	Good	
	41						Fair		Fair	Fair	Fair
	42						Fair	Good	Good**	Good**	
Florida beggarweed (Melibomia purpurea)	1940	Fair				Fair*	Poor		Failure*	Good	
	41						Poor		Fair	Fair	Fair
	42						Poor*	Poor	Good**	Good**	
Partridge pea (Chamaecrista spp.)	1940	Fair				Good		Good	Fair	Fair	
	41						Fair		Good	Good	Good
	42						Fair	Fair	Good	Good	
Grain sorghum (Sorghum spp.)	1940	Poor				Fail	Poor		Fair	Poor	
	41						Fail		Poor	Poor	Poor
	42							Poor		Poor	

Food	Year	Dense stands of loblolly & shortleaf pine fifteen to twenty-five years old				Dense long-leaf pine	Old field lob-lolly twenty-five years old	Old field lob-lolly forty years old	Sixty year old lob-lolly	Lob-lolly selec-tively cut	
		1	2	3	4	5	6	7	8	9	10
Bene (Sesamum indicum)	1940	Poor				Fail	Poor	Fair	Poor	Fair	
	41						Good		Poor	Poor	Poor
	42							Poor		Fair	
German millet (Chaetochloa italica)	1940	Poor				Poor	Poor	Fair	Fair	Good	
	41						Poor		Fair	Poor	Fair
	42									Poor	
Winter pea (Lathyrus hirsutus	1940	Poor	Fail	Poor				Fair	Good	Good	
	41								Fair	Fair*	
	42									Good	
Augusta vetch (Vicia angustifolia)	1940	Fair	Fail	Poor				Fair	Good	Good	
	41							Fair		Good	Good
	42								Fair	Good	
Hairy vetch (Vicia villosa)	1940	Poor	Fail	Poor				Fair	Fair	Fair	
	41							Fair			
	42								Fair	Good	Fair
Mung bean (Phaseolus aureus)	1940	Poor				Failure*			Failure*		
	41										
	42								Poor	Fair	

* Eaten by rabbits

** Poor stand

On plots 1, 2, 3 and 4, in dense stands of young shortleaf and loblolly pine, planted quail foods produced so poorly that the plots were discontinued after the second year. Only sericea lespedeza made enough seed to justify its planting. Plot 5 in longleaf was a poor producer except that during one year partridge pea did well. It was not continued after the second year. Plot 6 was only slightly better but it was located adjacent to the home of the man responsible for the work so it was continued. In plot 7, sericea lespedeza, kobe lespedeza, sesbania and partridge pea made at least one good crop during the three years they were planted. Partridge pea, resulting from new planting and volunteer plants from the previous crop, covered most of plot 8 in 1942. The stand averaged approximately six feet in height and produced an excellent crop of seed. Plots 9 and 10 supported less trees and, therefore, produced higher yields of quail foods. Only the grain sorghums failed throughout the whole study. On plot 10, a crop of Augusta vetch interplanted with sesbania was especially striking. In the fall, the vetch seed were sown between the rows of sesbania which had grown to an average height of about six feet and bore a good crop of seed. (See Fig. 24.) During the winter and early spring the Augusta vetch supported by the sesbania covered the area completely and reached a height of approximately five feet.

Fig. 24. Sesbania growing in an opening in a selectively cut stand.

Winter Food Strips

Most of the supplementary food produced in the plots matured in the fall when food was most plentiful due to the seed production of wild and cultivated plants. The need for food is probably greater in the spring as few plants produce seed at that time. To determine the possibilities of spring seed production, several winter growing species were planted on a strip five feet wide and twenty chains (1320 feet) long which extended the length of a field planted to Austrian winter pea. The different species were arranged as follows: - Willamette vetch (Vicia spp.) - two chains, Augusta vetch - three chains, winter pea - hairy vetch mixture - three chains, winter pea (Caley pea from Alabama) - three chains, hairy vetch - three chains and Austrian winter pea (Pisum sativum var. arvense) - three chains.

An excellent stand of each was secured and early growth was satisfactory. On December 22, hairy vetch had produced the greatest amount of foliage, followed by the others in this order: - Willamette, Augusta, mixed hairy vetch and winter pea, Austrian winter pea and winter pea. Following this, flood waters from a small creek covered the area three times within a short period.

The Austrian winter pea on the strip and on the entire field disappeared, leaving hardly a trace of their former presence. The Willamette vetch was damaged but partially recovered.

All species left on April 28 were growing well, with winter pea more erect and taller than the others, while Augusta vetch had already set a good crop of seed. A final check indicated that the winter pea produced the most food, with a stand that was about 2-1/2 feet high and almost completely covered with seed. Augusta vetch was the most productive vetch followed by hairy vetch. Willamette vetch produced a fair yield but probably not over 10-15% as much as the winter pea. The production on the other field plot was similar to that of plots in the Silcox Forest.

From these experiments, it may be concluded that the production of quail food in dense stands of timber is not feasible, however in the more open forest stands, the food plots produced satisfactorily. If the forest habitat is to maintain a quail population, from which an annual harvest can be taken, suitable cover conditions are as important as food. When cover is satisfactory, but food is scarce, the expenses of maintaining food plots or strips appear to be justified. The cost of establishing unfenced plots

will be low but where fencing is necessary to protect the food plants from livestock, an additional expenditure will be required.

Food species should be chosen so that some would mature seed in the fall, while others would produce seed in the spring. For fall seed production, sesbania and partridge pea are recommended, while wild winter peas and Augusta vetch are recommended for spring seed production. For best results, a complete fertilizer should be used when the first planting is made and applications of phosporous and potassium should be applied yearly thereafter. After the fruit crop, successive stands can be re-established by disking the soil at the proper time. Bicolor lespedeza,a perennial, which is growing in favor for quail food, can be planted. It should be cultivated and fertilized annually also.

Forest - Quail Relationships

As previously pointed out, the purpose of this phase of the investigation was to determine the influence of various forest management techniques on quail populations. A comprehensive study of quail has been made previously by Stoddard (27)

in the Southeastern part of the United States. The results make available much fundamental information, but quail production was his primary objective, whereas in this study the objective is multiple production of forest products. It is recognized that wood will probably always be the chief product and wildlife must be secondary. Stoddard (27) found that both woody and herbaceous vegetation in the forest must be regulated if a shootable population of quail is to be produced, and that fire provides the least expensive and most effective means by which this can be accomplished. Alternatives, such as brush cutting and cultivation, are too expensive.

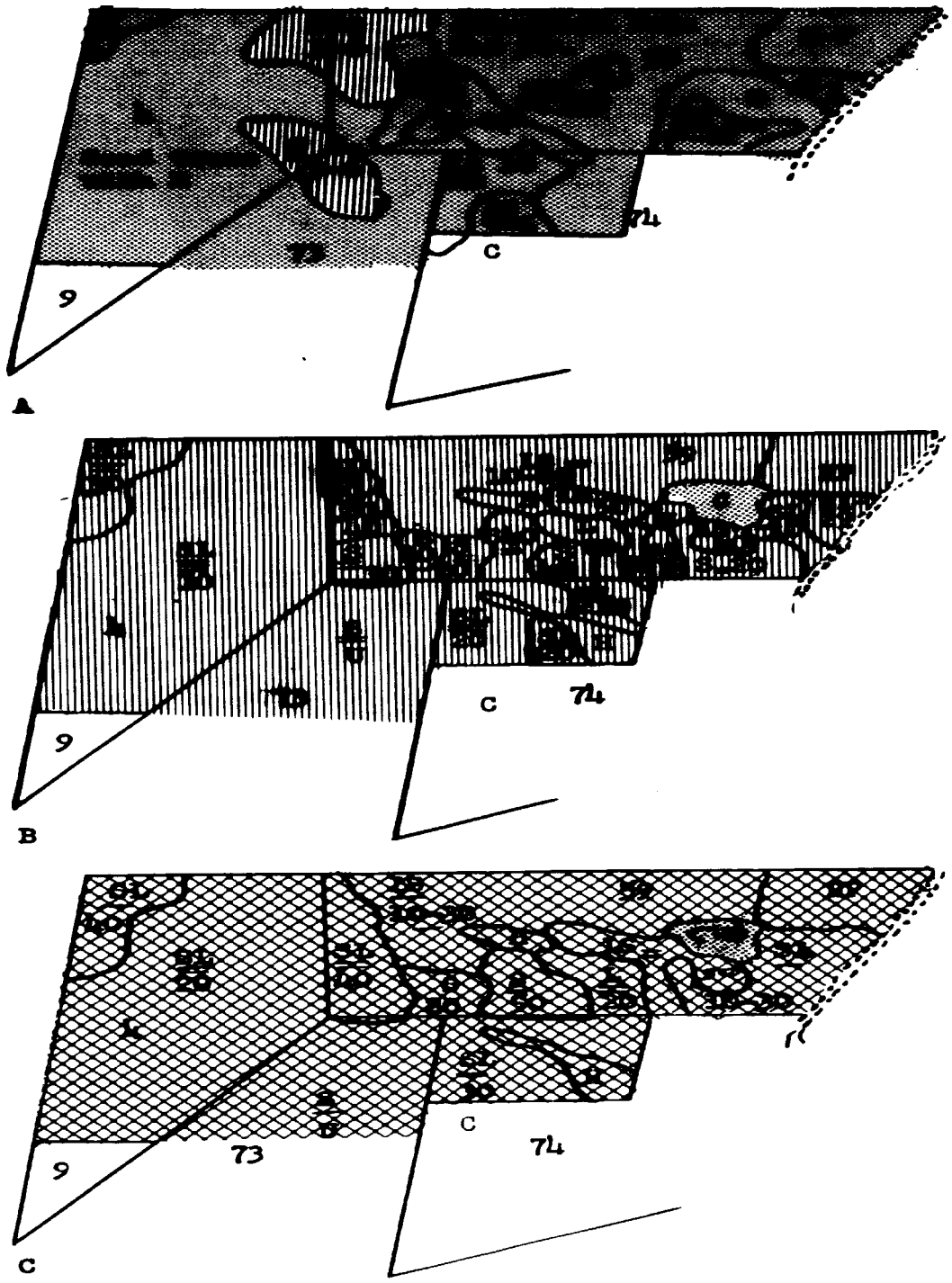
In the past, southern forests supported greater quail populations than they do today. This decrease is in part due to change in habitat conditions. Formerly, the forest was composed of rather open-grown virgin trees through which fire burned periodically, thus creating a condition similar to that advocated by Stoddard (27) for quail production. Following the cutting of the virgin timber, one of two conditions prevail over most of the southern pine forests, neither of which favor quail. First, with adequate fire protection grass, brush and hardwood trees have crowded out the seed bearing forbs. And, secondly, extensive cut-

over lands have been burned so frequently that growth of sufficient cover to hold quail has been prevented. In addition there has been a great increase in the hunting pressure in recent years.

The history of an area in northwest St. Helena Parish will be described to illustrate the changes that occur when a productive quail habitat is put under forest management with complete fire protection. This land was mapped by the writer in 1926, and again in 1933. A third map of the same area has been prepared from an air photograph, and all three are reproduced in Fig. 25. A comparison of these maps shows clearly the rapid rate at which quail habitat may be lost. Before 1924 the land had either been in cultivation or had been used as a woodland pasture on which annual or, at least, frequent fires had kept down the undergrowth. Residents of that neighborhood assert that cattle could easily be seen for a distance of one-half mile when looking across the area. Fifteen years later cattle were often well hidden when only one hundred feet away.

For a few years, following the change in land use from cattle production to forest production described above, between twelve and fifteen coveys of quail found a plentiful supply of legumes and other food on the land. In 1930, prior to the be-

FIG. 25. Maps showing same area: A - Mapped, 1926; B - Mapped 1933; C - Drawn from air map made in 1933



LEGEND:

Suitable Quail Habitat. Grass, brush, and reproduction thin and small.

Poor quail habitat. Brush and reproduction medium dense to dense.

Abandoned quail habitat. Brush and reproduction dense.

GENERAL:
L - Loblolly pine
S - Shortleaf pine
R - Pine reproduction
H - Hardwood
C - Cultivated

Map A
Stocking
- Good
= Medium
≡ Poor
Sizes, classes, (inches)
0-3, 3-6, 6-9

Map B and C
Density
No line -75-100%
- 51-75%
= 26-50%
≡ 0-25%
Ages-10 yr. grps.
10 = 6-15
20 = 16-25

FIG. 25. Maps showing same area: A - Mapped, 1926; B - Mapped 1934; C - Drawn from air map made in 1940.

ginning of this study, the owners established eight food plots, each of which was in the range of one or more coveys of quail. In the meantime, fire protection had become more efficient, less of the land burned, and brush became more dense. Following the change in cover conditions fox moved in and increased rapdily, as evidenced by the fact that hunters made it their principal hunting ground. On the other hand, quail hunters, in spite of the food plots, found it less and less productive as the years went by.

In 1940, one day was spent on the area with three bird dogs in order to determine the status of quail at that time. Not a single quail was found although one covey had previously been reported in the vicinity. The quail population there had almost completely disappeared. Although other factors may also have been involved in the change in population, it undoubtedly was due in most part to the change in habitat. In 1940, very little quail food was present, whereas there was an abundance of heavy grass, thick brush and deep straw, all of which are unfavorable for quail (27).

These unfavorable conditions are the direct result of fire protection. It must be remembered, however, that it is impossible to establish a shortleaf-loblolly pine forest without fire protection. Thus at certain times in a forest rotation, conflict between wildlife and timber values is inevitable. Elsewhere in this dissertation, the

use of fire in longleaf pine and in older shortleaf-loblolly pine forest is discussed fully. However, it seems appropriate to mention at this point that in the establishment of longleaf, fire (33) is essential during the early stages of development, whereas it may also be advantageous to the other pines later in the rotation.

The forest land owner, who is growing timber for profit, may be able to produce a shootable population of quail on his land, especially on longleaf sites by certain practices not destructive to the forest. However, he cannot turn to quail production as a major crop and reduce timber to secondary importance. Under good quail management, with timber considered secondary, the population on some forested areas may reach one quail on from three to five acres, and one quail might be harvested from each six to ten acres. Under average conditions, the managed forest should produce on the same area of six to ten acres from 2,000 to 3,000 bd. ft. per year.

From the standpoint of the public good, no great reduction in the production of timber can be justified so that quail may be produced. One quail in the bag will hardly balance the scales when placed opposite the employment and monetary return produced by the manufacture and utilization of from 2,000 to 3,000 bd. ft. of lumber. Therefore, the forest owner interested in a monetary return and the public interested in its own welfare cannot afford to

destroy timber production on any sizable area in order to produce quail. Nevertheless, by wise use of fire as a silvicultural tool both timber and quail may be benefitted in pine types, and a shootable population of quail may be maintained during a considerable part of the tree rotation.

RABBIT, TURKEY, FUR BEARERS AND PREDATORS

Within the forests of Louisiana, rabbit, turkey, several species of fur bearers and a few destructive predators make their homes. No special projects were organized to study these species, but because they are important components of the forest wildlife they have been studied incidentally during the past twenty years. These observations supplemented by other available information are summarized briefly in the following pages.

Rabbit

Although the cottontail rabbit (Sylvilagus floridanus) (19) is classified as a farm game, the cutover pine areas of the Florida Parishes have also supported heavy populations of this animal. On cutover longleaf pine land in Washington Parish in the late 1920's, commercial hunters, using headlights, killed twenty to thirty rabbits nightly. Following late afternoon showers

in that locality, where the rabbits are moving about, one or more rabbits would almost always be within view from an automobile driven along the road.

In the Florida Parishes, rabbits seldom eat woody vegetation. The only noticeable damage to the forest occurred when rabbits cut down newly planted pine seedlings. On one permanent check plot in a shortleaf pine plantation, nearly seventy-five per cent of the seedlings were cut off about one inch above the ground, however shortleaf-loblolly and slash pines all sprouted immediately after being cut so that the actual mortality was low.

Under normal conditions, there is enough green vegetation, even in winter, to supply most of the food required by rabbits. Winter cover crops of oats, rye grass and legumes are being grown in ever increasing quantities, therefore, the available winter food for rabbits is on the increase. Sweet potatoes are often available and the winter vegetable garden adds another source of food. In fact, most complaints of rabbit damage come from gardeners.

In addition to the cottontail, the swamp rabbit (Sylvilagus aquaticus) is native and inhabits the forest bottomlands. This species is much less common than it was twenty or twenty-five years ago.

Forest cutting practices that create openings and allow the growth of herbaceous vegetation are beneficial to the forest habitat of both species of rabbits.

Turkey

Within certain forests of Washington, St. Tammany, Tangipahoa, Livingston and St. Helena Parishes turkeys occur in considerable numbers. The habitats supporting the largest populations combine both hardwood and pine types; oak, beech, magnolia, dogwood, black gum and red gum with shortleaf, loblolly, slash and spruce pine are the principal trees.

Turkeys have survived in the face of continued illegal hunting pressure. In fact, nothing can better testify to the hardiness and resourcefulness of this bird than the fact that it has survived in the face of such obstacles. Reports in 1948 indicate that the fall population is greater than usual. There is little doubt that the turkey would multiply very rapidly in this section if it were given adequate protection from hunters.

The forest lands throughout the turkey range are well protected from fire and in addition the mature timber is being harvested by selective cutting. The forest practices at this

time are in accord with the recommendation (21) for turkey habitats.

Fur Bearing Animals

Louisiana's millions of pelts annually make her the leading fur-producing area of the continent. Most of these are muskrat (Ondatra zibethicus), and their production is not directly influenced by forest. In addition, some of the raccoon and mink are also produced in the marsh areas. Table 10 shows the annual production of fur animals which ordinarily depend on the forest, in part, or in full for a livable habitat.

These figures may not reflect present populations for several reasons. First, the pelts of these animals, with the exception of mink (Mustela vison) have been comparatively cheap recently; second, high employment and lack of labor for farms have reduced trapping; third, night hunting for opossum (Didelphis virginianus) and raccoon (Procyon lotor)as a form of recreation has decreased within the last few years; and last, many hunters are interested only in the sport or food furnished by the animal so they do not save the pelt. Reports of unprecedented high raccoon populations are especially common. Other fur bearing animals of Louisiana include the bobcat (Lynx rufus), gray fox

(Urocyon cinereoargenteus), red fox (Vulpes fulva), otter (Lutra canadensis), skunk (Mephitis mephitis), and wolf (Canis niger). All of these species may be destructive to other valuable wildlife at times. Except for local situations, excess numbers should be removed during the regular trapping season.

Table 10 gives the annual harvest of fur bearing animals of Louisiana that use a forest habitat, at least in part. The average take for the last nine years was 399,838. On a basis of 16,000,000 acres of forest land, this represents a production of one fur bearing animal on each forty acres. If, to the forest land is added seven million acres of non-forested farm land, the production would be one fur bearing animal harvested from each fifty-seven acres.

In the 1920's probably the only beavers (Castor canadensis) in Louisiana were on Amite River along the northwest boundary of St. Helena Parish. Those few beavers were protected by local landowners and their number increased until today there are beavers in at least six parishes of Louisiana. As the Amite River flows into the state of Mississippi, beavers have spread over considerable territory there.

Neither the feeding on forest trees nor flooding resulting from dams has caused extensive damage. Back water from

Table 10 Pelts Recorded by the Louisiana Department of Conservation and the Louisiana Department of Wildlife and Fisheries *

Year	Species						Total
	Mink	Opossum	Otter	Raccoon	Skunk	Miscel. **	
1914-15	112,000	180,000	2,750	420,000	25,500	2,000	743,250
1919-20	98,700	224,100	1,680	252,800	13,300	2,365	592,245
1924-25	84,201	287,180	2,110	145,810	14,752	947	535,000
1929-30	69,680	309,363	1,447	105,381	27,034	1,817	514,722
1934-35	80,364	126,000	789	83,467	47,955	2,415	340,990
1939-40	85,391	45,561	1,273	71,419	4,655	1,379	207,678
1940-41	113,245	95,027	1,726	162,853	13,779	4,271	390,901
1941-42	151,766	108,609	1,740	166,738	17,746	4,505	451,104
1942-43	128,226	78,664	1,411	164,109	17,340	3,963	393,713
1943-44	144,719	91,724	2,404	208,921	28,052	11,027	486,845
1944-45	132,821	66,000	1,912	176,911	11,155	6,740	395,539
1945-46	168,598	90,433	2,367	244,502	12,224	5,290	523,413
1946-47	153,027	77,264	2,832	186,750	4,830	3,081	427,784
1947-48	153,120	31,744	5,078	126,933	1,415	3,277	321,567

* Taken from bi-annual reports of Louisiana Department of Conservation and the Louisiana Department of Wildlife and Fisheries.

** Includes bobcat, fox and wolves.

dams is held within rather steep creek banks, and only an occasional red gum or spruce pine of saw log size is damaged by feeding. Willow heads a long list of woody and herbaceous plants used by the beaver. Corn is a favorite food and fields along inhabited creeks are often heavily damaged. Beaver have not been trapped legally in Louisiana for a long time.

Predators

Men, experienced in wildlife management (19), usually agree that proper food and cover are far more important than predator control in establishing and maintaining productive game populations, since the predator is apt to be far more destructive when cover is inadequate or food scarce. Men deeply interested in wildlife management but untrained in its practices are apt to overestimate the benefits of predator control programs. Then, too, a given animal may be considered a predator by one person and a favorite game animal by another. Also, predators may be beneficial as well as harmful. Those that feed largely on rats and mice, like barn owls, deserve protection, whereas those that destroy large numbers of desirable animals may at times require control.

Since 1940, foxes have increased in Louisiana to such an extent that public sentiment demanded some form of control. A brief

questionnaire was sent to selected county agents early in 1948, requesting specific information on fox. Information received indicates that fox populations reached a peak in the hill parishes of the state between 1942 and 1946, most commonly in 1944. Large numbers of domestic animals and a few people were reported bitten by foxes that were thought to be rabid, and as a result, a bounty was offered in several parishes and several hundred foxes were destroyed. Many fox heads were sent to the State Board of Health for rabies checks and about three-fourths were reported positive. Most reports indicate that at present fox populations are low in general; however, extremes ranging from almost complete absence of any evidence of fox to a very high population indicate that the population is not uniform.

Many residents of areas containing high populations of foxes believe that the present low populations of quail and rabbit are caused, in part, at least, by fox predation. In order to check reported fox predation, an examination was made of animal remains near a series of fox dens dug in the side of a sandy creek bank. Chicken feathers and squirrel skulls were scattered in front of each den, however, Errington (10) reports that foxes will carry carrion, including chickens, to their dens. No remains of rabbit

or quail were observed. As the forest along the creek was an excellent squirrel habitat, these animals were evidently the most available prey.

Although the forests of Louisiana support a widespread population of bobcats, wolves and an occasional cougar (Felis concolor), specific information is not sufficient to justify discussing them here. Feathered predators like sharp-shinned hawks (Accipiter striatus), Cooper's hawks (Accipiter cooperii) and great horned owls (Bubo virginianus) are enemies of game animals, but a discussion of them must be omitted for lack of definite information.

FIRE - ITS RELATION TO FOREST AND WILDLIFE

The pines of the South are a temporary stage in the ecological succession of the forest. Wahlenberg (33) has pointed out this fact concerning longleaf while Chapman (9) and Pierson (23) refer to a similar trend in shortleaf-loblolly stands. Hardwoods tend to take over the site as pine declines. Heavy cutting of pine and the leaving of hardwood in mixed pine-hardwood forest has accelerated this change.

Fire (33) has evidently burned in the southern pine forest

since before the coming of the Indians. Since man has inhabited the region, fire has recurred regularly, probably every two to five years. These statements (33) referred to longleaf but similar conditions undoubtedly existed in the shortleaf-loblolly forest. At least two conditions point to this fact. First, the forests of the past were more open then they are today after protection has been organized and, second, the high percentage of pine in the pine-hardwood forest indicates that succession has been arrested or, at least, slowed down for a long time.

The best agent (33) available to arrest ecological changes is fire. The reaction of different southern pines to fire may vary but small hardwoods on all pine sites may be controlled by its use.

The effect of fire on the forest directly and on wildlife indirectly is so important and far reaching that experimental burning has been resorted to at different times and places, in order to better understand these influences. In connection with these studies, two areas, each containing two acres were burned. One was in a fully stocked stand of old-field loblolly pine 25 years of age. The other was in a moderately stocked stand of old-field loblolly 10 to 12 years of age. Each plot was on a hillside with the fastest hardwood sprout growth occurring at the foot of the hill where the soil held more moisture.

In 1940, the first year of the experiment, each plot was subdivided into four one-half acre units. When first burned, each 1/2 acre was fired at different times; namely 2, 4, 5 and 8 P.M. of the same day. But the resulting burns showed such a small variation that, in the following years, each of the two acre plots was burned at the same time during the afternoon. Burning was done in late February or early March.

In the plot with the older trees, all hardwoods under two inches d.b.h. were killed by the first fire. Each year sprouts would reach a height of from 2 to 4 feet depending on their location on the plot but were killed back by the burning in 1942 and 1943. The spring burn of 1943 was the last until March 25, 1946. During that period, the maximum heights reached by various species were as follows: red gum - 8 feet, sumac - 6 feet, waxmyrtle - 5 feet, red oak and elm - 5 feet, French mulberry and dogwood - 4 feet. The burn was made following a twelve day dry period and the fire burned down hill into a slight breeze. Much of the partially decomposed litter was not burned.

When examined on March 29, four days later, the largest red gums were alive. The tops were green and apparently growing. However on April 13 all sprouts, including even the larger gums, were dead;

thus, the rather slow fire had killed all sprouts after three year's growth.

Grass was rather thin on both the dense plot and on the surrounding unburned area. Each summer following the fire, a check was made of seed-bearing forbs on each area. On the burned area, partridge pea, beggarweed and butterfly pea were more abundant than on adjacent lands, although the seed crop was never heavy because of the shade.

Before the first burn, the second plot that was characterized by more open young timber bore a heavy cover of native woods grass, averaging about 18 inches in height. In addition, there was a heavy accumulation of old dead grass which added greatly to the combustible material on the land. The fire was much hotter than that on the other plot, yet the only pines killed were overtopped trees or those infested with Cronartium fusiforme. (Hedge and Hunt)

Following the fire there was a noticeable increase of beggarweed, bush lespedeza (Lespedeza spp.) and partridge pea. Seed production on these plants was good. In late summer of the year following the burn, the grass, from a distance, looked

similar to that on the unburned area. A closer examination, however, disclosed a marked difference; on the burned plot it grew in bunches with much open, clean ground between, whereas on surrounding unburned land a heavy layer of dead grass covered all space between bunches.

From this study certain conclusions may be drawn concerning the effects of light surface fire: - First, hardwood brush was killed except those stems that had had from 4 to 6 years, depending on the species, to become established under complete protection. Second, excess litter was removed, thereby greatly reducing the danger from possible spring or summer fires. Third, enough unburned, partly decomposed litter was left so that erosion or other loss of soil did not occur on the hillsides. Fourth, conditions were produced that favored legumes and other seed-bearing forbs, and these plants became more plentiful on the burned than on unburned lands. And fifth, quail and other birds of similar habits could feed in the more open vegetation resulting from the use of fire, while this would be difficult or impossible in the unburned portions. (See Fig. 26 and 27.)

The problem of fire in southern forests has been a controversial subject since forest protection was inaugurated. Greene (17) and Stoddard were criticized for advocating burning practices in

Fig. 26. Experimental burning area, showing portion of burned plot in foreground and left, unburned to right.

Fig. 27. One year old sprout growth on burned plot.

longleaf pine that are now recommended by both state and federal agencies. In the early days of forestry awakening, some thirty years ago, fire (12) was considered to be the red demon that was largely if not wholly responsible for most forestry ills.

Research as well as general observations finally convinced foresters and landowners that longleaf was, as Greene (14) put it, "The Forest that Fire Made." Fire (33) is essential in longleaf management, first to remove competing vegetation so that seedlings may become established and second, to control brown spot needle disease Scirrhia acicola (Learn) until height growth has begun. Under certain conditions fire is needed to control hardwood brush and keep it from taking over the site. (8) (23) The use of fire in longleaf is so universally accepted that it is not necessary to discuss it here. Wahlenberg's "Longleaf Pine" (33) covers the subject adequately. It should be noted in passing that the recommendations for burning in longleaf for its perpetuation are very similar to the burning program outlined by Stoddard (31) for quail production.

The controversy on burning subsided somewhat when most foresters and landowners came to believe that fire could be used advantageously in growing longleaf pine, but it arose again when

Chapman (8) proposed using fire in shortleaf-loblolly pine stands. Many workers argued that fire had no place in these types. But with the protection of shortleaf-loblolly and slash pine stands two new hazards arose. Almost complete destruction to evenaged sawtimber stands resulted from fires, especially those that occurred in spring and summer on areas that had had complete protection for many years.

Such a fire in merchantable sawtimber located in West Central Louisiana occurred during the summer of 1947. A careful inspection of the burn was made by the writer some three weeks after the fire. Trees were being cut and these were examined by removing the bark along the burned side. On the older, thin-barked shortleaf pine, the cambium was black up to a height of between twenty and thirty feet, while it was not injured on the loblolly which had a thicker bark. A severe attack of bark bettles followed the fire and these two conditions combined killed most of the trees of both species.

In shortleaf-loblolly types that were protected completely from fire for many years, hardwood species (20), almost worthless when grown on typical pine sites, were threatening to take over the

land. This trend was hastened on many farms throughout Louisiana during the war years when pines were removed from mixed pine-hardwood stands, while only an occasional hardwood could be sold. The result was extensive conversion of pine to hardwood types, and some foresters began to study the use of fire control of these undesirable species.

Chapman (9) suggested a method of securing shortleaf-loblolly reproduction in which fire is a major agent. But his ideas are not accepted unanimously and there are those (7) who contend that fire has no or only a limited place in the silvicultural treatment of shortleaf and loblolly pine. Those foresters and forest owners who oppose the use of fire in shortleaf-loblolly forests do so for one or more reasons. Many of them are convinced that the damage done by fire is greater than any good that might be derived. Also because they know the tremendous danger of fire improperly used. They fear the public effect of advocating the use of fire especially after so many years of preaching against it. They would rather forego the possible benefits than risk an even greater loss that might result if the general public should revert to the old custom of promiscuous burning.

Some will admit that fire, in the hands of trained men, might be used to protect and maintain forest stands, yet they feel

that the cost of the necessary supervision would be greater than would be justified. Where a market for small-sized low quality hardwood is present, then hardwood overtopping pine may be removed at a reasonable cost, obviously a desirable practice when economically feasible.

Research has now demonstrated conclusively that some of the old concepts regarding fire must be revised. Studies have shown that the mineral content (16) of longleaf pine soils in the South is improved by fire, although the physical conditions may not be as good. Growth (33) is not affected by fire if the trees do not lose foliage as a result of the fire. Early spring grazing (15) is improved by fire although all-year grazing seems to be better in winter on unburned areas. And finally, fire (27) properly used can be made to improve the game habitat rather than destroy the game.

Today the South is producing great quantities of wood. True, this production falls far short of the total productive capacity of the forest, but it must be remembered that the virgin forests are gone. The trees being cut are second growth. And furthermore, nearly all of the sawtimber production of the South today is cut from trees that became established and grew without any organized fire protection.

For a time foresters seemed to assume that all southern pines would be managed on some sort of a selective cutting system. But rather early it was found that longleaf (33) was difficult to handle under this silvicultural system. Later the threat of hardwood invasion (8) in the shortleaf-loblolly type cast a shadow on the use of a strict tree selection in that type. For the small owner, who desires annual or periodic income from his forest land, the selection system offers many advantages, because he is usually in a better position to do intensive management than many large timber owners.

In an area where forestry has not been practiced long enough to grow and harvest one crop of pulpwood, much less a sawtimber crop, changes must be expected. The work done in forestry has not been lost but changes must be made to take advantage of new information. Therefore, it appears that southern pine may best be managed as evenaged stands (9) (33) with regeneration obtained by leaving seed trees or some other means of providing a supply of seed. Reproduction then would be a problem only once in each 40 to 60 years, and fire could be used to control brush and hardwoods without endangering the timber crop after it had been established. The first burn after reproduction has been secured would offer a

problem, but once the accumulated fuel had been removed, a fire once each 2 to 5 years, based on site conditions, would control the hardwood, prevent the destructive fires in older stands, make logging cheaper and easier and help keep the forest in pine.

A forest program that seeks to keep pine on pine stands does not eliminate wildlife. Instead, if the forester is willing to make a few concessions, the lands handled as suggested above will produce more rather than less wildlife, provided there is adequate interspersing of different age classes of other types within the pine type. The many stream bottoms should, therefore, be left in hardwoods and protected from fire. The control of hardwood brush does not necessitate the eradication of hardwoods from the pine stands. From the beginning, a large proportion of southern forests were in the shortleaf-loblolly-hardwood type. The purpose of management need not be to destroy this relationship but rather to maintain it in its proper balance.

With a program of brush control and pine thinnings, such areas would support a shootable population of quail and turkey. Sprout growth would offer a steady supply of browse for deer. Squirrels would find food and homes in the hardwood stream bottoms and in the pine-hardwood type where hardwoods were held in check but

not eradicated.

Lest the wrong impression result from the above discussion, it should be emphasized that the results would be fatal to the forest program of the South, if the state and federal fire protection systems were not maintained and even strengthened. Fire is a valuable tool in the hands of the trained forester, but can be a serious menace in the hands of the careless or uninformed. Therefore, it might be well if the average man on the soil were told the facts about fire. Through proper education, the vast majority of rural people could be taught to use fire properly in their forests. The truth should not be feared as much as the inconsistency evident in some localities where on the one hand the tremendous damage that can result from fire is being preached, while at the same time the inhabitants see controlled burning practiced on the national forest to secure reproduction or control brown spot. There seems to be no reason for expecting responsible men to start setting the forests on fire thoughtlessly because they were told that under certain conditions it benefitted the forest, anymore than one would expect the man who is already in the habit of setting fire to the woods to change his habits.

EFFECT OF CUTTING METHODS ON WILDLIFE

The ideal forest for sustained yield management (20) is one that has areas of equal productivity in successive age groups. In southern pine forests, these age groups would be determined by the cutting cycle which may be as short as five years or as long as fifteen years. There is much difference of opinion among foresters concerning the relative desirability of various silvicultural systems. When the silvicultural system is based on single tree selection, each acre would be partially cut in each cutting cycle. Successful shortleaf or loblolly pine reproduction can be secured where the openings in the overhead canopy are as small as 0.004 acre according to Wahlenberg. (34). Although the exact influence of such small openings on herbaceous and woody vegetation, suitable for wildlife food and cover, is not definitely known, it is doubtful if vegetation other than some hardwood sprouts would be able to grow and produce seed under such conditions. This would not be desirable for wildlife and a selection forest resulting from such treatment would be almost devoid of valuable animals.

On the other hand, if the silvicultural system was followed that called for clear cutting in groups or strips,

herbaceous vegetation would be able to grow and produce seed at least a limited time. Deer browse would be more plentiful and more vigorous, yet competition with pine should be no greater. Wahlenberg (34) states that pine seedlings in the small openings reached an average height of only 2.48 feet in five years, yet survived, while seedlings in larger openings reached an average height of 5.08 feet. As pine is less tolerant and faster growing than most of the hardwoods, with which it is associated, it seems that the tall pine in the large openings have at least as good a chance of escaping domination by hardwoods as does the smaller pine in the small openings. Group or strip cuttings, therefore, seem to have marked advantages over individual tree selection both for timber and wildlife production. The groups would grow up as evenaged stands. They need not be large to be practical. In the South, where logging is by truck and all pine land is easily accessible, small volumes can be logged without additional cost (25) because the cost of roads and other improvements would not differ appreciably from that required in single tree selection.

Forest management set up on this basis would create and maintain a habitat entirely suitable for forest game. If a few concessions were made for the benefit of wildlife such as

leaving food producing and nesting trees, then wildlife management could be integrated with the forest management and game species produced with almost no decrease in the forest crop. In fact, good forest and game management can be combined so as to increase the production of each above the yields now obtained, especially where suitable cutting practices are combined with intelligent use of fire as discussed previously.

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APPENDIX I

COMMON AND SCIENTIFIC NAMES OF PLANTS

Trees and Shrubs

Alder - Alnus rugosa (Du Roi) Spreng.

Arrow-wood - Viburnum dentatum L.

Ash - Fraxinus spp.

Ash, prickly - Xanthoxylum clava - herculis L.

Azalea, wild - Rhododendron canescens Sweet.

Beech - Fagus grandifolia Ehrh.

Birch - Betula nigra L.

Blackhaw - Viburnum rufidulum Raf.

Buttonbush - Cephalanthus occidentalis L.

Buckeye - Aesculus pavia L.

Catalpa - Catalpa bignonioides Walt.

Cedar - Juniperus virginiana L.

Cherry, black - Prunus serotina Ehrh.

Chinatree - Melia azedarach L.

Chinquapin - Castanea pumila Mill.

Cottonwood - Populus deltoides Bartr.

Crab apple - Malus spp.

Crapemyrtle - Lagerstroemia idica L.

Cypress, bald - Taxodium distichum Rich.

Dogwood, flowering - Cornus florida L.

Dogwood, roughleaf - Cornus asperifolia Michx.

Elderberry - Sambucus canadensis L.

Elm - Ulmus spp.

Fringetree - Chionanthus virginicus L.

Gallberry - Ilex glabra (L.) Gray.

Gum, black - Nyssa sylvatica Marsh.

Gum, red - Liquidambar styraciflua L.

Gum, tupelo - Nyssa aquatica L.

Hackberry - Celtis laevigata Willd.

Haw - Crataegus spp.

Hickory - Carya spp.

Holly, American - Ilex opaca Ait.

Holly, deciduous - Ilex decidua Walt.

Holly, shinyleaf - Ilex lucida (Ait.) T. & G.

Hornbeam - Carpinus caroliniana Walt.

Hophornbeam - Ostrya virginiana (Mill.) Koch.

Huckleberry, ground - Gaylussacia dumosa (Andr.) T. & G.

Huckleberry, summer - Gaylussacia spp.

Huckleberry, winter - Vaccinium arboreum Marsh.

Linden - Tilia americana L.

Locust, honey - Gleditsia triacanthos L.

Magnolia, American - Magnolia grandiflora L.

Maple, red - Acer rubrum L.

Mayhaw - Crataegus opaca Hook. and Arn.

Mimosa - Albizzia julibrissin Durazz.

Mulberry, French - Callicarpa americana L.

Mulberry, red - Morus rubra L.

Oak, blackjack - Quercus marilandica Muenchh.

Oak, bottomland red - Quercus nuttallii Palmer.

Oak, cherrybark - Quercus pagoda Raf.

Oak, cow - Quercus prinus L.

Oak, live - Quercus virginiana Mill.

Oak, overcup - Quercus lyrata Walt.

Oak, southern red - Quercus falcata Michx.

Oak, water - Quercus nigra L.

Oak, white - Quercus alba L.

Oak, willow - Quercus phellos L.

Osage-orange - Maclura pomifera Schneid.

Papaw - Asimina triloba (L.) Dunal.

Pecan, sweet - Carya pecan Engl. & Graebn.

Pecan, bitter - Carya aquatica (Michx. f.) Nutt.

Persimmon - Diospyros virginiana L.

Pine, loblolly - Pinus taeda L.

Pine, longleaf - Pinus palustris Mill.

Pine, shortleaf - Pinus echinata Mill.

Pine, slash - Pinus caribaea Morelet.

Pine, spruce - Pinus glabra Walt.

Plum - Prunus spp.

Poplar, yellow - Liriodendron tulipifera L.

Redbud - Cercis canadensis L.

Sassafras - Sassafras albidum (Nutt.) Nees.

Serviceberry - Amelanchier canadensis (L.) Med.

Silverbell - Halesia diptera Ellis.

Sloe - Prunus umbellata Ell.

Sourwood - Oxydendrum arboreum (L.) DC.

Stinkbush - Illicium floridanum Ellis.

Sumac, dwarf - Rhus copallina L.

Sweetbay - Magnolia virginiana L.

Sweetleaf - Symplocos tinctoria (Garden) L'Her.

Sycamore - Platanus occidentalis L.

Titi - Cyrilla racemiflora L.

Tung - Aleurites fordii Hemsl.

Waxmyrtle - Myrica cerifera L.

Willow - Salix nigra Marsh.

Yaupon - Ilex vomitoria Ait.

Witch-hazel - Hamamelis virginiana L.

Non-woody Vegetation

Beggarweed - Meibomia spp.

Beggarweed, Florida - Meibomia purpurea (Mill.) Vail.

Blackberry - Rubus spp.

Cherokee rose - Rosa laevigata Michx.

Clover, Mexican - Richardia scabra St. Hil.

Cocklebur - Xanthium spp.

Dewberry - Rubus spp.

Fern, bracken - Pteridium aquilinum (L.) Kuhn

Grape, wild - Vitis spp.

Honeysuckle, Japanese - Lonicera japonica (Thumb.)

Lespedeza, bush - Lespedeza spp.

Muscadine - Vitis spp.

Partridge pea - Chamaecrista spp.

Poor-joe - Diodia teres Walt.

Ragweed, small - Ambrosia elatios L.

Rattan vine - Berchemia scandens (Hill) Trelease

Sesbania - Sesbania spp.

Smilax - Smilax spp.

St. John's-worth - Hypericum densiflorum Pursh.

Switch cane - Arundinaria tecta (Walt.) Muhl.

Tea weed - Sida spp.

Tie vine - Thyella tamnifolia (L.) Raf.

Yankee weed - Eupatorium capillifolium (Lam.) Small.

Yellow jessamine - Gelsemium sempervirens (L.) Ait.

Field and Pasture Crops

Bene - Sesamum indicum L.

Buckwheat - Fagopyrum fagopyrum (1.) Karst.

Corn - Zea mays L.

Egyptian wheat - Sorghum roxburghii Stapf.

Lespedeza, common - Lespedeza striata (Thumb) H. & A.

Lespedeza, sericea - Lespedeza sericea (Thumb.) Benth.

Millet, browntop - Panicum adspersum Trin.

Millet, German - Chaetochloa italica

Mungbean - Phaseolus aureus Roxbg.

Pea, Austrian winter - Fisiumsatirum var. arvense Poir.

Pea, wild winter - Lathyrus hirsutus L.

Potato, sweet - Ipomoea batatas Lam.

Redtop cane - Sorghum Spp.

Soybean - Soja max (L.) Piper

Vetch, Augusta - Vicia angustifolia Reich.

Vetch, Hairy - Vicia villosa Roth.

APPENDIX II

COMMON AND SCIENTIFIC NAMES OF ANIMALS

Mammals

Beaver - Castor canadensis Kuhl

Bobcat - Lynx rufus Schreber

Cougar - Felis concolor True

Deer, white tail - Odocoileus virginianus Boddaert

Fox, gray - Urocyon cinereoargenteus Schreber

Fox, red - Vulpes fulva Desmarest

Mink - Mustela vison Schreber

Muskrat - Ondatra zibethicus Linnaeus

Opossum - Didelphis virginianus Kerr

Otter - Lutra canadensis Schreber

Rabbit, cotton tail - Sylvilagus floridanus Allen

Rabbit, swamp - Sylvilagus aquaticus Bachman

Raccoon - Procyon lotor Linnaeus

Skunk, striped - Mephitis mephitis Schreber

Squirrel, fox - Sciurus niger Linnaeus

Squirrel, gray- Sciurus carolinensis Gmelin

Wolf - Canis niger Bartram

Birds

Dove, mourning - *Zenaidura macroura* Linnaeus

Hawk, Cooper's - *Accipiter cooperii* Bonaparte

Hawk, sharpshinned - *Accipiter striatus* Vieillot

Owl, great horned - *Bubo virginianus* Gmelin

Quail, bobwhite - *Colinus virginianus* Linnaeus

Turkey, eastern - *Meleagris galopavo* Linnaeus

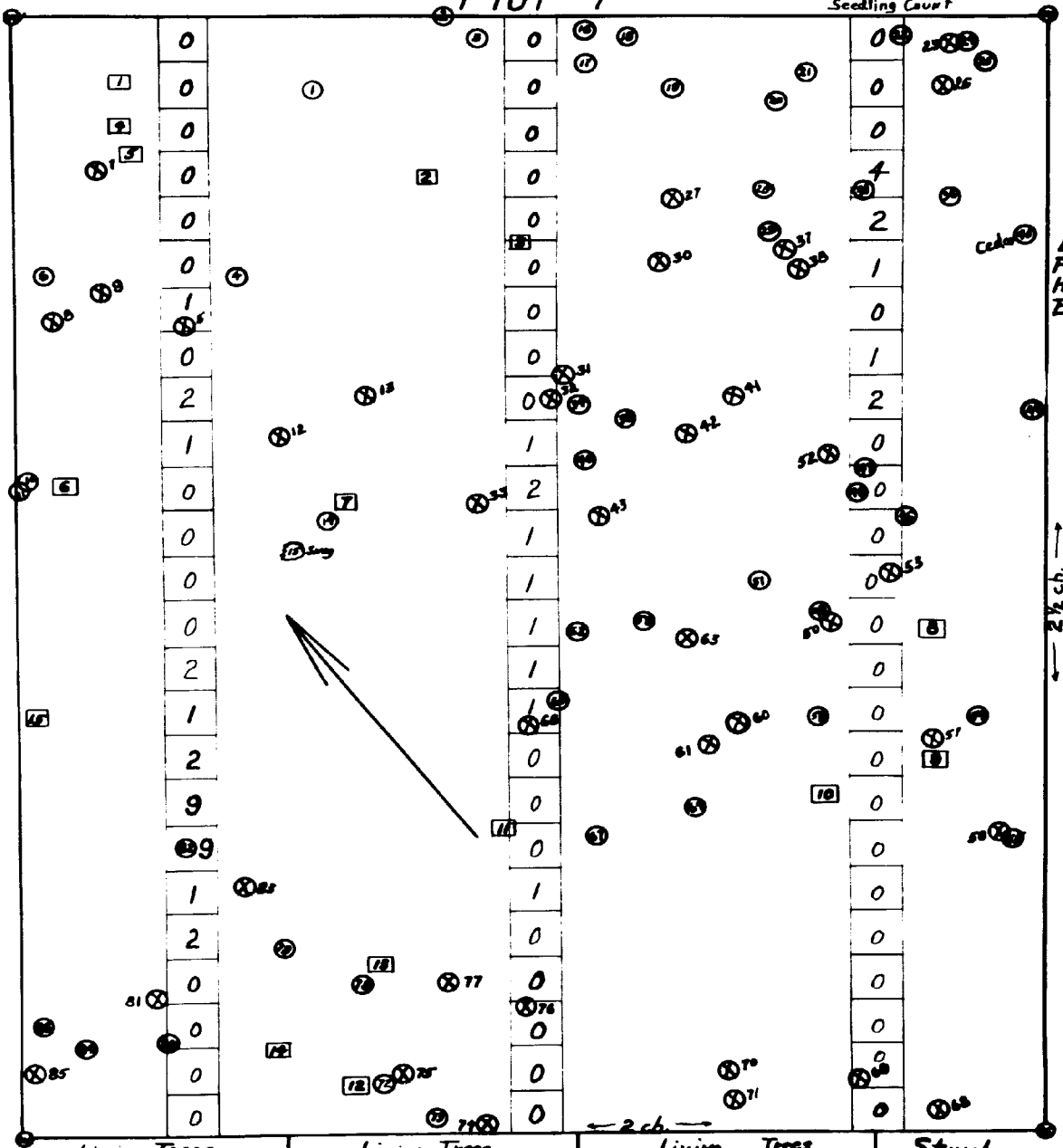
APPENDIX III

Vegetation not Over 5' From Ground By Percent of Area Covered

Species	Percent of 1/5 acre plot covered														
	0.1	0.5	1	2	5	10	20	30	40	50	60	70	80	90	100
Arrowwood															
Ash															
Bay															
Beech															
Blackhaw															
Buttonbush															
Cherry															
Chinquapin															
Crab apple															
Dogwood															
Elm															
Greybeard															
Gall berry															
Gum, Black															
Gum, Red															
Haw															
Hickory															
Holly															
Hornbean															
Hop-hornbean															
Huckleberry, ground															
Huckleberry, summer															
Huckleberry, winter															
Mulberry, Red															
Mulberry, French															
Lead plant															
Maple															
Oak, Blackjack															
Oak, Red															
Oak, White															
Oak, Water															
Persimmon															
Pine															
Redbud															
Sassafras															
Serviceberry															
Silverbell															
Sourwood															
Stinkbush															
Sumac															
Sweetleaf															
Titi															
Waxleaf myrtle															
Willow															
Witchhazel															
Winterberry															
Wild azalea															
Youpon															
Blackberry															
Grape															
Honeysuckle															
Smilax															
Yellow jessamine															

Plot 7

Sample Plot Seedling Count



2/6/38
Party
Bryan
Ferguson
Honwald
Brewer

Living Trees

Tree No.	D.B.H.	Tot. Ht.	Age	Sp.
1	14	72	41	Lob.
2	11	71	41	Lob.
3	7½	71	42	Lob.
4	5.3	47	34	Lob.
5	7.2	48		Oak
6	3.5	34	31	Lob.
7	6.8	Top Out		Oak
8	3.8	36		Oak
9	2	18		Oak
10	12	74	53	Lob.
11	7.3	58	45	Lob.
12	4	38		Oak
13	4	38		Oak
14	4.9	39	31	Lob.
15	Swag			
16	7.8	66	34	Lob.
17	9	66	38	Lob.
18	3.3	30		Oak
19	4.3	36	29	Lob.
20	15.6	70	29	Lob.
21	3.5	34	35	Lob.
22	9.2	71	38	Lob.
23	2.7	31		Oak
24	2.1	29	27	Lob.
25	4.7	39	37	Lob.
26	4.3	36		Oak
27	3.9	25		Oak
28	10.6	73	42	Lob.
29	8.4	52	37	Lob.

Living Trees

Tree No.	D.B.H.	Tot. Ht.	Age	Sp.
30	3.7	32		Oak
31	5.4	40		Oak
32	2.5	23		Oak
33	2.1	16		Oak
34	4.0	38	22	Lob.
35	11.6	73	42	Lob.
36	8.2	52	38	Lob.
37	3.4	26		Oak
38	3.4	20		Oak
39	4.3	42	22	Lob.
40	4.8	42	22	Lob.
41	4.9	30		Oak
42	2.5	29		Oak
43	3	27		Oak
44	12.6	79	34	Lob.
45	4.6	24		Cedar
46	9.7	74	37	Lob.
47	9.5	76	40	Lob.
48	11.4	74	41	Lob.
49	5.8	66	34	Lob.
50	6.7	45		Oak
51	12.2	76	27	Lob.
52	3.9	35		Oak
53	6.2	35		Oak
54	11.7	74	37	Lob.
55	6.3	68	40	Lob.
56	8.1	68		Oak
57	7	64		Oak
58	10.1	76	47	Lob.

Living Trees

Tree No.	DBH	Tot. Ht.	Age	Sp.
59	7.3	56	37	Lob.
60	4.3	40		Oak
61	4.7	35		Oak
62	6.5	74	39	Lob.
63	3	30		Oak
64	6.6	53	31	Lob.
65	4.2	53	34	Lob.
66	7.6	53		Oak
67	8.5	54	39	Lob.
68	4	40		Oak
69	10	65		Oak
70	7.8	65		Oak
71	5	30		Oak
72	11.9	74	44	Lob.
73	8.1	46	28	Lob.
74	3.2	12		Oak
75	2.8	15		Oak
76	5.2	32		Oak
77	4.1	30		Oak
78	4.7	45	34	Lob.
79	13.3	79	43	Lob.
80	11.1	77	50	Lob.
81	7.4	40		Oak
82	11.2	74	40	Lob.
83	6.5	38		Oak
84	3.5	38	23	Lob.
85	4.9	35		Oak
86	4.7	36	31	Lob.

Stumps

No.	Age	Dia.
1	63	23
2	48	17
3	39	15½
4	61	24.3
5	52	10.7
6	47	17.2
7	48	24
8	40	18.2
9	47	21.2
10	45	18.0
11	192	26.4
12	22	4.3
13	32	8.9
14	72	22.2
15	123	29.6

Location – S.E. corner of plot, 2 ch. 22½ lks, N12°E of corner of sections 77-12-78.

Legend

○ – Living Tree – Pine
⊗ – Living Tree – Hdw.
Lob. – Loblolly
□ – Stump

Note – Area covered with logging slash. S.W. exposure.

APPENDIX IV B

Five Year Check - MANAGEMENT PLOTS - ST. HELENA - Date_____
Plot No. _____ Date Last Fire _____

Pine reproduction by number and size classes * on continuous mil-acre plots; percent of each mil-acre covered by young hardwood; one or more pine reproduction dominant over young hardwood.

0-2'	2-5'	5'-1½"	2"	4"	%H	D.P.	0-2'	2-5'	5'-1½"	2"	4"	%H	D.P.	0-2'	2-5'	5'-1½"	2"	4"	%H	D.P.

* Size classes: 0-2' tall; 2'-5' tall; 5' tall to 1" dbh; 2" dbh, 1.1-30 dbh; 4" dbh - 3'.1-5.0 dbh, D,P, - dominant pine seedling.