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STUDY PLAN

LONGLEAF PINE SEED PRODUCTION

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LONGLEAF PINE SEED PRODUCTION

PROBLEM

Longleaf pine (Pinus palustris Mill.) is noted as an erratic seed producer, and lack of seeds is one of the major problems in the natural regeneration of the species. Very few seed crops are large enough to feed the many pine seed predators and still produce an acceptable seedling stand.

Longleaf pine seed crops are highly variable, but little is known about the extent of the variability. Most estimates of seed crop size have been subjective, and were summarized by Wahlenberg.[1/] With the exception of Maki's report[2/] for the years from 1946 to 1951, systematic quantitative records of longleaf pine cone production are not available.

A necessary step in coping with the problem of seed supply is to learn more about the variability in longleaf seed production, and the factors responsible for this variation. Long-term seed production records of selected stands and trees will provide valuable information on this subject.

1/ Wahlenberg, W. G. 1946. Longleaf Pine. Charles Lathrop Pack Forestry Found., Washington, D. C., in cooperation with U. S. Forest Service. 429 pp., illus.

2/ Maki, T. E. 1952. Local Longleaf Seed Years. Jour. For. 50: 321-322.

OBJECTIVES

Measure annual variation in longleaf pine seed crops on the Escambia Experimental Forest, and explore some factors affecting seed production through long-term records of:

1. Cone and seed production by stands of different densities and individual trees within stands.

2. Time of flowering of both male and female flowers.

3. Annual losses of flowers and cones.

SCOPE

This is primarily an observational study to accumulate quantitative data on cone and seed production by longleaf pine trees and stands. It will be superimposed on the Preparatory Cuts Study 1/ where seed production has been recorded since 1957. This study will continue indefinitely the observations on seed production, and provide for all the additional information required to meet the objectives stated above. Some of the limitations of the existing study will also apply to this one. Study plots contain second-growth longleaf timber of predominantly one age class (50-60 years), and are confined to two locations on the Experimental Forest. Any important leads developed by this rather broad exploratory study will be followed up by new, more specific studies.

1/ RS-SS, SILVICULTURE, General, EG-2.10, Study Plan, Preparatory Cuts, by W. D. Boyer, March 20, 1957.

METHODS

STUDY AREA

This study will be located on the Escambia Experimental Forest, Escambia County, Alabama, and superimposed on a study with ten 2.5-acre plots, five in each of two blocks (figure 1). Stand densities of 9, 18, 27, 36, and 45 square feet of basal area per acre were randomly assigned to the plots in each block. The existing 50- to 60-year-old second-growth longleaf stands were cut back to their assigned densities in March 1957.

The most recent measurements of the longleaf stands on each plot were made in February 1962. Pertinent stand data for central 0.9-acre net plots are shown in table 1. More complete data for each plot are given in table 2, appended.

Stand age and site index[1/] (index age of 50 years) now average 56 years and 76 feet on block A, and 62 years and 70 feet on block B.

TREATMENTS

The major treatments represented in this study are the range of stand densities created for the Preparatory Cuts Study. Individual tree characteristics (d.b.h., total height, crown ratio, crown class) will be study variables, and will be related to cone production.

1/ Site index derived from USDA Misc. Pub. No. 50, Volume, Yield, and Stand Tables for Second-growth Southern Pines, Sept. 1929.

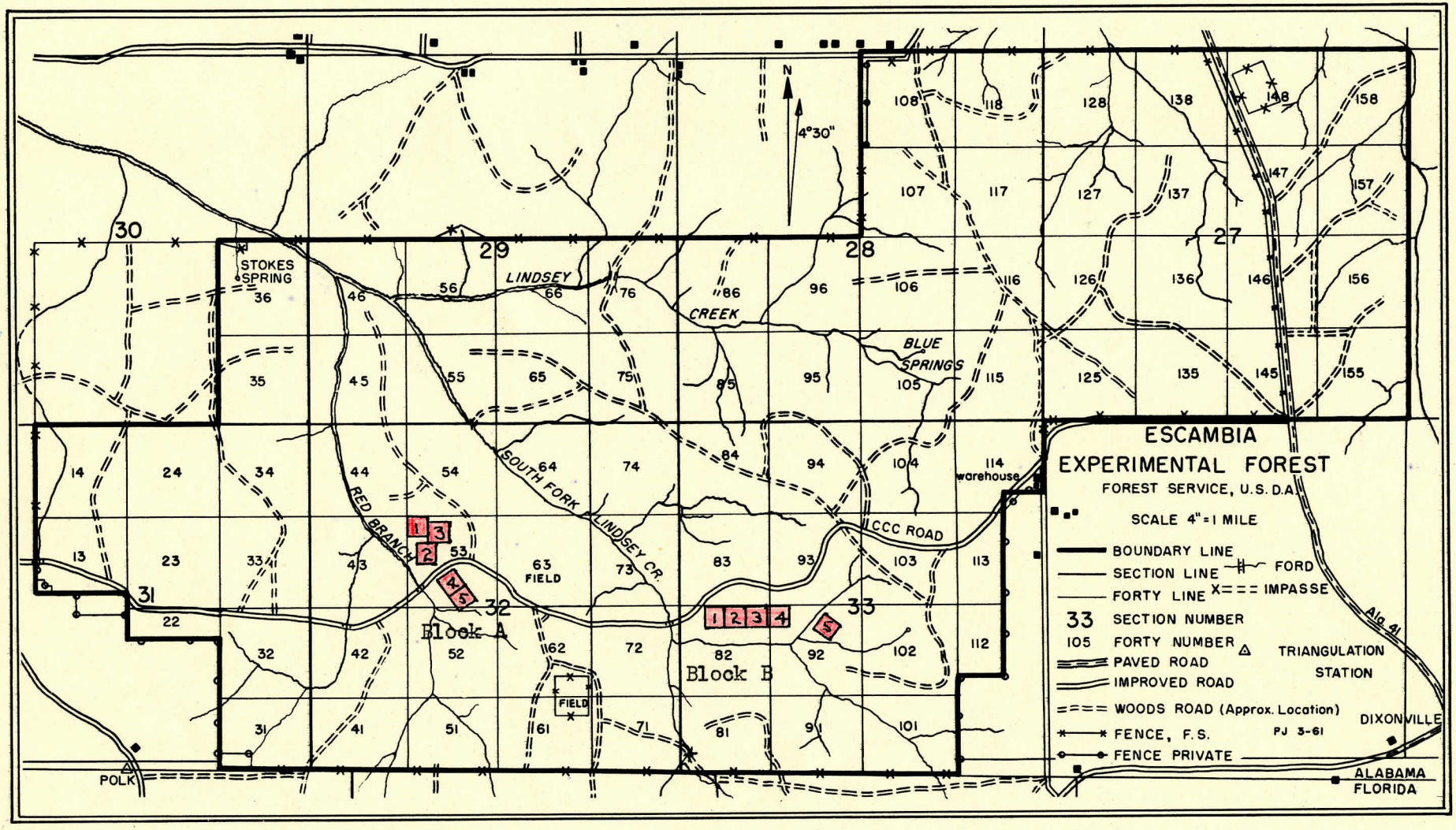


Figure 1.--Location of study blocks and plots.

Table 1.--Longleaf timber stand data

February 1962 *

Block	Plot	D.b.h. average	Trees per acre	Basal area per acre	Nominal BA
		Inches	Number	Square feet	
A	1	14.7	24	29.3	27
	2	14.3	18	20.0	18
	3	14.6	9	10.5	9
	4	13.8	37	38.6	36
	5	13.5	49	49.4	45
B	1	14.8	17	20.2	18
	2	13.7	44	46.6	45
	3	14.1	27	29.5	27
	4	14.3	36	40.1	36
	5	14.5	9	10.4	9

* For central net plot of 0.9 acres.

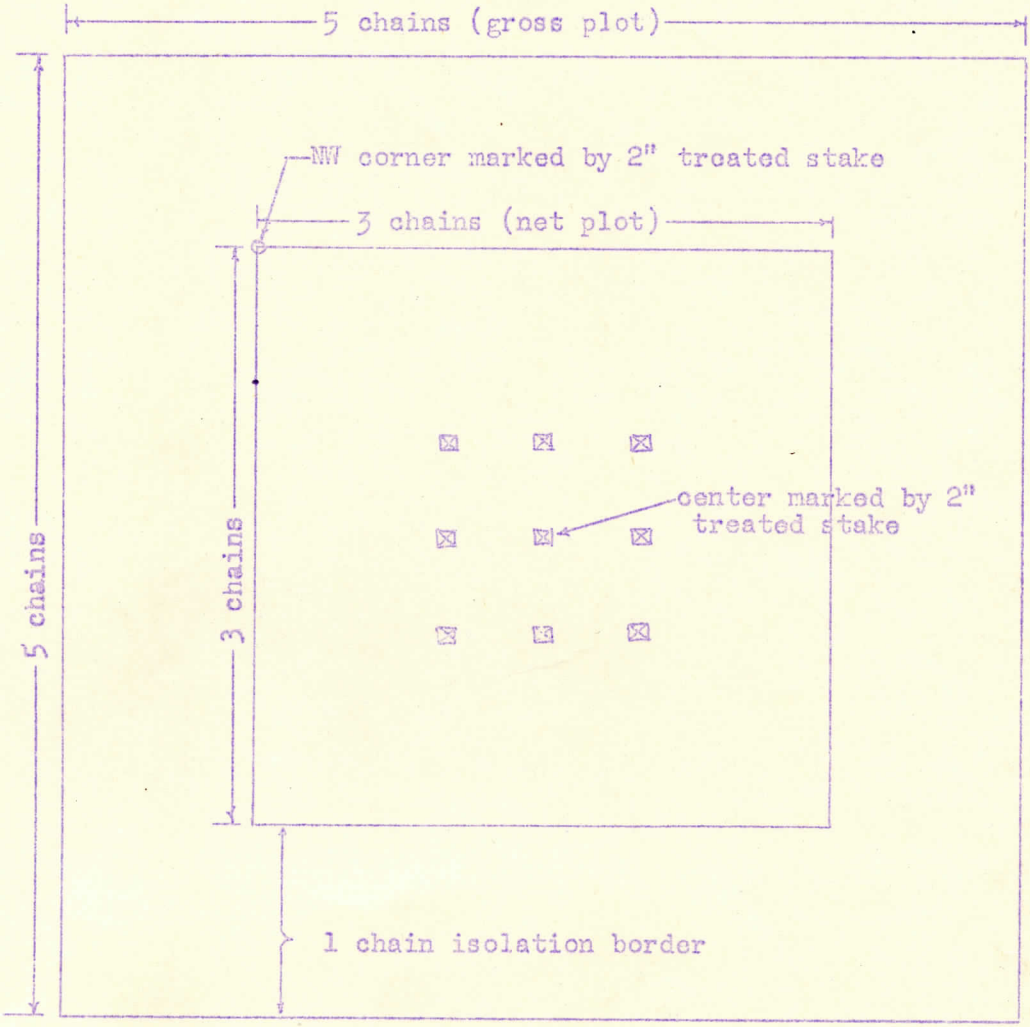
LAYOUT

Each of the two study blocks consists of five plots located and numbered as shown in figure 1. Each plot is 5 chains square (2.5 acres) and consists of a central net plot 3 chains square (0.9 acres) surrounded by a one-chain isolation border. Plot layout and monumentation are shown in figure 2.

MEASUREMENTS

Overstory

The overstory on all plots consists of longleaf pine trees in the 9-inch d.b.h. class or larger. The residual trees on both net plots and isolation borders have been counted and d.b.h. measured (table 2, appended). All pine trees on each net plot will be marked with an identification number. The diameter at breast height, total height, and length of live crown of each marked tree will be measured and recorded at 5-year intervals.



Scale: 1" = 1 chain

⊠ Location of seed traps

Figure 2.--Plot layout.

Seed Production

Annual seed production by the stand on each plot is being sampled by quarter-milacre paperboard seed traps. Nine of these traps are systematically arranged in a one-chain square grid at the center of each plot. Traps are spaced $\frac{1}{2}$-chain apart (figure 2). The distance of two chains between traps and the outside plot boundary is an effective barrier against seeds from outside the plot. Considering the limited dispersal range of longleaf seed (over 70 percent within one chain of seed source, if unimpeded) the bulk of trapped seeds should originate from trees on the net plot.

Trapped longleaf pine seeds will be collected at intervals of about one week during seed fall, and cut to determine soundness. Examinations will begin in mid-October and end when no seeds are found in two successive examinations. The total number of seeds and the number of sound seeds found in each trap at each examination will be recorded.

Cone Production

The cones produced by each marked longleaf pine tree will be counted annually, in the winter, when the opened cones can be easily seen. The count will include all the current year's cones on the ground under the tree as well as those still in the tree. Old cones still in the tree will be removed in September, before current year's cones open.

Flower and Cone Losses

Flower and cone losses will be sampled by following the fate of female flowers on selected twigs. Two twigs on each of four trees per net plot will be selected for observation. Twigs will be located in the upper half of tree crowns. Every spring, the number of new flowers and one-year-old conelets on each marked twig (terminal) will be recorded. The number of mature cones will be observed and recorded in September. At each examination, surviving conelets or cones will be listed as apparently healthy or obviously damaged. If damaged, the extent and cause--if known--will be recorded.

The selection and observation of sample twigs will have to be made from the ground. All will be selected so as to be easily visible from a single point. Each twig will be identified by tree number and the letter A or B. Letter A will be assigned to the twig with the smallest azimuth angle (measured clockwise, from north through 360°). The location of each sample twig will be fixed by an azimuth and altitude angle measured with a transit.

Flowering

The annual flowering dates of longleaf pine on the Escambia Experimental Forest will be recorded. Pollen dispersal will be sampled by pollen traps of the type described by Grano.[1/] A trap will be exposed in a standard weather instrument shelter at the beginning of pollen flight, and changed two to four times a week. Day and hour of exposure and recovery of each trap will be recorded. Longleaf pine pollen grains on the traps will be counted under a microscope, using a magnification of 100. The total count of pollen in ten separate 100X fields per trap will be recorded and converted to average number of pollen grains per square centimeter. This figure will be divided by hours of exposure to give the pollen dispersal rate in grains per cm^2 per hour.

The viability of a composite sample of longleaf pine pollen from five different trees will be tested, using the method described by Dillon and Zobel.[2/] If the germination of this limited sample of pollen is less than 20 percent, three additional composite samples (five trees each) will be tested to determine whether pollen viability is uniformly low.

The development of female flowers will be observed two or three times a week during flowering. Each time, a sample of at least ten flowers from five or more trees will be observed and the development stage recorded according to the designations of Cumming and Righter.[3/]

1/ Grano, Charles X 1958. A timesaving slide for trapping atmospheric pollen. Forest Sci. 4(1):94-95.

2/ Dillon, Elizabeth S. and Zobel, Bruce,J. 1957. A simple test for viability of pine pollen. Jour. Forestry 55:31-32.

3/ Cumming, W. C. and Righter, F. I. 1948. Methods used to control pollination of pines in Sierra Nev. of Cal. USDA Circ. 792. 18 pp.

Weather

Weather records are kept by a U. S. Weather Bureau station located about two miles north of the Experimental Forest. Relationships between climatic conditions and variations in cone production will be explored. A hygrothermograph will be maintained on the Experimental Forest from the beginning of February to the end of April, in order to cover the period of longleaf flowering. A continuous record of precipitation on the Experimental Forest will be obtained from a rain gauge located at the warehouse site in compartment 114.

I believe this should be continued thru summer, to cover the period of flower-bud differentiation for

ANALYSIS

The study design will permit statistical evaluation of the effect of stand density on cone and seed production, using an analysis of variance with the following form.

Source	df
Stand density	4
Years	X
Block	1
Stand density x year	4X
Error	4 + 5X
Total	9 + 10X

Relationships among the observed variables will be explored by correlation and regression analyses. Some of the specific relationships that will be tested, using measurements from marked dominant and codominant trees, are listed below.

Dependent variables	Independent variables
1. Average annual cone production (per tree)	(a) Tree size (d.b.h.)(height)(d^2h) (b) Crown ratio (c) D.b.h. growth (d) Stand density
2. Coefficient of variation, annual cone production	(a) Tree size (d.b.h.)(height)(d^2h) (b) Crown ratio (c) Stand density

The ranges represented in most of the independent variables in this study are probably not broad enough to develop useful prediction equations, and two important variables (site and tree age) are missing. However, the purpose at this stage is to identify some of the more important factors affecting cone production and annual variations in cone production.

PRESENTATION OF RESULTS

Progress reports will be prepared at intervals of four or five years. These reports will summarize annual seed production records, by trees and stands, during the interval since the preceding report. The degree to which measured variables are responsible for observed results will also be presented and discussed. When sufficient information of interest is acquired, it will be published in an appropriate technical outlet.

ADMINISTRATIVE DETAILS

ASSIGNMENT

Professional	W. D. Boyer
Technician	S. R. Evans

DURATION OF STUDY

Indefinite

VEHICLE REQUIREMENTS

Sedan or pick-up truck - 400 miles annually

MAN-POWER REQUIREMENTS

Man-days per year

	1964	Each succeeding year
Professional	10	5
Technician	20	20
Clerical	1	1

SAFETY

No special hazards are involved in this study. All safety precautions appropriate nor normal field work will be observed.

PROTECTION

A plowed or disked firebreak has been maintained around study blocks to protect them from wildfire. This protection will be continued. Blocks are surrounded by a single strand of wire, with plot-warning markers attached at intervals of 1 to 1½ chains.

CHRONOLOGICAL LIST OF JOBS

Job	Assignment	Date
Mark and measure trees	Evans	January 1964
Count cones	"	Annually, January
Count flowers and conelets on selected twigs	"	" spring
Trap and test pollen, observe flower development	"	" during flowering (March, Apr.)
Count mature cones on selected twigs	"	Annually, September
Remove old cones on marked trees	"	" September
Collect and count seed	"	Annually, during seedfall
Progress report	Boyer	June 1967, and 4-5 year intervals
Remeasure net plot trees	Evans	January 1967

APPENDIX

Table 2.--Longleaf timber stand data, February 1962

Block	Plot	Net plot (0.9 acres)			Isolation border (1.6 acres)		
		Trees	Mean D.b.h.	Basal area	Trees	Mean D.b.h.	Basal area
		Number	Inches	Square feet	Number	Inches	Square feet
A	1	22	14.7	26.36	47	13.1	45.28
	2	16	14.3	18.05	31	13.7	32.22
	3	8	14.6	9.43	13	14.9	15.99
	4	33	13.8	34.70	65	13.8	68.86
	5	44	13.5	44.48	88	13.1	83.61
B	1	15	14.8	18.22	27	15.0	33.72
	2	40	13.7	41.94	82	13.2	77.87
	3	24	14.1	26.51	49	13.2	47.38
	4	32	14.3	36.09	60	13.6	62.24
	5	8	14.5	9.31	13	14.9	16.08