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longleaf pine:

an annotated bibliography, 1946 through 1967

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Lists 665 publications appearing since W. G. Wahlenberg compiled the bibliography for his book, *Longleaf Pine*.

Contents

Longleaf Pine: An annotated Bibliography, 1946 Through 1967

Thomas C. Croker, Jr.

When W. G. Wahlenberg published *Longleaf Pine* in 1946, he included a complete list of the American literature on this important southern tree. The monograph stands as one of the major references of forestry literature, and its bibliography has saved untold hours for students and researchers.

In the 2 decades just past, *Pinus palustris* Mill. has been the subject of much research and observation, and the resulting publications have significantly advanced our knowledge of the species. It is the purpose of this annotated bibliography to give the reader a convenient summary of the literature accretions since Wahlenberg published.

The paper records all known publications from 1946 through 1967. It also includes some 1944 and 1945 titles that appeared after Wahlenberg's volume went to press. Popular as well as scientific articles are included.

Forestry Abstracts, published by the Commonwealth Agricultural Bureaux, Farnham Royal, England, was a chief source of references. The Bureaux' Catalog of World Forestry Literature on Microfilm and its Card Title Service were invaluable supplements to the Abstracts. The search also included the USDA Bibliography of Agriculture, the Dictionary Catalogue of the Yale Forestry Library, annual reports of the Southern and Southeastern Forest Experiment Stations, and a card file of references maintained by the author since 1946. No literature search can be completely successful when the subject is as broad as longleaf pine. There probably are important omissions, and notification of these would be appreciated.

Citations are arranged by the Oxford decimal system. The table of contents provides a key to the classifications, and further information is available in *The Oxford System o f Decimal Classification for Forestry*, published by the Commonwealth Agricultural Bureaux. Each publication is listed only once, under the subject code that appeared most appropriate. Classification was often difficult, and the reader is urged to scan related subject heads as well as the one in which his primary interest lies. For some users, the index of authors may partly compensate the lack of cross referencing.

The bibliography is completely annotated. Many of the abstracts are reprinted from Forestry Abstracts, with the generous permission of the Commonwealth Forestry Bureaux. These are identified with the legend FA. Authors' summaries or abstracts of their own publications were another common source, as were briefs appearing in the publications lists of the Southern and Southeastern Forest Experiment Stations. Many of the abstracts were written by the author after a reading of the original publication.

For what the bibliography contains or omits, the author alone is responsible. This being understood, he gratefully acknowledges the decisive assistance of Patricia J. Bridges, Orahlee F. Villoldo, and Patricia E. Armatis of the Southern Forest Experiment Station's Library. Without their help, the literature search would have been an impossible task. And he thanks Elaine P. McGowan of the Station's editorial staff for remorselessly combing his citations into some degree of typographical consistency.

1. FACTORS OF THE ENVIRONMENT, BIOLOGY

11 SITE FACTORS, CLIMATE, SITUATION, SOIL

Dixon, J. B., and Wear, J. I. 1964. X-RAY SPECTROGRAPHIC ANALYSIS OF ZINC, MANGANESE, IRON, AND COPPER IN PLANT TISSUE. Soil Sci. Soc. Amer. Proc. 28: 744-746.
Describes trial analyses of Pinus taeda, P. palustris, P. echinata, and P. elliottii, among others. Results show that the method is satisfactory for determining Zn, Mn, and Fe (but not Cu) in pine needles. FA

15 ANIMAL ECOLOGY. GAME MANAGEMENT

Goodrum, P. D., and Reid, V. H. 1959. DEER BROWSING IN THE LONGLEAF PINE BELT. Soc. Amer. Forest. Proc. 1958: 139-143.
Approximately 78 woody species of browse plants are available to white-tailed deer in the longleaf pine forests. Half of these are starvation forage, 17 percent are highly preferred, and 33 percent are intermediate. Prescribed burning is beneficial to deer. Longleaf pine habitat usually will not support more than one deer for 26 acres, but carrying capacity varies considerably. Usually there is no shortage of forage in the spring.

Lay, D. W. 1957. BROWSE QUALITY AND THE EFFECTS OF PRESCRIBED BURNING IN SOUTHERN PINE FORESTS. J. Forest. 55 : 342-347.
In the Siecke State Forest, Texas, samples of 28 species of deer forage were collected in 1954 and 1955 from a longleaf pine stand on sites that had been subjected to one, two, or three prescribed burns and from adjacent unburned areas. Ten of the species were sampled for the four seasons. Analyses of the nutrient content of the tips at 15 percent moisture content are tabulated. Burning increased protein content by as much as 42.8 percent and P_2O_5 by 77.8 percent, but these effects disappeared after ca. 2 years. FA

Lay, D. W. 1967. BROWSE PALATABILITY AND THE EFFECTS OF PRESCRIBED BURNING IN SOUTHERN PINE FORESTS. J. Forest. 65: 826-828.
Gives details of the effects of burning nearly half of a 58-acre deer-pen (in a Pinus palustris stand and containing four white-tailed deer) on the production and utilization of browse, in comparison with an unburned area. The results indicated that the production of browse on the burned area increased significantly (from 264 pounds per acre to 332 pounds after 2 years) and utilization on the burned area was more than double that on the unburned area. FA

Meanley, B. 1966. RED-WINGED BLACKBIRDS SEARCHING BENEATH PINE BARK FOR INSECTS IN WINTER. Auk 83: 480-481.
Over a 5-year period, always in winter, red-winged blackbirds (Agelaius phoeniceus) have been observed feeding on insects beneath the bark of longleaf pine in east-central Alabama.

Moore, W. T. 1967. DEER BROWSE RESOURCES OF THE ATOMIC ENERGY COMMISSION'S SAVANNAH RIVER PROJECT AREA. U. S. Dep. Agr. Forest Serv. Resource Bull. SE-6, 28 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Browse plants in the South Carolina sandhills are listed by preference classes for a number of overstory timber classes including pine plantations and natural stands of longleaf pine and longleaf-scrub oak

Reid, V. H., and Goodrum, P. D. 1960. BOBWHITE QUAIL: A PRODUCT OF LONGLEAF PINE FORESTS. In Trans. 25th N. Amer. Wildlife Conf., pp. 241-252.
In this forest quail study in southwestern Louisiana, marked fluctuations in annual production and populations were recorded. The better winter bobwhite populations were significantly related to high reproductive success the preceding nesting season. The population trend was much the same on hunted and unhunted longleaf pine range, and the percentage of young birds found on an area protected from hunting for 14 years closely approximated that for the surrounding annually hunted area. One of the best reproductive seasons had a good late quail hatch. Significant relationships were found between annual production and temperature and between annual production and precipitation records for the preceding summer months. In general, the best quail crops followed cool, moist summers while poorest reproductive success followed hot, dry summers. Temperature and precipitation readings during the warm month period may be useful criteria for predicting annual quail production and winter populations in this area. FA

Ripley, T. H., Wilhite, L. P., Downing, R. L., and Harlow, R. F. 1965. GAME FOOD PLANTS IN SLASH-LONGLEAF FLATWOODS. In Sixteenth Annu. Conf. Southeast. Assoc. Game and Fish Comm. Proc. 1962: 35-44.
Wiregrass and palmetto understory types were superior to the gallberry types for quail and turkey.

Stransky, J. J. 1968. TIMBER AND QUAIL-DUAL FOREST CROPS. Proc., 1967 Annu. Meeting, Tex. Chapter, Soc. Amer. Forest., pp. 1-5.
Quail management is compatible with timber management and other important uses of the longleaf-slash pine forests. Hunting and management practices are described.

Stransky, J. J., and Halls, L. K. 1967. TIMBER AND GAME FOOD RELATIONS IN PINE-HARDWOOD FORESTS OF THE SOUTHERN UNITED STATES. In Fourteenth Congr. Proc., Int. Union Forest. Res. Organ. Vol. 7: 208-217.
Discusses the maintenance of favorable game habitats and suggests various silvicultural ways of improving game food supplies in intensively managed forest. FA

16 GENERAL BOTANY

Allen, R. M. 1958. A STUDY OF THE FACTORS AFFECTING HEIGHT GROWTH OF LONGLEAF PINE SEEDLINGS. DISS. Abstr. 19: 620.
The study was limited almost entirely to very young seedlings. Measurements of photosynthesis and respiration showed that longleaf pine seedlings have a lower rate per unit needle-weight than either slash or loblolly pine seedlings, both of which, unlike longleaf, make normal epicotyl elongation very early. Slash and loblolly pine epicotyls showed no major differences in the metabolites resulting from incubating the epicotyls in labeled glucose or succinic acid. Longleaf epicotyls were found to contain a much larger quantity of free amino acids than the other two species, although qualitatively there was little difference between the species at any of the development stages studied. Neither cold treatment nor change in day-length increased the growth of longleaf seedlings, but two of the growth regulators studied, gibberellic triiodobenzoic acids, caused a small but consistent increase in epicotyl length. Paper-chromatographic studies of the ether-soluble acidic

substances in seedling epicotyls and sapling buds showed at least four growth-promoting and one growth-inhibiting substances to be present in pine; one of the growth-promoting substances was absent from extracts of nonelongating longleaf pine epicotyls. FA

Allen, R. M. 1960. CHANGES IN ACID GROWTH SUBSTANCES IN TERMINAL BUDS OF LONGLEAF PINE SAPLINGS DURING THE BREAKING OF WINTER DORMANCY. Physiol. Plant. 13: 555-558.
The greatest changes in ether-soluble acid growth-substances were an increase in the amount of a growth promoter that appeared similar to IAA when examined chromatographically, using isopropanol/ammonia/water as the solvent, and a decrease of an inhibitor similar to inhibitor-â. The results showed that the acid growth-promoters and inhibitors regulate the winter rest period of P. palustris, or are closely connected with its regulation. FA

Allen, R. M. 1964. CONTRIBUTIONS OF ROOTS, STEMS, AND LEAVES TO HEIGHT GROWTH OF LONGLEAF PINE. Forest Sci. 10: 14-16.
Pinus palustris Mill. saplings made 31 percent of their normal spring elongation from food reserves in the woody stem. The roots supplied materials for an additional 15 percent when the needles were present or 29 percent in their absence. The old needles apparently furnished enough materials for 40 percent of normal elongation, but this was increased to 54 percent when the roots were partially isolated from the top by girdling.

Allen, R. M., and McGregor, W. H. D. 1962. SEEDLING GROWTH OF THREE SOUTHERN PINE SPECIES UNDER LONG AND SHORT DAYS. Silvae Genet 11: 43-45.
Pinus taeda, P. echinata, and P. palustris from different geographical seed sources were grown under (1) short (9.5-hour) and (2) long (15-hour) photoperiods. P. taeda of southern provenances made greater growth under both (1) and (2) than northern provenances. Seedlings of P. echinata grown under (1) showed clinal variations, similar to those of P. taeda; under (2), however, there were significant differences suggestive of ecotypes. P. palustris grew quicker under (2) than (1) but no significant differences could be distinguished in the different geographical provenances. This may be because the P. palustris seed was representative of a smaller latitudinal range than in the other species. FA

Allen, R. M., and Naylor, A. W. 1960. STUDIES ON THE GROWTH SUBSTANCES IN LONGLEAF AND SLASH PINES. Assoc. Southern Agr. Workers Proc. 57: 251-252.
Paper chromatography and bioassay of growth substances in the epicotyls of longleaf revealed no differences that might explain the dwarf growth habit.

Barnes, R. L., and Naylor, A. W. 1961. UTILIZATION OF RADIOACTIVE ORNITHINE BY GERMINATING EMBRYOS OF LONGLEAF AND SLASH PINES. Forest Sci. 7: 130-135.
Embryos from the seeds of these pines, germinated 0-15 days, were incubated in phosphate buffer at pH 6.6 with DL-ornithine-2-CI4 for 24 hours. Trends in the use of the ornithine carbon skeleton are shown by two-way chromatographic and autoradiographic techniques and findings discussed. Protein hydrolysates made after the incubation showed radioactive arginine, proline, and glutamic acid. A complete ornithine-urea cycle was not established in embryos of either species, no urea having been detected. FA

Boyer, W. D., and Evans, S. R. 1967. EARLY FLOWERING IN LONGLEAF PINE RELATED TO SEED SOURCE. J. Forest. 65: 65:806. *Trees of one seed source produced 71 percent of the female flowers on pines from 11 seed sources planted at two locations in Alabama.*

Brown, C. L. 1958. STUDIES IN THE AUXIN PHYSIOLOGY OF LONGLEAF PINE SEEDLINGS. In Physiology of Forest Trees, Part VII, Chapter 26, pp. 511-525. K. V. Thimann (ed.) N. Y.: Ronald Press.
The mechanism controlling the short shoot habit of longleaf pine may be fundamentally different from that observed in ginkgo.

Brown, C. L. 1964. THE SEEDLING HABIT OF LONGLEAF PINE. Ga. Forest Res. Counc. Rep. 10, 68 pp.
A comprehensive investigation was made of the physiological processes associated with hypocotyl extension in longleaf, loblolly, and Sonderegger pines. The grass stage in longleaf is under rigid genetic control, but the length of time individual seedlings remain in it is strongly influenced by environment. Of the methods studied, none promoted height growth during the first year from seed.

Burns, R. M. 1960. RESPONSE OF SELECTED CONIFEROUS SEEDS TO GIBBERELLIC ACID. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest Res. 1: 13-16. *In tests on unstratified seeds (450 per species) with gibberellic acid as 10 percent K salt in concentrations of 0, 75, 150, 225, and 300 mg. per liter in various forms, with or without a supplement, response was erratic within and between species. None of the seeds of Juniperus virginiana germinated but 62 percent of the seeds recovered at the conclusion of the experiment, after 90 days, were apparently viable. The effect on germination of Pinus palustris was not significant, but responses appeared to increase with concentration, and distilled water appeared to be the best carrier. For P. taeda, germination rate, total germination, and height growth were significantly improved, being greatest at 150 mg. per liter. In a second series, in which P. taeda seed was stratified at 34° F. for I to 4 days in peat soaked with aqueous solutions of gibberellic acid in strengths from 6 to 200 mg. per liter, germination was not significantly affected, but height growth responded positively to concentration and duration of treatment, with a maximum for 3 days at 150 mg. FA*

Cain, S. A., and Cain, L. G. 1944. SIZE-FREQUENCY STUDIES OF PINUS PALUSTRIS POLLEN. Ecology 25: 229-232.
As the result of a study of variability in pollen of Pinus palustris from widely-scattered localities in the eastern United States the author concludes that the size-frequency method of species identification is of limited application where species differ only slightly with respect to size characteristics. FA

Campbell, T. E., and Wakeley, P. C. 1961. POSSIBLE REFINEMENTS IN CONTROLLED POLLINATION OF SOUTHERN PINES. Sixth Southern Conf. on Forest Tree Impr. Proc. 1961: 121-128.
Itemizes the "Placerville" stages of longleaf pine flowers for bagging, pollination, and debagging to attain certain degrees of seed set and freedom from contamination, and evaluates laboratory germination of pollen in terms of fertilizing ability.

DAVIS, T. S. 1962. EFFECT OF COBALT-60 GAMMA RADIATION ON PINE SEED AND ONE-YEAR-OLD SEEDLINGS. Forest SCI. 8: 411-412.
Irradiation of (a) loblolly, (b) slash, and (c) longleaf pine seed with 10, 20, 30, 40, and 50 thousand r. at 620 r. per minute showed survivals at 4 months for the 10,000-r. treatment of 28, 32, and 0 percent for (a), (b), and (c), vs. 46 and 57 percent for controls of (a) and (b). Dormant 1-year seedlings of (a) were exposed to 3, 4, 5, 6, and 7 thousand r. at 7.95 r. per minute. Eight months later all were dead. Similar seedlings, exposed to 500, 1,300, 1,800, 2,300 and 2,800 r. at 2.70 or 6.95 r. per minute, after 8 months' growth

appeared to be affected by intensity of, as well as total, dosage. Survival was slightly better for controls than for the 500-r. treatment; after dosages > 500 r., survival and growth decreased sharply. Similar results were obtained for seedlings of (b). FA

Derr, H. J. 1963. BROWN-SPOT RESISTANCE AMONG FI PROGENY OF A SINGLE, RESISTANT LONGLEAF PARENT. Forest Genet. Workshop Proc. 1962: 16-17. Southern Forest Tree Impr. Comm. and Soc. Amer. Forest. Tree Impr. Comm.
Resistance of open-pollinated progeny of a resistant parent was greatly superior to that of controls on lightly, moderately, and severely infected sites, in terms of survival, rate and degree of infection, and continuance of height growth at age 4 . Selfed progeny were as resistant, but slower to start height growth, and initially had longer and finer-textured foliage. Progeny of nonresistant mothers and the resistant parent were less susceptible than their open-pollinated half-siblings. Resistance appeared to be due to a physiological condition of foliage restricting the pathogen's ability to infect. FA

Dorman, K. W. 1956. PROGRESS IN THE SELECTION OF SUPERIOR STRAINS OF SOUTHERN PINES. Assoc. Southern Agr. Workers Proc. 53: 151-152.
Variations in growth rate, fusiform rust infection, and crown width among progeny of superior mother trees indicate that important traits are strongly inherited and selection of superior types is possible.

Eggler, W. A. 1961. STEM ELONGATION AND TIME OF CONE INITIATION IN SOUTHERN PINES. Forest Sci 7: 149-158.
Multiphase stem growth (successive elongation from successive buds in one growing season) is common in Mississippi and Louisiana pines (P. palustris, P. elliottii, P. taeda, P. echinata). Branches elongate in one-four phases, this being characteristic of young trees. Three procedures were used to determine the initiation period of cones: (1) weekly collection and dissection of buds from several trees; (2) mass collection of buds from one side and at a later date from the other side of a tree, a comparison of the number of recognizable primordia in the two collections indicating when most cones form; (3) cutting off ca. 12 primary or secondary buds on each of two trees just above the bud base. After (3), one case occurred of a branch producing _cones in its first year, and it is assumed therefore that cones were initiated after the date of disbudding. FA

Ferré, Y. de. 1956. ÉTUDE D'UNE PLANTULE ANORMALE DE PINUS PALUSTRIS. Soc. d'Hist. Nat. Bull. 91(3/4): 416-417. Also in Trav. Lab. Forest. 1(5) : 4. Toulouse
Anatomical study of a seedling without cotyledons.

Ferrill, M. D., and Woods, F. W. 1966. ROOT EXTENSION IN A LONGLEAF PINE PLANTATION. Ecology 47: 97-102. Also in Diss. Abstr. 25: 730. 1964.
Root extension in a 24-year-old longleaf pine plantation in the North Carolina sandhills was studied by the application of 10 mc. of I^{131} directly to the soil, on the surface, or at depths of 1 or 3 feet, and surrounding trees monitored with a portable scintillation counter. Within 10 feet of the point of application, all trees above 3.0 inches absorbed I131 in sufficient quantities to be detected. Beyond 22 feet for surface applications, and 33 feet for I- and 3-foot depths, no I_{131} was detected in any trees. Regressions were computed to determine whether root extension could be Predicted. When distance from the point of application was used as the dependent variable, an index of competition and the angle from the tree row proved to be the most useful, to the exclusion of the various measures of tree size.

Florida School of Forestry. 1957. LONGLEAF PINE HYBRIDS. Fla. Sch. Forest. Res. Rep. 4, pp. 25-26.
Comparison of natural and artificial hybrids of Pinus palustris × P. elliottii var, elliottii with South Florida slash pine (P. elliottii var. densa) leads to the conclusion that the latter may have originated through introgressive hybridization between slash and longleaf pines.

Garin, G. I. 1958. LONGLEAF PINES CAN FORM VIGOROUS SPROUTS. J. Forest. 56: 430-431.
Five-year-old Pinus palustris in Alabama were cut at ground level with an ax. Six months later all the stumps that had all or part of the root collar left had produced vigorous shoots with dense foliage. FA

Hare, R. C. 1965. BREAKING AND ROOTING OF FASCICLE BUDS IN SOUTHERN PINES. J. Forest. 63: 544-546.
Pinching the branch tips of longleaf, slash, loblolly, shortleaf and spruce pines forced fascicle buds into active growth, but only 23 of 6,239 active-budded fascicles rooted when dipped in 8,000 p.p.m. IBA in talc and inserted in perlite under intermittent mist. Species, age, and season of pinching strongly influenced both bud breaking and rooting. FA

Hesseltine, C. W., and Snyder, E. B. 1958. ATTEMPTS TO FREEZE-DRY PINE POLLEN FOR PROLONGED STORAGE. Bull. Torrey Bot. Club 85: 134-135.
A report on unsuccessful attempts to adapt to Pinus palustris methods used to treat fungus spores for storage. FA

Hough, W. A. 1964. AN INVESTIGATION OF SURFACE ROOT DISTRIBUTION IN LONGLEAF PINE-TURKEY OAK-STAND USING RADIOIODINE. Diss. Abstr. 25: 731-732..
I_{131} monitored for radioactivity. Maximum distance for detection of 1_{131} in pine was 55 feet, and 48.7 feet for oak.

Kaloyereas, S. A., Mann, W. F., Jr., and Miller, J. C. 1961. EXPERIMENTS IN PRESERVING AND REVITALIZING PINE, ONION, AND OKRA SEED. ECOn. Bot. 15: 213-217.
Partial drying can extend the viability of pine seed stored both above and below freezing point. For longleaf pine, drying to 8 percent moisture aided in preserving viability at subfreezing temperatures. Drying to 5 percent was preferable for storing at room temperature.

Kraus, J. F. 1959. METHOXONE TREATMENT OF LONGLEAF PINE SEED. J. Forest. 57: 650.
Seeds were soaked at room temperature for 24 hours in aqueous solutions of methoxone and then rinsed and sown. Concentrations of methoxone at > 500 p.p.m. proved toxic to longleaf pine seed, and the effect of low concentrations was either too short-lived or did not stimulate the desired acceleration of height growth and early seedling development. FA

Kraus, J. F., and Johansen, R. W. 1960. A TEST OF GIBBERELLIC ACID ON LONGLEAF PINE. J. Forest. 58: 194.
Tests on the response of Pinus palustris to a 200 p.p.m. solution of gibberellic acid at the Lake City Research Center in March 1957 gave negative results. Treatments, with 60 seedlings in each, were: dipping the entire plant; dipping the root system only; dipping the foliage to the root collar; and an untreated control. Four months after planting, survivals were 45, 62, 68, and 88 percent respectively. The differences were significant at the 1 percent level of probability. Untreated controls looked the most vigorous. FA

McCulley, R. D. 1945. GERMINATION OF LONGLEAF PINE SEED AT HIGH AND LOW TEMPERATURES. J. Forest. 43: 451-452.
Earlier experiments have indicated that temperatures much above 80° F. are unfavorable to germination of longleaf pine (Pinus palustris) seed. In order to make a direct comparison between germination at high and low tempera-

tures an experiment was set up in which samples from each of two lots of seed were cooled with ice to about 65° F. and comparable samples were allowed to remain at laboratory temperatures of 85-100°F. Total germination in 25 days was 49 and 64 percent for the two ice-cooled samples of seed and 14 and 18 percent for the two samples of seed at laboratory temperatures. Of the seed which remained ungerminated at the end of 25 days. 9 and 24 percent of the ice-cooled and 41 and 63 percent of seed at laboratory temperature was found to be sound, a further indication of the inhibitory effect of high temperature upon germination of seed of this species.

McGregor, W. H. D. 1960. EFFECT OF PHOTOPERIOD ON NURSERY GROWTH, OUTPLANTING SURVIVAL, AND SUBSEQUENT GROWTH OF SLASH, LONGLEAF, AND SAND PINE. Assoc. Southern Agr. Workers Proc. 57: 252-253.
Longleaf grown under long (20-hour) and normal photoperiods showed no difference in height growth in the nursery or in field survival and growth. Normal-day seedlings had more foliage.

Maki, T. E. 1963. BETTER FOREST MANAGEMENT THROUGH BETTER ADAPTATION. Seventh Southern Conf. on Forest Tree Impr. Proc. 1963: 12-15.
Marked differences in longleaf pine root systems seem to be related to origin of seed, the more fibrous root systems being associated with seed from the more moist habitats. Errors in adaptation of species to site are mentioned. including replacing longleaf with slash and loblolly on deep sands and other droaghty sites.

May, J. T., Johnson, H. H., and Gilmore, A. R. 1962. CHEMICAL COMPOSITION OF SOUTHERN PINE SEEDLINGS. Ga. Forest Res. Counc. Res. Pap. 10, 11 pp.
Samples of Pinus taeda, P. palustris, and P. elliottii were collected from three nurseries over a period of 6 years. Nutrient concentrations in needles, stems, and roots were found to be influenced by inheritance, organ sampled, stage of development, season, years or cyclic effects, ferilization. cover crops, sawdust in the soil, MeBr soil fumigation, and irrigation.

Mayer, A. M., and Poljakoff-Mayber, A. 1963. THE GERMINATION of SEEDS. 236 pp. Oxford: Pergamon Press.
A review of a wide literature field including: Structure of seed and seedlings: chemical composition of seeds: factors affecting germination: dormancy inhibition and stimulation; metabolism of germinating seeds: the effect of germination inhibitors and stimulators on metabolism: and the ecology of germination, with many examples from woody species. FA

Mergen, F. 1953. GUM YIELDS IN LONGLEAF PINE ARE INHERITED. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 29, 2 pp. Also in Nav. Stores Rev. 62 (47) : 18-19. Also in AT-FA J. 15 (5) : 14, 17.
Gum yield is an inherited character in longleaf pine. In a .study started in 1935 at Lake City. Florida, it has been found that gum yields of 17-year-old longleaf pine trees from above-average mother trees are significantly higher than yields from below-average trees.

Mergen, F. 1953. SELECTION AND BREEDING OF LONGLEAF PINE. Nav. Stores Rev. 63 (7) : 12-14, 23-26.
See second entry below.

Mergen, F. 1953. SELECTION AND BREEDING OF SLASH AND LONGLEAF PINE AT LAKE CITY. FLORIDA. Second Southern Conf. on Forest Tree Impr. 7 pp. Also in Eleventh Congr. Proc., Iut. Union Forest. Res. Organ. Sect. 22, pp. 481-487. 1954.
A species improvement program established in 1941 at the Forest Service's research center in Lake City. Florida, aims to develop superior strains of longleaf and slash pine for naval stores.

Mergen, F. 1954. IMPROVING THE EARLY GROWTH OF LONGLEAF PINE. Forest Farmer 13(11): 8-9, 16-17, 19. Also in Nav. Stores Rev. 64(3) : 12-13, 21.
Early growth can be accelerated with genetically improved stock, but some time will elapse before such stock is developed.

Mergen, F., and Pomeroy, K. B. 1954. TREE IMPROVEMENT RESEARCH AT THE LAKE CITY, FLORIDA, RESEARCH CENTER. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 45, 59 pp.
Superior attributes sought are rapid growth, disease resistance, better stem form, and improved grain or density of wood.

Mergen F., Rossoll, H., and Pomeroy, K. B. 1955. HOW TO CONTROL THE POLLINATION OF SLASH AND LONGLEAF PINE.
U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 58, 14 pp.
A description of the technique, with illustrations of the various steps. e. g.. isolation of ~ flowers. collection of a catkins, extraction of pollen. and pollination, including equipment and records. FA

Namkoong, G. 1963. COMPARATIVE ANALYSES OF INTROGRESSION IN TWO PINE SPECIES. DISS. Abstr. 24: 1801.
A study was tirade of the form of introgrcssion between longleaf (Pinus palustris) and loblolly (P. taeda) pine in western Louisiana. Intermediate Fr types are being continually produced in the area and a bidirectional gene flow into both longleaf and loblolly pine is occurring. The directions of introgressive influence seem to be related to site factors.

Nelson, R. M. 1952. OBSERVATIONS ON HEAT TOLERANCE OF SOUTHERN PINE NEEDLES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 14, 6 pp.
Needles of loblolly, longleaf. slash, and pitch pine were immersed in water at temperatures .from 50 to 64° C. At 60° C. needles for all species were killed almost instantly.

Parker, J. 1959. SEASONAL VARIATIONS IN SUGARS OF CONI-
FERS WITH SOME OBSERVATIONS ON COLD RESISTANCE. Forest Sci. 5: 56-63.
Sucrose, glucose, and fructose. often found in the warmer months, usually increased in winter in the bark and leaves of six conifers investigated in New York State. Suspected raffinose and stachyose increased in autumn to early winter in the bark of all and in the leaves of some of these. Similar increases of these two sugars occurred in deciduous hardwoods (six spp.) but not in broadleaved evergreens. In Pinus strobus (one tree) the branch- and root-wood contained four or five of these sugars in winter and only sucrose in summer, at the levels sampled. In the branch and root-bark, all five sugars markedly increased in winter while starch reached minima in midsummer throughout the tree and in winter in the aerial parts only. Leaves of P, palustris seedlings (exotic, from the Deep South), grown in the open, did not develop in winter the high sugar content, freezing resistance or indication of stachyose found in P. strobus, similarly grown. Greenhouse seedlings of both species had in winter less sugar and more starch and less cold resistance than those grown in the open though their hardiness increased somewhat in spring. FA

Parker, J. 1961. SEASONAL TRENDS IN CARBON DIOXIDE AB-
SORPTION, COLD RESISTANCE, AND TRANSPIRATION OF' SOME EVERGREENS. Ecology 42: 372-380.
In a study at New Haven, on a 10-year-old Chamaecyparis pisifera growing in the open and 3-year seedlings of Pinus

sylvestris and P. palustris growing (a) in the open, (b) in a greenhouse, CO_2 absorption (tested in the open for all plants) continued to be high in November (when leaf fall was nearly complete) gradually declined towards nil in late January in the open, and started again in early April (well before general bud opening). In (b), high values were occasionally recorded throughout the winter. Seasonal changes in cold tolerance and in transpiration were roughly but not closely similar. In P. palustris, in particular, winter increase in cold resistance teas the same in (a) and (b). This moderate increase, and the slightly greater one in. (b) .for P. sylvestris, which appeared to be independent of temperature. is attributed to the effect of shorter days. There was no seasonal change in leaf water contents. Maximum cold tolerances are given for the following species: P. palustris -24° C., C. pisifera -43°. Rhododendron spp. -48°, Taxus baccata -56', Tsuga canadensis -58°, P. sylvestris -80° , and P. strobus lower than -77°. FA

Perry, T. O. 1954. CONTROLLED POLLINATION OF PINE SPECIES IN NORTH AMERICA. J. Forest. 52: 666-671.
Flower stages of longleaf pine strobili are illustrated with photographs.

Pomeroy, K. B. 1953. BETTER TREES FOR TOMORROW. Nav. Stores Rev. 63 (20) : 19, 21-22. Also in AT-FA J. 16 (2) : 18.
Propagation and controlled breeding, proven methods of the horticulturist and agronomist, are now being used in developing superior strains of longleaf and slash pine.

Saylor, L. C. 1967. VARIABILITY OF CHROMOSOME STRUCTURE AND BEHAVIOR IN SOUTHERN PINE HYBRIDS. Ninth Southern Conf. on Forest Tree Impr. Proc. 1967: 95-100.
Variability of chromosomal structure and behavior was studied in three species and ten hybrid combinations of Pinus echinata, P. elliottii var. elliottii, P. palustris, and P. taeda. Loblolly, longleaf, shortleaf, and slash pines appear compatible enough to allow interspecific hybrids, including three-way crosses, to be formed and to develop normally.

Sebopmeyer, C. S. 1953. A REVIEW OF SOME PHYSIOLOGICAL ASPECTS OF OLEORESIN FLOW FROM SLASH AND LONGLEAF PINE. Assoc. Southern Agr. Workers Proc. 50: 172.
Oleoresin flow from wounds stop after about 1 week, probably because crystallized resin plugs the ducts. Dehydrating agents applied to the wound prolong the flow to 2 weeks, probably by inhibiting the occlusion of water released by the wounded tissue. Spraying with 50 percent sulfuric acid is the most effective treatment for prolonging gum flow.

Snyder, E. B. 1961. EXTRACTING. PROCESSING, AND STORING SOUTHERN PINE. POLLEN. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 191, 14 pp.
Recommends extracting pollen from ripe strobili in dry, warm. moving air and storing it at 22 percent relative humidity and 32' F.

Snyder, E. B. 1961. MEASURING BRANCH CHARACTERS OF LONGLEAF PINES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 184, 4 pp.
From measurements of all mature branches on 48 longleaf trees it was deduced that the best place to determine inherent branch angles and diameters was a "zone of equilibrium" in the middle crown where diameters of successive branches down the bole increased in proportion to bole diameter.

Snyder, E. B. 1961. RACIAL. VARIATION IN ROOT FORM OF LONGLEAF PINE SEEDLINGS. Sixth Southern Conf. on Forest Tree Impr. Proc. 1961: 53-59.
In a study of root forms of 20 provenances from Georgia and one each from Mississippi, Alabama, and Louisiana, the root systems of seedlings from east Georgia appeared to be more fibrous and to have more lateral roots, the progenies with the most roots usually also having the greatest total root length. Root length was not related to seedling size. It is suggested that the fibrous root form may be related to the wetter summers and autumns of the region. FA

Strohl, M. J., and Seikel, M. K. 1965. POLYPHENOLS OF PINE POLLENS: A SURVEY. Phytochemistry 4: 383-399.
Pollen of Pinus taeda, P. strobus, P. resinosa, P. elliottii var. elliottii, P. banksiana, P. ponderosa, P. echinata, and P. palustris was analyzed. Phenolic acids and coumarate esters varied little with species. but the flavonoid fraction and the carbonate-soluble material from the ether extractives were promising for taxonomic diagnosis. FA

Texas Forest Service. 1953. FIRST PROGRESS REPORT, FOREST TREE IMPROVEMENT PROGRAM OF THE TEXAS FOREST SERVICE. Texas Forest Serv. Cir 35, 14 pp.
Describes genetics research, including the selection and testing of "superior" longleaf pines.

Wakeley, P. C., and Campbell, T. E. 1954. SOME NEW PINE POLLINATION TECHNIQUES. U.S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 136, 13 pp.
Illustrates flower development stages in longleaf pine. Discusses pollination techniques and simple equipment for controlled breeding of southern pines.

Woods, F. W. 1960. GIBBERELLIC ACID FAILS TO STIMULATE GROWTH OF LONGLEAF PINE SEEDLINGS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest Res. 1: 17.
Height growth was not promoted by foliage sprays of gibberellic acid in oil or water.

Wright, J. W. 1962. GENETICS OF FOREST TREE IMPROVEMENT. FAO Forest, and Forest Prod. Study 16, 399 pp.
Contains 12 sections: (1) Illustrations of basic genetic principles in forest trees (24 refs.); (2) Population genetics--mutation, migration, population size: (3) Population genetics-selection and pollination mechanisms (24 refs.): (4) Migration rates and population sizes in forest trees (19 refs.): (5) Individual tree selection and selective breeding (73 refs.): (6) Geographic variation to forest trees (with special reference to Acer saccharum, Fraxinus americana, Larix decidua, L. leptolepis, Picea abies, Pinus contorta, P. echinata, P. palustris, P. elliottii, P. pinaster, P. ponderosa, P. resinosa, P. sylvestris, P. taeda, Populus balsalnifera, P. deltoides, P. trichocarpa, Pseudotsuga taxifolia, and Quercus) (56 refs.): (7) Species and racial hybridization (with special reference to Pinus, Picea, Abies, Larix, Araucaria, Populus, Quercus, Castanea, Aesculus, Acer, Eucalyptus, and Betula) (133 refs.): (8) Tree introduction (with special reference to Australia. New Zealand. S, Africa. Trinidad and Tobago, Kenya. France, Italy, Great Britain. and the N. E. United States) (40 refs.): (9) Polyploidy and its importance in tree breeding (57 refs.): (10) Experimental design and analysis (15 refs.): (II) Controlled pollination (32 refs.): and (12) Vegetative propagation (34 refs.). FA

17 SYSTEMATIC BOTANY

DeVall, W. B. 1945. A BARK CHARACTER FOR THE IDENTIFICATION OF CERTAIN FLORIDA PINES. Fla. Acad. Sci. Proc. 1944: 101-103.
The appearance of the cork cambium or phellogen layer has proved to be a useful diagnostic feature in the identification of native Florida pines. The native species having ivory-white. conspicuous phellogen lines arc Pinus australis Michx f., P. palustris Mill., P. echinata Mill., P. caribaca Mor., P. glabra Walt., and P. clausa Engclln. In the remaining two species P. taeda L. and P. serotina Michx.)

the lines are inconspicuous or, at most. slate-grey in color. This bark character as been particularly useful for separating P. taeda from P. palustris in the Gainesville area when other characters failed. FA

Fernald. M. L. 1948. THE CONFUSED BASES of THE NAME PINITS PALUSTRIS. Rhodora 50: 241-249.
Account of the circumstances that led to the name Pinus palustris. Suggests that Pinus australis, a name given by Michaux, would be preferable.

Grelen, H. E., and Duvall, V. L. 1966. COMMON PLANTS OF' LONGLEAF PINE-BLUESTEM RANGE. U. S. Dep. Agr. Forest Serv, Res. Pap. SO-23, 96 pp. Southern Forest Exp. Sta., New Orleans, La.
Descriptions and botanical drawings of more than 80 understory species, with notes on values for cattle and wildlife.

Langdon, O. G., Bomnard, M. L., and Cassady, J. T. 1952. FIELD BOOK OF FORAGE PLANTS ON LONGLEAF PINE-BLUESTEM RANGES. U. S Dep. Agr. Forest Serv. Southern Forest Fxp. Sta. Occas. Pap. 127, 117 pp.
Illustrated descriptions.

Mirov. N. T. 1967. THE GENUS PINUS. 602 pp. New York: Ronald Press Co.
Comprehensive treatise: history, paleobotany, geography, genetic aspects, morphology and reproduction, physiology and ecology, chemical aspects, chemical geography, and taxonomy. Various references to Pinus palustris.

Wahlenburg, W. G. 1945. LONGLEAF PINE. 1. Southern Lumberman 171 (2153 I : 168-170.
Distinctive characteristics of longleaf pine. Also uses, strength., durability. and pulping characteristics of the wood.

West, E., and Arnold. L. E. 1946. PINUS PALUSTRIS MILL. I.ONGLEAF PINE. YELLOW PINE, SOUTHERN PINE (PINACEAE: PINE FAMILY). In The Native Trees of Florida, p. 8. Gainesville: Univ. Fla. Press.
Description, distinguishing characteristics, and general comments. Drawings of cones, needles. and seed.

Wood, J. W. 1952. CANDLES IN THE WILDERNESS. Frontiers 16: 80-81.
Photographs and brief popular description of longleaf pine vegetative buds (candles).

18 PLANT ECOLOGY

Allen, R.M. 1956. RELATION OF SAW-PALMETTO TO LONGLEAF PINE REPRODUCTION ON A DRY SITE. Ecology :37: 195-196.
On a dry ridge in Mississippi, Pinus palustris seedlings were found only near clumps of Serenoa repens. Apparently the palmetto shade protected the seedlings from lethal temperatures and improved their water relations.

Allen, R.M. 1965. LONGLEAF PINE (PINUS PALUSTRIS MILL.). In Silvics of Forest Trees of the United States, pp. 384-389. U. S. Dep. Agr., Agr. Handbook 271.
A very complete summary of silvical characteristics.

Boyer, W. D. 1956. TIME OF LONGLEAF SEEDFALL. U. S. Dept. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 102.
In a better-than-average crop in south Alabama, the first viable seed was trapped on October 14 and the last on February 6, with the bulk falling between October 24 and November 21, 1955.

Boyer, W. D. 1958. LONGLEAF PINE SEED DISPERSAL IN SOUTH ALABAMA. J. Forest 56: 265-268.
Number of sound seeds dispersed from forest walls into openings was halved with each 55-link increase in distance from the seed source. Seventy-one percent fell within 1 chain of the base of the parent trees.

Boyer, W. D. 1963. DEVELOPMENT OF LONGLEAF PINE SEEDLINGS UNDER PARENT TREES. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-4, 5 pp. Southern Forest Exp. Sta., New Orleans, La.
In southwest Alabama, unburned seedlings under overstories ranging up to 90 square feet of basal area per acre survived as well as those with no tree competition. After 7 years, milacre stocking averaged 99 percent and survival 72 percent. Growth, but riot survival, improved with distance from parent trees. Seedlings under tree crowns had less brown spot than those in the open.

Boyer, W. D. 1963. LONGLEAF PINE SEED DISPERSAL. U. S. Dep. Agr. Forest Serv. Res. Note SO-3, 2 pp. Southern Forest Exp. Sta., New Orleans, La.
Two transects of seed traps were established at right angles to each of four forest walls enclosing a rectangular 80-acre clearing in 65-feet-high, 40- to 50-year Pinus palustris in Alabama. Seed production was 104,000 sound seeds per acre in 1955 and 1958, 19,000 in 1957, and nil in 1956. Of sound seed trapped beyond the edges of the forest walls, 71 percent fell less than 1 chain from the base of the parent trees, and the number dispersed was halved with each 55-link increase in distance from the seed source. FA

Boyer, W. D. 1966. LONGLEAF PINE POLLEN DISPERSAL. Forest Sci. 12: 367-368.
A high ratio of pollen drift to deposition and the high level of pollen found in an open area suggest that Pinus palustris forests fill the air with pollen that travels for long distances, with density declining mostly through diffusion rather than fallout.

Boyer, W. D., and Fahnestock, G. R. 1966. LITTER IN LONGLEAF PINE STANDS THINNED TO PRESCRIBED DENSITIES.
U. S. Dep. Agr. Forest Serv. Res. Note SO-31, 4 pp. Southern Forest Exp. Sta., New Orleans, La.
Reports a study to determine the affects of stand density of even-aged second-growth Pious palustris in southeast Alabama on the composition, deposition, and accumulation of litter on the forest floor. The relation of litter weight to stand basal area was exponential, and pine needles constituted 70 percent of the trapped litter. The mean weight of material. on the forest floor, excluding the miscellaneous partly decayed material, ranged from 2,587 to 4,256 pounds per acre exponentially according to stand density. There was a significant negative curvilinear correlation between grass weight and stand density. The amount of flash fuel increased rapidly with increase of basal area, but its total weight did not become great enough, under stands of up to 50 square feet per acre, either to support a high-intensity fire or to equal 2 years' deposition of needles. It is concluded that, in the absence of significant quantities of flammable brush, prescribed burning for hazard reduction alone does not seem to be warranted in such light stands. FA

Burk, C. J. 1959. A FLORISTIC STUDY OF' A SANDHILL AREA ON THE NORTH CAROLINA COASTAL PLAIN. J. Elisha Mitchell Sci. Soc. 75 (2) : 135-138.
The following plant communities were observed: (I) A xeric ridge community with Pinus australis (P. palustris) as the dominant tree species in association with Quercus laevis and Aristida stricta; (2) a pocosin community composed of elliptic-leaved evergreen Ericaceous species and hollies, succeeded by members of the bay forest; (3) and ecotonal community composed of members of both the adjoining ridge and pocosin communities, as well as elements unique to the ecotone: and (4) disturbed communities of cutover pine forests, old fields, and roadsides. FA

Campbell, R.S. 1955. VEGETATIONAL CHANGES AND MANAGEMENT IN THE. CUTOVER LONGLEAF PINE-SLASH PINE AREA OF THE GULF COAST. Ecology 36: 29-34.
Secondary plant succession in the longleaf pine-slash pine belt of the Gulf Coastal Plain is influenced by timber cutting, burning. and grazing. The damaging effects of wildfire and of uncontrolled annual burning are in part alleviated by their replacement in managed stands by prescribed burning. which is useful in reproducing and growing longleaf pine and slash pine stands and in improving grazing. Hogs and sheep are serious threats to the early survival and growth of both longleaf and slash pines, but cattle usually allow the stands to develop with little disturbance. The scrubby hardwoods and underbrush that naturally develop when only the pines arc cut or when complete fire protection is practiced constitute a problem on which more and more attention is being focused. Increasing intensity of land management for timber growing and range grazing is aggravating conditions of soil fertility and physical condition which may soon be reflected in stand structure and growth of both trees and grass. These problems should be attacked from the ecological viewpoint.

Chapman, H. H. 1950. LIGHTNING IN THE LONGLEAF. Amer. Forests 56 (1) : 10-11, 34.
Gives evidence for the theory that Pinus palustris represents a fire climax and meteorological data to show the probability of lightning having been the cause of this development long before man-rnadc fires occurred.

Chapman, H. H. 1950. LONG-LEAF YELLOW PINE OWES ITS EXISTENCE TO FIRE. Coastal Cattleman 16 (3) : 10-13.
Speculates on the role of lightning fires, before the advent of man-caused fires, in the ecology of longleaf pine. An estimated 150,000 acres were burned annually by lightning fires in Alabama, Florida, Louisiana, Mississippi, and Texas. These fires favored the development of pure stands of longleaf.

Collingwood, G. H., and Brush, W. D. 1947. LONGLEAF PINE (PINUS PALUSTRIS MILL.). In Knowing Your Trees, pp. 54-55. Amer. Forest. Assoc. Wash., D. C
A popular description, including botanical and silvical characteristics and economic importance.

Cooper, J. R. 1946. THE SILVICULTURAL MANAGEMENT OF LONGLEAF PINE. M. S. Thesis. Yale Univ. Sch. Forest. New Haven, Conn.
Broad treatise, covering tree characteristics, silvicultnral characteristics, management, and utilization.

Croker, T. C., Jr. 1952. EARLY RELEASE STIMULATES CONE PRODUCTION. U. S. Dcp. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 79.
In southern Alabama, longleaf pine seed trees that were released from competition for 32 months before cones matured produced almost four tines as many cones as trees with only 8 months of release.

Croker. T. C., Jr. 1958. SOIL DEPTH AFFECTS WINDFIRMNESS OF LONGLEAF PINE. J. Forest. 56: 432.
A survey of trees felled by hurricane Flossy in 1956 indicated that longleaf pines on the Escambia Experimental Forest in south Alabama were most susceptible to windthrow where surface soils were underlain by clay at a shallow depth. Restricted root development on shallow soils, along with greater saturation during rainstorms, is believed to be primarily responsible.

Davis, V. B. 1955. DON'T KEEP LONGLEAF SEED TREES TOO LONG! U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 98.
When some 3-year-old longleaf pine seedlings were burned to control brown-spot needle blight, it was found that seedling mortality was highest close to the overstory pines, where seedlings were smaller and heavy needle cast added to the fuel supply.

Derr, H. J., and Enghardt, H. 1957. SOME FORESTRY LESSONS FROM HURRICANE AUDREY. Southern Lumberman 195 (2441): 142-144.
Slash pine was hit harder than loblolly or longleaf, chiefly because it has been widely planted on poorly drained flatwood sites, where a high degree of windfirmness cannot be expected. Much of the loss was in windthrow of dominant and codominant trees. Stands below merchantable size were damaged mainly by breakage of fusiform-infected stems. Dense stands were harmed less than some that had recently been heavily thinned.

DeVall, W. B. 1943. THE CORRELATION OF SOIL PH WITH DISTRIBUTION OF WOODY PLANTS IN THE GAINESVILLE AREA.
Fla. Acad. Sci. Proc. 6 (1) : 9-24.
A study was made to obtain specific data on the relationship between soil acidity and the species and distribution of woody plants present in the Gainesville district, Florida. The seven areas selected for study represented the following major forest types: (1) pine flatwoods, (2) mixed hardwood hammock, and (3) scrub oak ridge. All trees within a radius of 20 feet and all associated shrubs within a radius of 10 feet of a soil sample were tallied. Of the 68 species included in the study, 28 occurred on definitely alkaline soils, 28 on neutral soils, 41 on slightly acid soils with a pH of 6.0-7.0, 50 on moderately acid soils (pH of 5.0-6.0),12 on strongly acid soils (pH of 4.0-5.0), and one (Pinus palustris) on an extremely acid soil with. a pH of 3.8. The species are grouped in five fidelity classes according to sociological tendencies to mix with other plants on a large scale or to be exclusive. FA

DeVall, W. B. 1952 . INVASION OF A LONGLEAF PINE SITE BY SLASH PINE AND INFERIOR HARDWOODS. Ala. Acad. Sci. J. 22: 106-107.
On the Little River State Forest in south Alabama, slash pine seedlings have invaded a longleaf site where fires have not burned since 1934.

Dorman, K. W., and Barber, J. C. 1956. TIME OF FLOWERING AND SEED RIPENING IN SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 72, 15 pp. Tabulates approximate dates in 1956 for pollen and seed ripening for slash, longleaf, loblolly, and shortleaf pines throughout their natural ranges, with similar data from a few stations for some minor pine species. There was a strong correlation between tine of pollen ripening and latitude. FA

Gaines, E. M. 1950. SCRUB OAK HELPS LONGLEAF SEEDLINGS ON DEEP SANDS. U. S. Dep. Agr. Forest Serv. Southern Forest Esp. Sta. Southern Forest. Notes 69. Also in Nav. Stores Rev. 60 (28) : 2.
Observations of first-year seedlings in Alabama during 1948 and 1949 showed that seedlings on deep sands survived late spring drought better when shaded by scrub oak than in the open. FA

Gaines, E. M. 1952. SCRUB OAK AS A NURSE CROP FOR LONGLEAF PINE ON DEEP SANDY SOILS. (Abstr.) Ala. Acad. Sci. J. 22: 107-108.
Initial establishment was better under hardwood crowns than in the open, presumably because of improved soil moisture and reduced seedling transpiration. After the pines are well established, perhaps in a year or less, the scrub oak nurse trees become competitors.

Gaines, E. M., Campbell, R. S., and Brasington, J.J. 1954.
FORAGE PRODUCTION ON LONGLEAF PINE LANDS OF SOUTHERN
ALABAMA. Ecology 35: 59-62.
A study was made in second-growth longleaf pine [Pinus palustris] lands in southern Alabama to determine relationships between production of grasses and forbs and several ecological factors. Herbage production decreased as the basal area of the tree stand increased. The curvilinear regression showing this relationship is highly significant statistically, but accounts for only 14 percent of the variation in herbage production. Distribution of the tree stand also affects herbage production. A single longleaf pine tree, 7to 14 inches d.b.h.., influences grass production only 6 to 8feet from the trunk, while a group of trees reduces herbage production up to 20 to 30 feet away from the forest wall. Weight of tree litter was closely associated with herbage production. The linear regression is highly significant statistically, and accounts for 21 percent of the variation in herbage production. Three major upland soil groups were recognized in this study. The mean herbage production per acre (adjusted to average litter weight) by soil groups was: soils with clay subsoils-860 pounds, soils with loam subsoils-680 pounds, and deep sands-470 pounds. Soil groups and litter weight together account for 31 percent of the variation in herbage production. Herbage production was highest on moist sites favorable to slender bluestem. Up-lands produced about 2.75 times as much grass as did the bottom lands. Since bottom-land soils are basically more productive than upland soils, the difference is attributed to heavy brush and tree competition in the bottoms. FA

Gemborys, S. R. 1967. VEGETATION AND HABITAT OF SMALL STREAM RRANCH-BOTTOMS OF SOUTHWESTERN ALABAMA. Diss.
Abstr. 28: 4018-B.
A phytosociological investigation was made in branch bottoms interlacing longleaf forests in southwestern Alabama. Species frequency was determined on a variety of sites ranging from dry to wet and from burned to unburned. Ranking of leading species from dry to wet (and most burned to least burned) sites was: Cornus florida, Pinus palustris, Quercus nigra, Liquidambar styraciflua, Nyssa sylvatica var. sylvatica, P. elliottii var. elliottii, and N, svlvatica var. biflora.

Greene, J. T., and Reines, M. 1959. REPRODUCTION OF LONGLEAF PINE OUTSIDE ITS NATURAL RANGE. U. S, Dep. Agr. Forest Serv. Tree Planters' Notes 35, pp. 26-27.
Records natural regeneration of Pinus palustris in a plantation at Athens, Georgia, ca. 60 miles northwest of the nearest natural limits of the species. FA

Grelen, H. E. 1962. PLANT SUCCESSION ON CLEARED SANDHILLS IN NORTHWEST FLORIDA. Amer. Midland Natur. 67: 36-44.
Annual composites such as Balduina angustifolia, Erigeron pusillus, and Aplopappus divaricatus dominated the earliest stage of succession. Annual grasses were scarce, but two perennials, Panicum malacon and Leptoloma cognatum, came in quickly. At the end of 4 years, Eupatorium compositifolium was the dominant herbaceous plant. Andropogon virginicus increased steadily after the second year. Scrub oaks and Aristida stricta, which dominate uncleared areas, occurred only as scattered plants.

Harkin. D. A. 1962. DIAMETER GROWTH PERIODICITY OF SEVERAL TREE SPECIES IN THE SOUTH CAROLINA COASTAL PLAIN. Forest Sci. 8: 363-370.
Presents data from weekly readings of the basal area and radial growth at breast height for Pinus elliottii and P. taeda, showing also the variation in their initiation and cessation of growth in three seasons, with further information on this duration of seasonal growth for P. palustris, Nyssa sylvatica, Quercus nigra, and Q. stellata. FA

Hedlund, A., and Janssen, P. 1963. MAJOR FOREST TYPES IN THE SOUTH. U. S. Dep. Agr. Forest Serv. Southern and Southeast. Forest Exp. Stas., 1 p.
Map, in color, at scale of 40 miles to the inch.

Hough, W. A., Woods, F. W., and McCormack, M. L. 1965.
ROOT EXTENSION OF INDIVIDUAL TREES IN SURFACE SOILS OF A
NATURAL LONGLEAF PINE-TURKEY OAK STAND. Forest Sci. 11: 223-242.
In the sandhills of North Carolina, 1-131 was introduced to soil at selected spots, absorbed by roots, and translocated. Radioactivity was detected in pine stems as far as 55.1 feet from plot center and in oak stems out to 48.7 .feet. All pines within 17 feet of plot center showed contact with the isotope source. and all oaks within 15 feet. Factors most closely related to distance of root extension were elevation and tree age for longleaf, and age and tree height for turkey oak.

Janssen, P., and Weiland, M. R. 1960. SOFTWOOD DISTRIBUTION MAPS FOR THE SOUTH. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Forest Surv. Release 83, 12 pp.
The maps present the relative concentration and approximate range in 12 Southern States, of 11 species (Pinus palustris, P. elliottii, P. taeda, P. echinata, P. serotina, P. virginiana, P. clausa, P. strobus, Taxodium distichum, Tsuga spp. and Juniperus spp.). FA

Laessle, A. M. 1958. THE ORIGIN AND SUCCESSIONAL RELATIONSHIP OF SANDHILL VEGETATION AND SAND-PINE SCRUB.
Ecol. Monogr. 28: 361-387.
The strongly washed and sorted siliceous sands and clays of peninsular Florida are occupied by scrub vegetation where drainage is good or by hammock where fire has been excluded or minimized. Other well-drained deposits, less severely washed and sorted, are occupied by the longleaf pine/turkey-oak association. Circumstantial evidence indicates that the differences in flora of these communities are due to nutritional differences. In absence of fire both of those communities would be succeeded by evergreen hardwoods, known as hammocks.

Lemon, P. C. 1949. SUCCESSIONAL RESPONSES OF HERBS IN THE LONGLEAF-SLASH PINE FOREST AFTER FIRE. Ecology 30: 135-145.
A greater number of species participate in the ground cover in the first 3 years following a fire than after 8 years of fire protection. The greater variety of forage plants on a fresh burn is probably a dietary advantage to cattle. Various morphological adaptations seem to be of value for rapid aggregation of plants on burns. Many of the fire followers have a large number of small seeds, frequently windborne, supplemented by rhizomes. crown buds, and tillers. FA

McLemore, B. F., and Derr, H. J. 1965. LONGLEAF PINE
CONE MATURITY IS INDEPENDENT OF POLLINATION DATE. Silvae Genet 14: 133.
Period of seed development is constant for individual trees but varies between trees. The order of cone ripening is nearly identical from year to year.

Monk, C. D. 1966. EFFECTS OF SHORT-TERM GAMMA IRRADIATION ON AN OLD FIELD. Radiat. Bot. 6: 329-335.
A 12-year-old field that had been planted in longleaf pine 5 years previously was exposed for 400 hours to a 9.200 c Cs_{137} *irradiator in May 1965. Exposure for 400 hours was not sufficient to establish vegetation zones corresponding to different radiation levels; however, Fimbristylis autumnalis did invade the 160 kR zone following exposure.*

Changes in floristic composition along a radiation gradient exhibited a 50 percent reduction in similarity and diversity at 530 and 750 R per day respectively. Root biomass production decreased with increased radiation. The reduction teas related to direct radiation damage and to indirect damage through the death of shoots followed by root degradation. Terminal stem elongation in longleaf pine was reduced to 50 percent by 1 R per day. At the end of the 1965 growing season, mortality resulted in all pine that received 9,000 R.

Muntz, H. H. 1954. HOW TO GROW LONGLEAF PINE. U. S. Dep. Agr. Farmers' Bull. 2061, 25 pp.
Topics include: reasons for growing longleaf pine, tree characteristics, how to establish and manage the stand, marketing the crop, naval stores, and dual use of forests to produce cattle as well as trees.

Parker, J. 1965. THE ABILITY OF WARM-CLIMATE PINES TO BECOME COLD HARDY. Pakistan J. 15: 156-160.
Needles from seedlings of (a) Pinus taeda and (b) P. palustris were tested for resistance to low, temperature from summer into midwinter in south Connecticut: (b) was capable of hardening from -10 to --15° C. Greenhouse seedlings did as well in this respect as those grown in the open, suggesting the lack of a temperature induction mechanism for hardiness development; (a) was capable of hardening from ca. -12 to --14° C., but only in the case of field-grown seedlings. The general weakness of the hardening mechanism in these two species helps to support the idea that low temperatures limit their northern geographical range. FA

Pessin, L. J., and Chapman, R. A. 1944. THE EFFECT OF LIVING GRASS ON THE GROWTH OF LONGLEAF PINE SEEDLINGS IN POTS. Ecology 25: 85-90.
Longleaf pine (Pinus palustris) seedlings were grown for a period of 2 years in 1-gallon metal containers in some of which grass was sown while the remainder were kept free of grass. Two watering schedules were tested at 250 and 500 ml weekly. Where pines were grown with grass(pure broom sedge and a mixture of other species), the vegetation cover was either (a) burned off once a year. the ashes being returned to the soils in the containers. (b) clipped twice a year. or (c) left undisturbed ('rough') as a check. The average dry weight of the pine seedlings grown in cultures without grass was significantly greater than that of seedlings grown in cultures with grass in the rough condition, but it was not significantly influenced either by mulching or by the amount of water applied. Analysis of the seedlings grown with grasses under the three different conditions (a, b, and c) noted above, showed that the average dry weight of pines grown with burned broomsedge was significantly greater than that of pines grown with clipped broomsedge, which in turn was significantly greater than the average dry weight of those grown with 'rough broomsedge. No significant differences in average dry weight appeared, however, among pines grown with mixed species other than broomsedge, subjected to the same three treatments. Of the pines grown with broom-sedge, those receiving 500 ml. of water showed a significantly greater average dry weight than those receiving 250 mi.. though this difference was not observed for pines growing with mixed grasses other than broonisedge. FA

Quarterman, E., and Keever, C. 1959. CLIMAX FOREST OF THE LONGLEAF PINE BELT OF THE SOUTHEASTERN UNITED STATES. Proc. 9th Int. Bot. Congr., Vol. 2, p. 315.
The seral position of hardwood stands on upland sites in this Coastal Plain belt has been in question. Phytosociological studies, in which widely distributed stands were sampled, have been made over a 3-year period. Soils from each of the sampled stands were also analyzed mechanically and for major nutrients. These studies have established the continuity throughout the area of a mixed hardwood type of forest unified by certain binding species in a way similar to the various portions of the mixed mesophytic forest of Braun. Data obtained provide evidence for regarding this mixed hardwood type as the regional climax. FA

Smith, L. F. 1955. DEVELOPMENT OF LONGLEAF PINE SEEDLINGS NEAR LARGE TREES. J. Forest. 53: 289-290.
If pine litter is removed periodically, large pines and oaks may be left for 5 or 6 years without causing severe mortality among pine seedlings. Earlier removal is preferable, however.

Smith, L. F. 1961. GROWTH OF LONGLEAF PINE SEEDLINGS UNDER LARGE PINES AND OAKS IN MISSISSIPPI. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 189, 4 pp.
When brown-spot needle blight was controlled, longleaf seedlings survived and started height growth near large pines and oaks . Oaks were severer competitors than pines.

Smith, L. F. 1966. EARLY FLOWERING IN LONGLEAF PINE. J. Forest. 64: 198-199.
One tree bore female flowers after its fourth year in plantation, many trees had male or female flowers after the fifth year. Annual cultivation appears to promote early flowering in longleaf.

Stone, E. L., Jr., and Stone, M. H. 1954. ROOT COLLAR SPROUTS IN PINE. J. Forest. 52: 487-491.
A study of six species of pine showed that `root-collar' shoots arise from buds in the axils of primary needles, those just above the cotyledons generally bearing these buds most abundantly. The assumption (from their occurrence below lateral roots) that shoots may arise from root tissues is due to distortion, subsequently concealed by growth. No adventitious buds were found, and decapitation below cotyledons resulted in no regeneration of shoots. That these buds produce coppice shoots in older stems after long dormancy is of minor silvicultural interest but it is important in the survival of seedlings injured by fire, grazing or cutting and even in normal nursery conditions (P. palustris). FA

Tall Timbers Research Station . 1962. TALL TIMBERS RESEARCH STATION FIRE ECOLOGY PLOTS. Tall Timbers Res. Sta. Bull. 2, 179 pp. Tallahassee, Fla.
Plant lists, photos. and sketch maps for 84 square 1/2 -acre fire ecology plots established in 1959.

Wahlenberg, W. G. 1946. LONGLEAF PINE. II-NATURAL DISTRIBUTION OF LONGLEAF PINE AND THE ROLE OF FIRE IN ITS REGENERATION. Southern Lumberman 172 (2154) : 64-66.
Fire furnished the primary control of the distribution of longleaf under natural conditions, largely through its effects on competing species. In managed stands, some burning is essential to secure reproduction and to prevent a hardwood invasion. Frequent fires have a slightly beneficial effect on chemical composition of surface soil and a slightly detrimental effect on physical properties.

Wahlenberg, W. G. 1946. LONGLEAF PINE: ITS USE. ECOL-OGY, REGENERATION, PROTECTION, GROWTH AND MANAGEMENT. 429 pp. Wash., D. C.: Charles Lathrop Pack Forest. Found, and U. S. Dep. Agr. Forest Serv.
This comprehensive monograph renders accessible to the forester, timber grower, research worker, and teacher much information, some of it previously unpublished, on the resources, uses. silviculture and management of Pinus palustris. Part I deals with resources, uses and properties; Part 2 with ecology, including a chapter on the role of fire in regeneration of longleaf pine; Part 3 with problems of natural and artificial regeneration; Part 4 with protection from

fire, insects, diseases, animals and climatic injuries; and Part 5 with management, including chapters on naval stores operation and growth and yield of longleaf pine trees and stands. Each chapter is briefly summarized. Eleven appendices include a glossary, stand tables, diameter and height tables, volume tables, normal growth and yield tables for second-growth longleaf pine. There are 74 original text figures, 48 plates, a bibliography of over 600 references, and a subject index. FA

Wakeley, P. C., and Campbell, T. E. 1960. SEEDLESS LONGLEAF CONES CAN MATURE AND OPEN. U. S. Dep. Agr , Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 127. *In a pollination study in Louisiana, where mixed fresh longleaf pine pollen was applied to bagged flowers on three trees, the ratios of cones produced to flowers pollinated, and of seeds to cone, varied greatly. On one tree, 30 pollinated flowers yielded but one core and this contained no seed. FA*

Walker, L, C., and Davis, V. B. 1954. FOREST WALLS RETARD YOUNG LONGLEAF. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 93. Also in Southern Lumberman 189(2369) : 117.
Border trees of longleaf timber stands slowed the growth of .seedlings as far as 55 feet into openings. Large trees (over 11 inches d.b.h.) had a greater effect than small border trees.

Walker, L. C., and Davis, V. B. 1956. SEED TREES RETARD LONGLEAF PINE SEEDLINGS. J. Forest. 54: 269.
Longleaf pine seed trees reduced the survival and growth of seedlings for at least 50 feet--well beyond the reach of the tree crowns.

Walker. L. C., and Wiant, H. V., Jr. 1966. SILVICULTURE OF' LONGLEAF PINE. Stephen F. Austin State Coll. Sch. Forest. Bull. 11, 105 pp.
Growth. natural reproduction, artificial reproduction, genetics, thinning, pruning, competition control, range management, game management, prescribed burning, destructive agents, and nutrition of longleaf pine forests.

Wilhite, L. P., and Ripley, T. H. 1965. IMPORTANT UNDERSTORY PLANTS OF THE SLASH-LONGLEAF FLATWOODS. Ga.
Forest Res. Counc. Res. Pap. 29, 4 pp. Also in AT-FA J. 27(11): 11-14. Plots were established in the slash-longleaf flatwoods of southeast *Georgia and northeast Florida to determine disturbance succession of the understory and response of planted slash pines to increasing intensities of site preparation. This paper describes understory plant communities in the interval between clear cutting of the overstory and burning and harrowing of the sites in preparation for tree planting.*

Woods, F. W. 1957. FACTORS LIMITING ROOT PENETRATION IN DEEP SANDS OF THE SOUTHEASTERN COASTAL PLAIN. Ecology 38: 357-359.
Root penetration of all species is very shallow on these sandhills; fertility is poor, field capacity small, and the water table at least 40-50 feet below the surface. The scrub oak (mainly Quercus laevis and Q. incana) and Pinus palustris, like all other species, form a thick mat of fibrous roots within 4-5 inches of the surface. Below this are a few large roots and almost no small ones. The factors influencing this form of root system are the superior moisture, nutrient status, and temperature in the surface soil. FA

Woods, F. W. 1959. SLASH PINE ROOTS START GROWTH SOON AFTER PLANTING. J. Forest. 57: 209.
Root growth had started 22 days after planting on all four slash pines in the trial, but on only two of the four longleaf pines and on two of the four sand pines. Observations in other years supported these findings. FA

Zobel, B. J., and Goddard, R. E. 1954. PINE FLOWERING AND SEED RIPENING IN TEXAS. Tex. Forest Serv. Res. Note 8, 10 pp. Phenological data on Pinus palustris, P. taeda, P. elliottii, P. echinata, and × P. sondereggeri. FA

2. SILVICULTURE

22 SILVICULTURAL SYSTEMS

Crokcr. T. C., Jr. 1956. CAN THE SHELTERWOOD METHOD SUCCESSFULLY REGENFRATE LONGLEAF PINE? J. Forest. 54: 258-260.
Regeneration of longleaf pine by the seed tree method has been successful because of inadequate seed crops, invasion of the site by brush and grass, and other problems. Recent results suggest that a modified shelterwood system may be feasible. Some needed research is proposed.

Korstian, C F, Maki, T. E., Ostrom, C. E., and Scheer, R. L. 1954. DESIRABLE CUTTING PRACTICES FOR NORTH CAROLINA FORESTS. N. C. Forest. Assoc., 22 pp. Raleigh.
Recommendations for several types: Eastern white pine, mountain cove. loblolly-shortleaf pine, Virginia pine, long-leaf pine, pond pine, and bottom-land hardwoods of the Coastal Plain.

Perry, J. H., and Riebold, R. J. 1955. STRIP CLEAR-CUTTING TO RGENERATE LONGLEAF PINE. Southern Lumberman 211 (2632): 153-154.
A 45-year-old stand of longleaf pine was regenerated by clearing and disking strips 200 to 300 feet wide and leaving intervening seed-source strips 1 chain in width. Milacre stocking averaged 60 percent, with good distribution over the cleared strips. When cattle and hogs had access to the area, the damage was disastrous.

23 REGENERATION AND FORMATION OF STANDS

231 NATURAL REGENERATION

Batcman, B. A., Roark, C. B., and Harris, H. E. 1967. NATURAL LONGLEAF REPRODUCTION AND ESTABLISHMENT IN S()UTHWESTERN LOUISIANA. La. State Univ. LSU Forest. Notes 74, 2 pp.
Stands can be established where seed supply is adequate, seedlings are protected from hogs, and prescribed fire is used properly.

Bickford, C. A., and Bruce, D. 1948. FIRE AND LONGLEAF PINE REPRODUCTION. Southern Lumberman 177 (2225) : 133-135.
In order to study the effect of different seedbeds on the natural regeneration of longleaf pine (Pinus palustris), an area on the Dry Prong Tract in central Louisiana was fenced and protected from fire at the time of the 1935 seedfall. When the seedlings were a year old, various kinds of controlled burning were tried. Fresh burns and 1-year roughs

(land burned and left fallow for a year) had much the highest survival of first-year seedlings. Burning once or twice after the seedlings were a year old gave a better 6-year-old survival than no burning or annual burning. FA

Boyer, W. D. 1964. NEW LIFE FOR AN OLD FAVORITE. Southern Lumberman 209 (2609) : 99-101.
The difficulty in obtaining Pinus palustris regeneration is commonly attributed to: poor seed production; poor seedling establishment due to destruction by birds, mammals, and insects; low seedling survival due to inability to survive prolonged competition from trees, weeds, etc.; and poor subsequent growth due to competition and Scirrhia acicola attack during the grass stage. A recent experiment in Alabama, however, showed that: maximum (and sufficient) sound seed production per acre was reached under a parent crop density of basal area 35 to 50 square feet per acre; 80 percent of seedlings, protected from fire, survived and were healthy after 7 years under a crop density of basal area 90 square feet per acre, although height increment was suppressed even by quite thin overstories; S. acicola attack was inhibited by the canopy; and, even after 8 years' suppression, seedling response to release by felling the overstory was prompt. Grass stage seedlings appear to be resistant to logging damage. Experiments on other site types are required. FA

Boyer, W. D. 1965. NATURAL REGENERATION OF LONGLEAF PINE: A NEW LOOK AT AN OLD PROBLEM. Ala. Forest Prod. 8(10): 53-56.
Recent research suggests that longleaf pine on many sites can be regenerated from seedling stands established under relatively full parent overstories.

Bruce, D. 1949. LONGLEAF REGENERATION IMPROVED BY BURNING. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 60.
Fire improves seed catch, increases survival. and stimulates height growth.

Bruce, D. 1949. SEED LOSS TO BIRDS UNIMPORTANT ON FRESH BURNS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 63.
In south Mississippi in 1947 and 1948, birds ate very little of the Pinus palustris seed on several small, fresh burns having heavy seed supplies, and the difference between open and screened plots was not great. The greatly increased catch of seedlings on the screened compared with the open plots on old rough was probably due to the discouragement of rodents. FA

Bruce, D. 1950. IT ISN'T THE ASHES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 66.
Rapid early growth of longleaf seedlings on spots where pine logs have recently burned seems due to the action of the fire in killing grass roots rather than any fertilizing or mulching effect of the ashes.

Bruce, D. 1956. YOUNG LONGLEAF DO BEST ON FRESH BURNS. U. S. Dcp. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 101.
Age of rough influences early growth and survival.

Bruce, D., and Bickford, C. A. 1950. USE OF FIRE IN NATURAL REGENERATION OF LONGLEAF PINE. J. Forest. 48: 114-117.
In a study on a 1,000-acre tract in Louisiana, 1-year roughs and fresh burns gave the best seedbeds. Burning once or twice in a 6-year period after seedling establishment was better than no burning. Benefits of burning were especially important where seed supply was poor.

Chapman, H. H. 1948. THE INITIATION AND EARLY STAGES OF RESEARCH ON NATURAL REFORESTATION OF LONGLEAF PINE. J Forest. 46: 505-510.
A review of research in the natural regeneration of Pinus palustris during the last 35 years, with a summary of the conditions now generally accepted as essential (1) all competition by brush and other trees to be reduced by cutting and burning; (2) burning must be done before seedfall, preferably during the preceding winter; (3) winter burning must be carried out in the third and fifth years to eliminate brown-spot disease and competing vegetation; (4) fire must then be excluded until the crop is above 3 feet in height, after which winter burning can be resumed at 3- to 5-year intervals throughout the life of the stand, as a protection against destruction by hot summer fires; (5) where seed trees are inadequate and planting is necessary, fire should be used in the same way. FA

Croker, T. C., Jr. 1957. SCALPING AIDS LONGLEAF SEEDLING CATCH. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 112.
Scalping the seedbed just before seedfall more than doubled the catch of longleaf pine on a sandy site in southern Alabama.

Croker, T. C., Jr. 1959. SCALPING STIMULATES LONGLEAF GROWTH. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 121.
On a sandy ridge in southern Alabama, scalping the seedbed just before seedfall markedly increased the number of longleaf pine seedlings that began height growth in their third year.

DeVall, W. B. 1952. FACTORS AFFECTING THE ESTABLISH-MENT OF LONGLEAF PINE SEEDLINGS FROM THE **1947** SEED CROP. Ala Acad. Sci. J. 21: 16-20.
A dense understory of hardwoods was related to inadequate stocking from a heavy seed crop in southern Alabama. Seedling densities were highest on sites with grassy covers, lowest on sites with leaves and needles but no grass. Soils with clay within 12 inches of the surface usually had good catches of seedlings; deep sandy soils were inadequately stocked.

Kircher, J. C. 1944. SEED CROP SAID TO BE BEST IN YEARS. AT-FA J. 6(4): 8-9. Also as BURN NOT THESE TINY SEEDS; THE FORESTS OF TOMORROW MUST COME FROM TODAY'S LONGLEAF PINE SEED CROP. Ala. Conserv. 15 (7) : 5, 12.
*The 19**44** longleaf pine seed crop is the best since 1935. Landowners should provide fire protection for the germinating seedlings.*

Laros, J. W. 1961. PRESCRIBED BURNING HELPS MOUNTAIN LONGLEAF IN ALABAMA NATIONAL FORESTS. Southern Lumberman 203(2537): 126-127.
Prescribed burning is beneficial for control of brown spot and for seedbed preparation in mountain longleaf stands and has been successful on slopes of 10 to 15 percent. Usually burning is done in September and October within 5 days after a measurable rain. Fires are set on ridgetops and allowed to burn downslope.

Lemon, P. C. 1946. PRESCRIBED BURNING IN RELATION TO GRAZING IN THE LONGLEAF-SLASH PINE TYPE. J. Forest. 44: 115-117.
Studies in southern Georgia show that prescribed burning improves the forage for grazing. It may also be beneficial in fire-hazard reduction, seedbed preparation, and control of brown-spot disease. Careful planning and extreme care are necessary in using fire.

McMinn, J. W. 1966. SITE PREPARATION AIDS LONGLEAF REGENERATION. J. Forest. 64. 385-387.

A study in Florida tested effects of four site treatments on the regeneration of naturally seeded longleaf pine (4 to 6 seed trees per acre). Treatments were: (1) burning alone; (2) burning, followed by strip-harrowing; (3) burning, followed by a single harrowing; (4) burning, followed by a double harrowing. Treatments were begun in September 1961, and the study conducted through January 1963. Weather was unfavorable during the 1961 seedfall, and the 1962 seedfall was negligible; thus overall stocking was very low. Stocking for the most intensive treatment was nine times that for burning alone.

Maki, T. E. 1952. LOCAL LONGLEAF SEED YEARS. J. Forest. 50: 321-322.
In southern Mississippi there have been nine medium or better, and 14 light or better, longleaf pine seed crops since 1930. Thus a light or better crop occurred twice in every 3 years.

Mann, W. F., Jr., and Derr, H. J. 1958. REGENERATION OF UNDERSTOCKED LONGLEAF STANDS . . . SKILL NOT LUCK! Forests and People 8 (2) : 20-21, 53.
A 256-acre tract in central Louisiana was regenerated from the bumper 1955 seed crop. Regeneration measures included fencing out hogs and cattle, a seedbed burn in March 1955, cutting trees not needed for seed, supplemental sowing of Morkit-treated seed on 100 acres where seed trees were scarce, and controlling Texas leaf-cutting ants. At the end of the first year there were 5,720 seedlings per acre.

Morriss, D. J., and Mills, H. O. 1948. THE CONECUH LONGLEAF PINE SEEDBED BURN. J. Forest. 46: 646-652.
A prescribed burn was made on 26.000 acres of the Conecuh National Forest in southern Alabama between August 1 and October 31. 1947 . *The aim was to prepare the site to receive a bumper longleaf seed crop. Results were good; stands of 4,000 or more seedlings per acre became established on 7.3 percent of the area.*

Smith, L. F. 1961. TREE PERCENT ON BURNED AND UNBURNED LONGLEAF SEEDBEDS. J. Forest. 59: 201-203.
Establishment of Pinus palustris seedlings was studied on (a) plots burned before seedfall to eliminate ground cover and (b) unburned control plots in six stands in south Mississippi . Stocking after 1½ years was much superior on (a) (2.467 seedlings per acre vs. 800 for (b)). Details are given of the sampling technique used and the distribution of seed and seedlings. FA

Wahlenberg, W. G. 1946. LONGLEAF PINE. III--SEEDS, SEEDBEDS. AND SEEDLINGS. Southern Lumberman 172 (2155): 32.
A discussion of regeneration problems, including natural regeneration, direct seeding, nursery practice, and planting.

Wakeley, P. C. 1947. THE 1947 CONE CROP AND FOREST FIRES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 51. Also in Forest Farmer 6 (12) : 5. Also in Southern Lumberman 175(2201) : 184.
At least 2.000 cones per acre are required for natural regeneration of longleaf pine. A good cone crop, far in excess of these minimum requirements, is reported for the fall of 1947 from Alabama to Texas. Fire should be excluded from the stands resulting from this crop until the seedlings arc at least 1 year old.

Walker, L. C. 1954. EARLY SCRUB-OAK CONTROL HELPS LONGLEAF PINE SEEDLINGS. J. Forest. 52: 939-940. Also in Southern Lumberman 189 (2369): 169-170.
Survival anti growth of seedlings released (by Ammate poisoning) during the first year after germination, were significantly greater than in those released in the second and third years, and in unreleased plants. Where the oak was poisoned one year before germination, diameter growth was significantly less, owing to grass invasion, than in plots released at germination. FA

232 ARTIFICIAL REGENERATION

232.1 CHOICE AND TRIAL OF SPECIES

Anonymous. 1947. LONGLEAF AND SLASH PINES (PINUS PALUSTRIS AND PINUS CARIBAEA). Del. State Forest. Dep. Rep. 1946-47, p. 22.
Planted trees did best on well-drained sandy soils free of competing vegetation. Snow and frost caused little more damage than to native P. taeda.

Anonymous. 1947. SEED PROVENANCE. Rep. Dep. Forest. South Afr., 1946, pp. 6-7.
In 1941 precocious seedlings of P. palustris were noticed in the nursery at Kwambonambi Plantation, and a test was made of their subsequent growth. Fifty-six months later, they averaged 20.4 feet in height and 5.1 inches in d.b.h., as compared to 13.9 feet and .3.2 inches for normal longleaf seedlings.

Anonymous. 1949. EXOTIC PINES IN NORTHERN RHODESIA. Rep. Forest. Dep. N. Rhodesia, 1948, p. 8.
A review was made of test plantings made at Ndola (lat. 13°, altitude 4,000 feet). Definitely slow growers are P. palustris, P. arizonica, P. echinata.

Allen, P. H. 1961. FLORIDA LONGLEAF PINE FAIL IN VIRGINIA. J. Forest. 59: 453-454.
Highly significant differences were found in 6-year survival and height of Pinus palustris from seed sources in Florida, Louisiana, Mississippi, Georgia, and Virginia, planted in Nansemond County, Virginia. Height and survival were not significantly related to temperature zone, latitude, or longitude of seed source. The Florida source had poorest survival and height. The local source appeared best. FA

Bateman, B. A. 1954. CHOICE OF SPECIES AND STAND COMPOSITION. La. State Univ. Third Annu. Forest. Symp. Proc. 1954: 34-39.
Various ecologic factors affect suitability of longleaf, slash, loblolly, and shortleaf pines for planting. Slow height growth is a prime reason for longleaf's lack of popularity in planting programs.

Bateman, B. A., and Roark, C. B. 1954. In Research in agriculture, 1952-53, pp. 231-233. La. State Univ. Agr. Exp. Sta. Annu. Rep.
See next entry.

Bateman, B. A., and Roark, C. B. 1955. In Research in agriculture, 1953-54, pp. 267-268. La. State Univ. Agr. Exp. Sta. Annu. Rep.
Brief account of recently installed studies. A stand averaging 2,350 seedlings per acre was obtained from longleaf seed trees on an area burned before seedfall; the stand on an unburned area averaged 534. In the first year of a fertilizer trial, longleaf seedlings receiving a 60-60-60 mixture, plus lime, grew taller than unfertilized trees.

Bethune, J. E., and Roth, E. R. 1960. SOURCE OF SEED AFFECTS GROWTH OF LONGLEAF PINE-FIFTH YEAR RESULTS.
U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 146, 2 pp.
Discusses seedling height, seedling .survival and branch length, time in grass stage, percent of trees forked, and percent infected by brown-spot needle blight.

Box, B. H., Linnartz, N. E., and Applequist, M. B. 1964. GROWTH OF SLASH AND LOBLOLLY PINE IN A MIXED PLANTATION IN SOUTHWESTERN LOUISIANA. La. Agr. Exp. Sta. LSU Forest. Notes 58, 3 pp.
In an 80-acre experiment on a poorly drained, clear-felled

Pinus palustris site in southwest Louisiana, five mixtures were planted at 6 ´ 6 feet in 1952, viz: (1) and (2) 4- and 8-row P. palustris + P elliottii, (3) 4-row P. palustris + P. taeda, (4) and (5) 2- and 4-row P. taeda + P. elliottii. P. palustris showed only 27 percent survival after 2 years, and of the survivors 70 percent were infected with Scirrhia acicola. After 11 years, only (4) and (5) showed promise, (4) being best. P. elliottii, which had better height, d.b.h.., volume per acre, and resistance to Coronation fusiform, though lower survival, is preferable to P. taeda on poorly drained sites. FA

Collins, A. B., III. 1964. LONGLEAF PINE SEED SOURCE PLANTING IN GEORGIA--TENTH YEAR RESULTS. U. S. Dep. Agr. Forest Serv. Res. Note SE-19, 3 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Six seed sources of longleaf pine at age 10 show height growth correlated with latitude or temperature. The greatest difference in height, 4.7 feet, was between the Coastal Plain and the Piedmont sources in Alabama. Since only 0.2 foot separated the Georgia and Texas sources, longitude appears to have little effect on height growth. An average survival of 80 percent for the entire study and average height of 25 feet at age 10 indicate that species diversification is practical on suitable sites.

Derr, H. J. 1966. LONGLEAF × SLASH HYBRIDS AT AGE 7: SURVIVAL, GROWTH, AND DISEASE SUSCEPTIBILITY. J. Forest. 64: 236-239.
Hybrids planted in central Louisiana are demonstrating desirable characteristics of both parent species. They closely resemble longleaf pine in form and branching habits but start height growth immediately and grow almost as fast as slash pine. They appear less susceptible than their parents to the brown-spot needle blight of longleaf and the fusiform rust of slash pine.

Garin, G. I. 1967. REESTABLISHING FOREST STANDS IN UPPER COASTAL PLAIN. Highlights Agr. Res. 14 (3) : 11. Auburn Univ. Agr. Exp. Sta., Alabama.
On deep sandy soil in central Alabama planted longleaf survived poorly; for this reason plantation yields at 20 years were low. Loblolly did well. Slash pine produced adequate stands on recently cultivated land but not on abandoned fields or cleared forest sites.

Gibbs, J. A. 1948. GROWTH OF TREE PLANTINGS FOR EROSION CONTROL IN THE SOUTHEASTERN REGION. IOWA State Coll J. Sci. 22 (4) : 371-386.
During the past 13 years about 180 million trees have been planted in the southeastern region of the U.S.A. as part of an erosion control program. The pine species (P. taeda, P. caribaea, P. echinata, P. palustris, P. rigida, and P. Virginiana) have survived and grown well, Robinia pseudoacacia and other hardwoods badly. Pine plantings, over a wide range of conditions, have established ground cover and completely controlled erosion in 8-10 years, though longer is needed in some of the worst eroded sites. Cronartium (Cronartium fusiforme) cankers were frequently found, but were confined mostly to slash and loblolly pines. In most cases infected main stems can be eliminated in the first thinnings without seriously reducing stand density. Figures are given of average annual increment (diameter, height. volume) for all species used. FA

Hamilton, J. R. 1956. AN EVALUATION OF SOUTHERN PINE PLANTATIONS IN THE GEORGIA PIEDMONT PLATEAU. Ga. Agr. Exp. Sta. Bull. N. S. 20, 41 pp.
A study was made of 103 plantations scattered through the area, to determine the effect of spacing on growth and development of stands. It was found to have a marked effect on d.b.h., basal area per acre, branch size, live crown ratio, and bark thickness. but not on total height. Spacings recommended are 4 ´ 4 feet for Pinus echinata and P. palustris, and 6 ´ 8 feet for P. taeda and P. elliottii. Though P. echinata is not planted to any great extent on the Piedmont Plateau, it should be considered for planting in areas subject to frequent glaze storms owing to its relative immunity to deformation due to glaze damage; P. elliottii is very susceptible, P. taeda rather less so. All species respond well to good sites and are disappointing when planted on spoilmounds. FA

Hebb, E. A. 1955. OPERATION SANDHILLS---TWO YEARS LATER. Southern Lumberman 191(2393) : 159-160.
Two years after being planted on the sandhills of western Florida, slash pine has better survival, ,growth, and form than loblolly, shortleaf, longleaf, or Monterey pine.

Huckenpahler, B. J. 1950. DEVELOPMENT OF NINETEEN YEAR-OLD SOUTHERN PINE PLANTATIONS IN TENNESSEE. J. Forest. 48: 722-723.
An examination was made of one plantation each of Pinus echinata, P. taeda, P. palustris, and P. caribaea, near Jackson, Tennessee, where the two last are considerably north of their native range. Planting had been done on abandoned cropland already showing slight gully erosion. The stand structure of the 19-year-old plots is described. All plots now have a complete ground cover of needle and leaf litter, native grasses, shrubs, and vines; and hardwood reproduction and further loss of soil are being effectively prevented. FA

McKinnon, A. D. 1945. DEVELOPMENT OF SOUTHERN PINES IN AUCKLAND CONSERVANCY. N. Zeal. J. Forest. 5: 127-132.
Analysis of some 5,000 acres of plantations of Pinus caribaea, P. echinata, P. palustris, and P. taeda in Auckland, N. Z. It is concluded that plantings of all southern pines, except P. palustris, should be confined to well sheltered, lower slopes, generally below the 400-foot contour. Evidence suggests that P. palustris can withstand greater exposure, and establishment up to 700 feet seems justifiable. The percentage of trees of defective habit in P. taeda and P. echinata is so high that further plantings of these species should be discontinued until the development of existing stands can be followed through to a greater age. The raising of sturdy nursery stock, necessitating drastic culling in nurseries and careful treatment at all stages from nursery to planting site, is of particular importance for southern pine. It is of the greatest importance to keep planting lines opened up so as to reduce early injury to succulent shoots by the abrasive action of crowding scrub ,growth. Early pruning and thinning of stands are essential. FA

Plass, W. T., and Burton, J. D. 1967. PULPWOOD PRODUCTION POTENTIAL ON STRIP-MINED LAND IN THE SOUTH. J. SOIL and Water Conserv. 22: 235-238.
Discusses results of experimental plantings. especially of the oldest one, of Pinus taeda, P. resinosa, and P. palustris near Jasper, Ala., in which all pines were healthy and had reached ca. 40 feet in height after 20 years, and where the best, P. taeda, had a stocking of ca. 20 cords per acre. It is concluded that production prospects are as good as or better than on abandoned farm lands and other shallow soils. The extent of areas involved, their ownership, physical characteristics, suitability (e.g. pH), etc. are briefly discussed. FA

Rodger, Sir Alex. 1951. A VISIT TO SOUTH AFRICA. PART III--EXOTIC PLANTATIONS. Empire Forest. Rev. 30, 143 pp.
General account of forestry in the Union, with sonic details of exotic plantations. Longleaf is a slow growing tree adapted to the cooler areas. Suggested rotations are: first quality site-40 years, second quality-50 years, third quality-60 years.

Scheer, R. L. 1959. COMPARISON OF PINE SPECIES ON FLORIDA SANDHILLS. J Forest. 57: 416-419.
So far, slash pine has performed better than loblolly, shortleaf, and longleaf. Monterey pine has been a total failure.

Scheer, R. L., and Hodges, J. D. 1960. PLANTED SAND PINE GROWS WELL ON UNPREPARED FLORIDA SANDHILLS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest Res. 1 : 7-8.
On the deep sands of western Florida, sand pine planted on unprepared sites grew well with little or no release from competing vegetation. Longleaf and other southern pines did poorly without release.

Shoulders, E. 1965. SEED ORIGIN AFFECTS LONGLEAF PINE. IN LOUISIANA PLANTATION. U. S. Dep. Agr. Forest Serv. Res. Note SO-19, 3 pp. Southern Forest Exp. Sta., New Orleans. La.
In a 5-year-old plantation in central Louisiana. seed source (10 provenances) significantly affected both survival and height of Pinus palustris. Survival was correlated with mean annual temperature, and height with the Jan.-April rainfall at the source. FA

Smith, L. F., and Smith, H. D. 1963. GROWTH OF SLASH, LOBLOLLY, AND LONGLEAF PINES ON CULTIVATED SITES. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 59, pp. 1-2.
Comparison of longleaf pine growth with that of the other two species already reported showed that though the latter were ca. 6 feet taller than longleaf at 4 years old, current annual increment was very nearly the same at that age. Early growth of longleaf was much improved by site preparation, cultivation, and brown spot control. FA

Wakeley, P. C. 1951. IMPORTANCE OF GEOGRAPHIC STRAINS. First Southern Conf. on Forest Tree Impr. 9 pp.
Geographic strains exist in loblolly and probably in longleaf and shortleaf pines. They may exist in slash but there is not much evidence. A comprehensive regional seed source study is proposed to investigate the hypothesis that geographic strains exist in the major southern pines.

Wakeley, P. C. 1953. PROGRESS IN STUDY OF PINE RACES. Southern Lumberman 187 (2345) : 137-140.
An interim report on a study by the permanent Committee on Southern Forest Tree Improvement on the effect of P. taeda, P. echinata, P. palustris, and P. elliottii provenances on their growth in a region stretching from Maryland to Florida and west to Texas. FA.

Wakeley, P. C. 1953. STUDIES OF GEOGRAPHICAL RACES OF SOUTHERN PINES. Nav. Stores Rev. 62(51) : 12-13, 30.
General description of establishment of Southwide Pine Seed Source Study, with some account of earlier studies.

Wakeley, P. C. 1953. THE. SOUTH ESTABLISHES A MAJOR PINE GEOGRAPHIC SEED SOURCE STUDY. Second Southern Conf. on Forest Tree Impr. 6 pp.
Four hypotheses will he tested. (1) That geographic races are associated with temperature zones, (2) that races are associated with rainfall zones or major soil groups within a temperature zone, (3) that races are associated with ancient land masses. (4) that geographic races do not exist.

Wakeley, P. C. 1955. SFT-BACKS AND ADVANCES IN THE SOUTHWIDE PINE SEED SOURCE STUDY. Third Southern Conf. on Forest Tree Impr. Proc. 1955: 1O-13.
Notes on racial variations in the nursery and early plantation phases. Losses to drought in western part of study territory necessitate additional longleaf and shortleaf pine plantations.

Wakeley, P. C. 1959. FIVE-YEAR RESULTS OF THE SOUTHWIDE PINE SEED SOURCE STUDY. Fifth Southern Conf. on Forest Tree Impr. Proc. 1959: 5-11.
Seedlings from the southernmost source of longleaf pine seed, Hillsborough County, Florida, have survived poorly. There is strong evidence of racial variation in rate of height growth.

Wakeley, P. C. 1961. RESULTS OF THE SOUTHWIDE PINE SEED SOURCE STUDY THROUGH 1960-61. Sixth Southern Conf. on Forest Tree Impr. Proc. 1961: 10-24.
Significant variations in survival and height appear among different geographic sources of both loblolly and shortleaf pine, especially from north to south. In longleaf they appear almost as much from east to west as from north to south. Loblolly varies significantly in fusiform rust infection, especially from east to west. Compared to these species, slash pine north and west of mid-Florida exhibits little racial variation.

Wakeley, P. C. 1963. HOW FAR CAN SEED BE MOVED? Seventh Southern Conf. on Forest Tree Impr. Proc. 1963: 38-43.
Pending definitive results from provenance tests, the author hazards 10 recommendations concerning distances and directions that southern pine seed can be moved from source to planting site.

Ware, L. M., and Stahelin, R. 1948. BEHAVIOR OF DIFFERENT PINE SPECIES UNDERPLANTED IN HARDWOOD STANDS. Rep. Ala. Agr. Exp. Sta. 1945-46, p. 29.
One-year seedlings of slash, loblolly, shortleaf, and longleaf pines were planted in regular 6 ´ 8 feet spacing under a dense stand of hickory, oak, and sweetgum 4-8 feet high which had come in on a clearcut longleaf pine area. On one part the pines were released 4 years after planting, on another part they were not released. Release cutting increased the survival and the growth of each species of pine but in different degrees (slash pine three times, shortleaf about six times, loblolly much less). The slash and loblolly were about equally good when underplanted and released. The shortleaf was not so well adapted to underplanting. The longleaf gave too low a rate of survival to permit study. FA

Williston, H. L . 1959. GROWTH OF FOUR SOUTHERN PINES IN WEST TENNESSEE. J. Forest. 57: 661-662.
Though planted well beyond their natural range, longleaf, slash, and loblolly pine have outgrown the native shortleaf. After 29 growing seasons, volumes per acre arc 4.3 cords for loblolly, 39 for longleaf, 36 for slash, and 28 for shortleaf.

Williston, H. L., and Huckenpahler, B. J. 1958. RESPONSE OF SIX CONIFERS IN .NORTH MISSISSIPPI UNDERPLANTINGS. J. Forest. 56 : 135-137.
Immediate release greatly stimulated height growth of all species on a ridge .site. Loblolly appears to be best for restocking but shortleaf and Virginia pine survive best on droughty sites. Because of poor survival and susceptibility to ice damage, slash and longleaf are not recommended. Eastern redcedar survives well but is severely browsed by deer.

Yarham, E.R. 1946. EXOTICS IN NEW ZEALAND. Wood 11 (8) : 216-218. Also as NORTH AMERICAN SPECIES THRIVING IN NEW ZEALAND. Brit. Columbia Lumberman 29: 69-70. 1945. *The New Zealand State forests of exotics occupy just under 450.000 acres; .370,000 acres are held by over 30 companies planting exotics. The annual cut of rough-sawn exotic pine timber alone in 1941-42 was 58,247,000 board feet. The species planted in North Island in recent years have been Pseudotsuga taxifolia, western yellow pine (Pinus ponderosa), Pinus radiata, and Corsican pine (P. nigra var. calabrica). The southern pines (Pinus palustris, P. taeda,*

and P. caribaea) have shown promising results in the Auckland Conservancy. In South Island western yellow pine, Corsican pine, Pseudotsuga taxifolia and Pinus radiata are used. The last-named species has proved the most highly productive of the introduced pines. FA

232. 2 PREPARATORY WORK, AUXILIARY MEASURES

Bruce, D. 1959. EFFECT OF LOW COMPETITION ON LONGLEAF PINE SEEDLING GROWTH. Soc. Amer. Forest. Proc. 1958: 151-153.
In small-scale tests in southern Mississippi, scalping, and methods of burning that kill grass roots, particularly log burning, reduced competition and promoted growth more effectively than herbicides (allyl alcohol, TCA and others being tried). Brown-spot infection was often troublesome if not controlled, particularly on the plots without grass. Diameter at ground level at the end of the first year was a good indicator of probable start of height growth, and the need for measures to reduce competition.

Fassnacht, D. L. 1954. PREPARATION OF SOME ADVERSE SITES IN THE SOUTHEAST. La. State Univ. Third Annu. Forest. Symp. Proc. 1954: 69-79.
Discusses use of fire, chemicals, and mechanical equipment to prepare sandhill sites for planting. Best first-year survival of longleaf occurred on bulldozed sites, poorest where woody vegetation was killed with chemicals.

Langdon, O. G. 1959. SITE PREPARATION REQUIREMENTS FOR DIRECT SEEDING OF LONGLEAF AND SLASH PINES. Direct Seeding in the South, 1959, a Symposium, pp. 109-113. Duke Univ.
Examples of suitable preparation in areas of east Texas, Mississippi, Louisiana, and Florida.

Muntz, H. H. 1951. CONVERTING SCRUB OAK AREAS TO PINE PLANTATIONS. J. Forest. 49: 714-715. Also as RELEASING PINE PLANTED UNDER SCRUB OAK. Southern Lumberman 181 (2273): 200-201. 1950.
Loblolly, .slash, and longleaf pines were planted in oak scrub and released at different times and by different methods. It was established that this process of conversion can be done successfully, provided that release is not deferred long after planting. FA

Shipman, R. D. 1955. FURROWS IMPROVE LONGLEAF SURVIVAL IN SCRUB OAK. Southern Lumberman 190(2381) : 70, 72. ALSO as PLANTING IN FURROWS AIDS INITIAL SURVIVAL OF LONGLEAF IN SANDHILLS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 82, 2 pp.
First-year survival of one-year-old planting stock was higher (71 percent) on areas with furrows ca. 6 feet apart, 8 inches deep and with a flat base 18 inches wide, with old oaks (about 20 percent of the original number) left standing between the furrows, than in completely cleared areas (48 percent survival) those in which 45 percent of the oaks were felled and the stumps poisoned (45 percent), or in untreated controls (57 percent). Soil moisture anal surface soil temperature were no more favorable on the furrowed than on the other sites, and the reason for the higher survival is not clear. FA

Shipman, R. D. 1956. FURROW OLD FIELDS TO PLANT LONGLEAF IN THE SANDHILLS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 98, 2 pp.
Tests when planting I + 0 longleaf pine seedlings in furrows 8 inches deep by 24 inches wide, near Aiken, South Carolina, on old fields with `rough' aged 7 or 8 years, showed that soil moisture, particularly in the top 3 inches of soil, was greater and dropped below wilting point for shorter periods than on controls. The method has since been applied to 81/2 million seedlings on 10,600 acres of old field, with marked superiority in initial survival compared with unfurrowed fields. FA

Shipman, R. D. 1963. SCRUB OAK CONTROL WITH FENURON PELLETS IN THE SOUTH CAROLINA SANDHILLS. J. Forest. 61: 217-220.
One-year-old longleaf and slash pine seedlings were interplanted among scrub oak (mainly Quercus laevis) and pellets were applied 1 month after planting. First-year survival was 68 percent for longleaf and 76 percent for slash pines, with no after-treatment effects. Scrub oak mortality was satisfactory, but not greatly influenced by increasing the dosages from 30 to 60 pounds per acre. The major kill was of trees > 1 inch d.b.h. Studies are continuing. FA

Shoulders, E., and Wilson, R. H. 1962. WHY TREAT A GOOD SITE? Southern Lumberman 205(2561) : 143-144.
On a good site in central Louisiana, three-fourths of the longleaf seedlings planted on disked and furrowed plots were making height growth at age 3, as compared with 43 percent on scalped or check plots. Survival averaged 80 percent on furrowed plots, 66 percent on disked plots, and 67 percent for no preparation.

Starr, J. W. 1965. THE ROLE OF HERBICIDES IN DIRECT SEEDING. Proc., Direct Seeding Workshops, Alexandria, La., and Tallahassee, Fla., pp. 5-7. U. S. Dep. Agr. Forest Serv., Atlanta, Ga.
Discusses use of herbicides for controlling scrub hardwoods on sites scheduled for direct seeding of longleaf.

232. 3 SEED, NURSERY PRACTICE, DIRECT SOWING

Allen, R. M. 1953. RELEASE AND FERTILIZATION STIMULATE LONGLEAF PINE CONE CROP. J. Forest. 51: 827.
Second-growth Pinus palustris trees were given one of four treatments: (1) release from all dominant, codominant, and intermediate trees from a radius of 17-20 feet, (2) application of 5-15-5 fertilizer, (3) a combination of (1) and (2), and (4) untreated controls. No effect was observed until the third and fourth years after treatment, when average annual cone production per tree was 6.9 for (1), 13.5 for (2), 16.7 for (3), and 1.3 for (4). FA

Allen, R. M. 1953. STIMULATION OF LONGLEAF PINE SEED PRODUCTION. Second Southern Conf. on Forest Tree Impr. 3 pp.
Describes methods of increasing cone production by improving vigor of seed trees through release and ferilization.

Barnett, J. P. 1964. STORED LONGLEAF SEED SUCCESSFULLY DIRECT SEEDED. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 65, pp. 3-5.
Gives particulars of an experiment in sowing Pinus palustris seed stored for 7 years in various conditions of temperature and moisture. Recommended storage conditions are temperatures of ca. 0-25` F. and seed moisture content < 10 percent. FA

Barnett, J. P., and MeLemore, B. F. 1961. TREE AGE UNIMPORTANT IN LONGLEAF SEED VIABILITY. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 135.
In central Louisiana, neither initial germinability nor germinability after 5 year's storage differed significantly among seed from trees aged 21, 40, and 85 years.

Boyer, W. D. 1956. LAMBERT SEEDS LONGLEAF PINE. Ala. Lumberman 8 (7) : 12, 14, 16.
Mr. Brooks Lambert, of the T. R. Miller Mill Company, direct-seeded a dry sandy ridge in southern Alabama after

clearing off oaks and wiregrass with heavy machinery. The seed was coated with anthraquinone to repel birds.

Cossitt, F., and Tomlinson, H. 1949. PLANTING FROM THE SKIES. Southern Lumberman 179 (2249) : 176-177.
Describes an undertaking of the U. S. Forest Service in the southern region, where 1,230 acres were sown with Pinus palustris from the air. The seed (3,590 pounds) was clean and dewinged. Half had been kept in cold storage since 1946, and half was fresh. It was sown from a height of about 75 feet in strips 50 feet wide. The fresh seed gave an initial establishment of 45-65 percent, and the stored seed 7-17 percent, the difference being largely due to the germination percent of the seed. Ten months after sowing it was clear that acceptable stands had been established. The success of the operation was probably due to the following factors: (1) the sowings were made in November soon after rain, (2) warm, rainy weather continued till January, and (3) the area was burned over in advance and town ant colonies were poisoned. FA

Croker, T. C., Jr . 1959. DIRECT SEEDING LONGLEAF PINE IN SOUTH ALABAMA AND NORTHWEST FLORIDA. Ala. Conserv. 30(5): 18-19, 27.
Good results were achieved with longleaf, slash, loblolly, and shortleaf pine, but not with sand pine. Seed was coated with Arasan to repel birds and with endrin to deter rodents.

Croker, T. C., Jr. 1964. FRUITFULNESS OF LONGLEAF TREES MORE IMPORTANT THAN CULTURE IN CONE YIELD. J. Forest. 62: 822-823.
Five-year cone production of 60-year-old longleaf pines in south Alabama was influenced more by inherent fruitfulness of individual trees than by fertilization and irrigation.

Croker, T. C., Jr. 1964. TWO H-C FURROW SEEDERS. U. S. Dep. Agr. Forest Serv. Res. Note SO-5, 4 pp. Southern Forest Exp. Sta., New Orleans, La.
Describes and illustrates two machines that simultaneously prepare a seedbed and sow longleaf and other pine seed in rows. Explains the adjustment and operation of these machines behind a farm tractor.

Derr, H. 1956. AERIAL RESEEDING BOOSTS LONGLEAF PINE. Forests and People 6 (1) : 30, 52.
Eight thousand acres of cutover Louisiana forest land were seeded with longleaf pine in 4 weeks. Total cost per acre was $4 to $5. Much of the work was done with an airplane that covered 1,000 acres in a day. Procedures for seeding of longleaf were developed at Alexandria, Louisiana, by the Forest Service, USDA. Seed loss to birds, a crucial problem, was obviated by coating seed with Morkit, a German-manufactured repellent.

Derr, H. J. 1952. DIRECT SEEDING BY AIR. Forests and People 2 (l) : 20-21.
Longleaf pine was direct-seeded on 600 acres on the Kisatchie National Forest in central Louisiana. Seeding on 500 acres was done by airplane at a cost of $1 per acre for plane and personnel, including ground flagmen. A 100-acre tract was seeded with cyclone seeders at a cost of 30 to 35 cents per acre for labor. Establishment results are not given but losses to birds were heavy [the seed had no repellent treatment].

Derr, H. J. 1958. DIRECT SEEDING: A FAST RELIABLE METHOD OF REGENERATING LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 32, pp. 15-20.
Draws on 10 years of research at Alexandria, Louisiana, to make recommendations on site preparation, freshness of seed, rate and date of sowing, seed treatments, sowing methods, and evaluation of results.

Derr, H. J. 1959. TIME OF YEAR FOR DIRECT SEEDING. Direct Seeding in the South, 1959, a Symposium, pp. 114-118. Duke Univ.
February appears to be the best time for sowing loblolly, shortleaf, and possibly slash pine. Seed should be stratified and coated with repellents. Longleaf is sown unstratified, usually in late November or early December.

Derr, H. J., and Cossitt, F. M. 1955. LONGLEAF PINE DIRECT SEEDING. J. Forest. 53: 243-246.
Summarizes experience from eight trials on 8,000 acres scattered in Mississippi and Louisiana.

Derr, H. J., and Mann, W. F., Jr. 1954. FUTURE FORESTS BY DIRECT SEEDING. Forests and People 4(4): 22-23, 38-39.
In November 1953, 440 acres in Louisiana were direct seeded at the rate of 10,000 good seed per acre. The seedbed had been burned in early 1953. Patrols were made for several weeks to keep birds away, and rabbits were controlled by night hunting. In May 1954 early establishment was good, averaging 2.500 to 3,200 seedlings per acre. A chemical bird repellent is being sought.

Derr, H. J., and Mann, W. F., Jr . 1959. GUIDELINES FOR DIRECT-SEEDING LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 171, 22 pp. Reprinted in Forest Farmer, 1960. Six parts. L-19 (4) : 6-7, 15-17; I1-19(5): 16-20; 111.-19(6): 28, 30, 32; IV.-19(8): 14-16; V.-19(9) : 12-14, 16; VI.-19(10) : 14-15.
Discusses all major aspects: choice and preparation of site; seed, seed hazards, and protection by repellents; rates, season, and methods of sowing; evaluation of results and early tending, including brown-spot control.

Dorman, K. W. 1947. LONGLEAF PINE CUTTINGS ROOTED IN GREENHOUSE. J. Forest. 45: 594.
In October 1946, 12 cuttings were taken from each of three longleaf pines [Pinus palustris] all of at least 9 inches in diameter; eight of each set were given chemical treatments that had proved successful with slash pine and the remaining four were untreated controls. The most effective treatment was 24-hour soaking of the bases in a solution containing 15 p.p.m. traumatic acid, 15 p.p.m. sodium pentachlorophenate, 10 p.p.m., vitamin B_, 5 percent sucrose and 0.4 percent of a commercial plant food containing essential minerals, vitamins, and hormones. Of cuttings receiving this treatment, 38 percent rooted as against none of the untreated controls. FA

Dorman, K. W., Schopmeyer, C. S., and Snow, A. G. 1944. TOP BRACING AND GUYING IN THE BREEDING OF SOUTHERN PINES. J. Forest. 42: 140-141.
In order that breeding operations such as bagging and pollination may be carried out in slash pine (Pinus caribaea) and longleaf pine (P. palustris), it is necessary to brace the tops of the trees to prevent breakage and provide efficient working conditions. Bracing consists of three pieces of 2 ´ 2 inch pine 10-16 feet long, firmly bound to the main stem and extending to the top of the tree. Three guy wires are fastened between the braces and nearby stumps or trees to prevent swaying. FA

Downs, A. A. 1949. DEVELOPING BETTER PINES FOR GUM PRODUCTION. Southern Lumberman 179(2249): 233-236.
Describes methods for rooting longleaf pine cuttings. Such cuttings do not have a grass stage. Performance of slash-longleaf hybrids is discussed.

Ferguson, J. L. 1959. ....AND DIRECT SEEDING WAS BORN. Forests and People 9 (1) : 6-12.
A popular account of direct seeding of longleaf pine in

Louisiana, with emphasis on problems in seeding 16,000 acres of cutover lands.

Johansen, R. W., and Kraus, J. F. 1958 . PROPAGATION TECHNIQUES APPLICABLE TO LONGLEAF PINE. J. Forest. 56: 664.
Brief notes citing instances of successful propagation by cuttings, grafting, and air-layering. FA

Jones, E. P., Jr. 1963 . A TEST OF DIRECT SEEDING DEPTHS FOR SLASH AND LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Res. Note SE-5, 2 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
In two studies in Georgia, in nursery-type beds in a loamy sand, in which sowing depth was varied from 0 to 1¼ inches, germination percent was highest for both species at ¼ and lowest at 1¼ inches. The earliest planting dates (February) were best for germination of both species. Stratification increased germination percent of slash but not of longleaf pine. FA

Jones, L. 1963. GERMINATION OF REPELLENT-TREATED SOUTHERN PINE SEED BEFORE AND AFTER STORAGE. U. S. Dep. Agr. Forest Serv. Res. Note SE-15, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Stratified and unstratified seed of Pinus elliottii, P. taeda, P. echinata, and P. palustris treated with 20 percent anthraquinone and 1 percent endrin (by weight) lost little germinative capacity when stored at 70-80° F. for 60, and at 38° for 370 days. Arasan-75 at 10 percent significantly reduced germination (except in P. palustris), but storage for 20 days at 70-80°, or up to 60 days at 38°, caused no additional reduction. To avoid damage to radicles by Arasan, the test medium should be watered before planting the seeds. FA

Jones, L. 1967. STUDIES OF SOME FACTORS AFFECTING SURVIVAL OF WOODY PLANT SEEDLINGS. Ph.D. Thesis. Univ. Ga. Athens. Diss. Abstr. 28: 2208-B.
Longleaf pine seed was sown in tubes of polyethylene and kraft paper.

Jones, L. 1967. TUBED SEEDLINGS. Forest Farmer 26 (13) 10-11, 18.
Longleaf pine seeds were sown in kraft paper tubes filled with a mixture of perlite, soil, and peat. Eight weeks later the resulting seedlings, each still in its tube, were outplanted. Six months after planting, survival was 92 percent and roots of many seedlings had grown in excess of three feet.

Jones, L., Barber, J. C., and Mabry, J. E., Jr. 1964. EFFECT OF METHYL BROMIDE FUMIGATION ON GERMINATION OF LONG-LEAF, SLASH, AND LOBLOLLY PINE SEED. J. Forest. 62: 737-739. (Abstr.) U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 55, p. 25.
Seed was fumigated at rates equaling 0.5, 1.0, and 2.0 times the dosage normally used to kill insects in seed being imported. Results indicated that slash and loblolly seed can be safety fumigated at normal dosage if their moisture content is 10 percent or below, whereas longleaf seed should be at 5-percent moisture content or below.

Lewis, C. H., Jr. 1953. A NEW APPROACH TO AN OLD PROBLEM. Forests and People 3 (1) : 24-26. Also as DIRECT SEEDING OF LONGLEAF PINE. La. State Univ. Third Annu. Forest. Symp. Proc. 1954: 1-8. 1954.
Longleaf pine is costly to plant, and survival often is poor. To avoid these difficulties, Crosby Chemical Company direct-seeded 940 acres in Louisiana during November 1952. A tractor-drawn machine seeded disked strips at the rate of 45 acres daily. Total costs approximated those of planting slash pine, and initial establishment was good.

McDermid, R. W., and Branton, D. W. 1959. REPELLENT-TREATED LONGLEAF PINE SEEDS RETAIN VIABILITY DURING 15-DAY REFRIGERATION. La. Agr. Exp. Sta. LSU Forest. Notes 33, 2 pp.
In a study of 12,800 Pinus palustris seeds tested with 32 treatments, it was established that repellent-treated seed keep better under refrigeration (34° F.) than at air temperature. The treated seed may be kept under refrigeration for > 15 days without loss in viability after 10 days, whether treated or not. Best results were obtained with a repellent composed of 5 percent Arasan blended with 0.5 percent endrin. It should be noted that these results were obtained by storing small amounts of seed; large quantities of stored treated seed might react differently. FA

McLemore, B. F. 1959. CONE MATURITY AFFECTS GERMINATION OF LONGLEAF PINE SEED. J. Forest. 57: 648-650.
Samples of cones were taken at four different dates from 27 specimens of 40-year longleaf pine, and divided into specific gravity classes. Differences in mean germination percent by cone specific gravity classes were highly significant, mainly because of the much higher germination from low specific gravity cones for the first three dates of collection. Owing to the quite wide variations in the date of cone maturity between individual trees, however, the only safe way to lengthen the collecting season is to confine early efforts to trees on which the cones have a specific gravity _ 0.88. FA

McLemore, B. F. 1961. ESTIMATING PINE SEED YIELDS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 134.
Formulae for predicting yield of seeds from the number of full seeds exposed when longleaf, slash, and loblolly cones are sliced longitudinally.

McLemore, B. F. 1961. HILA OF FULL AND EMPTY LONGLEAF PINE SEEDS ARE DISTINGUISHABLE. Forest Sci. 7: 246.
Pinus palustris seeds with distinct and indistinct hilum (cone-scale attachment-scar) are respectively full and empty. Checking by cutting test of a sorting of 1,993 seeds from 14 trees into 1,393 "full" and 600 "empty" on this basis, proved the method 97 percent correct. Among the 14 trees, reliability varied, one showing only 83 percent correct, 13 _95 percent, and six 100 percent correct. Seeds should have wings and, to obviate aberrant cases, seeds of individual trees should be kept separate. FA

McLemore, B. F. 1961. PROLONGED STORAGE OF LONGLEAF CONES WEAKENS SEED. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 132.
Viability of longleaf seed after I year of storage is substantially reduced if cones are kept in burlap bags for more than 30 days prior to kilning.

McLemore, B. F. 1961. STORAGE OF LONGLEAF PINE SEED. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 47, pp. 15-19.
Moisture content is more critical than temperature in storage of longleaf pine seed. Moisture contents of 10 percent or less are recommended. Temperatures from 0° to 25° are preferable to 34° F. because they provide a safety factor for seed that may have a moisture content slightly above 10 percent. Moisture content is less important when seed is stored at 0° F. Lower temperature compensates for higher moisture.

MeLemore, B. F. 1962. PREDICTING SEED YIELDS OF SOUTHERN PINE CONES. J. Forest. 60: 639-641.
Develops regression equations showing the relationship of average number of sound seeds exposed in sliced cones to average total number of sound seeds per cone, for loblolly. longleaf, and slash pines. FA

MeLemore, B. F. 1965. PENTANE FLOTATION FOR SEPARATING FULL AND EMPTY LONGLEAF PINE SEEDS. Forest Sci. 11: 242-243.
Full and empty seeds of Pinus palustris Mill. can be separated with high precision by flotation in n-pentane, which is not harmful to viability. While this method is probably best suited for small lots of seed, it can also be used for large ones. Specific gravity of 0.62 at 25° C. is suitable for testing this buoyant seed. Precautions for handling the highly inflammable pentane are outlined.

McLemore, B. F. 1967. THE INFLUENCE OF LIGHT ON GERMINATION OF LONGLEAF PINE SEED. Ph.D. Thesis. La. State Univ. Baton Rouge. Diss. Abstr. 28: 2679-B.
Seed extracted in darkness and kept in the dark failed to germinate. Seed exposed to white and red light germinated. Seed extracted in the usual manner also has light requirements for germination. Germination is inhibited by far-red light.

McReynolds, R. D. 1960. MORTALITY OF NEWLY GERMINATED SOUTHERN PINE SEEDLINGS FOLLOWING INUNDATION. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 43, pp. 23-25.
At ages of 25 days from seed, most loblolly and slash pine seedlings survived 20 days of flooding, but shortleaf and longleaf died after 12 days. Summer flooding was more damaging than spring flooding.

Maki, T. E. 1950. EFFECT OF VARYING AMOUNTS OF POTASH AND NITROGEN ON THE DEVELOPMENT AND VIGOR OF LONGLEAF PINE SEEDLINGS. (Abstr.) Assoc. Southern Agr. Workers Proc. 47: 141.
Ample potash fertilization appears requisite for vigor and survival of field-planted stock.

Mann, W. F., Jr. 1954. DIRECT SEEDING RESEARCH WITH LONGLEAF, LOBLOLLY, AND SLASH PINES. La. State Univ. Third Annu. Forest Symp. Proc. 1954: 9-18.
Discusses research by USDA Forest Service at Crossett, Arkansas, and Alexandria, Louisiana.

Mann, W. F., J r. 1956. DIRECT-SEEDING THE SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 25, pp. 12-19. Also in Assoc. Southern Agr. Workers Proc. 53: 152.
Instructions for direct seeding longleaf pine.

Mann, W. F., Jr. 1957. DIRECT-SEEDING THE SOUTHERN PINES. Forest Farmer 17(2): 8-9, 12, 16-18. *Also in* Forest. Newsletter, Southeast. Sect. Soc. Amen Forest.13 (2) : 10-15. *Also in* Forest Farmer (Sixth Manual ed.) 17 (7) : 73-75. 1958. *Also in* (Seventh Manual ed.) 18(8): 72-75. 1959. *Also in* (Eighth Manual ed.) 19(7): 87-90. 1960. *Also in* (Ninth Manual ed.) 20 (7) : 58-61. 1961. *Also as* GUIDES FOR DIRECT SEEDING THE SOUTHERN PINES. Forests and People 8(3): 16-17, 44, 47-48, 51-52. 1968.
Instructions for sowing longleaf, loblolly, and slash pine.

Mann, W. F., Jr. 1961. DIRECT SEEDING COMES TO THE SOUTH. Soc. Amer. Forest. Proc. 1960: 5-18.
Discovery of successful bird repellents greatly stimulated direct-seeding in the South. By 1959-1960 seeded acreage in Louisiana totaled 75,000.

Mann, W. F., Jr. 1962. HOW TO DIRECT-SEED THE SOUTHERN PINES . Forest Farmer (Tenth Manual ed.) 21 (7) : 52-55. *Also in* Forest World 1(2): 24-30, 32.
Instructions for seeding most of the southern pines.

Mann, W. F., Jr. 1966. DIRECT SEEDING THE SOUTHERN PINES: DEVELOPMENT AND APPLICATION. Proc., Direct Seeding Workshops, Alexandria, La., and Tallahassee, Fla., pp. 2-3. U. S. Dcp. Agr. Forest Serv., Atlanta, Ga.
Resumé.

Mann, W. F., Jr., and Burkhalter, H. D. 1961. THE SOUTH'S LARGEST SUCCESSFUL DIRECT-SEEDING. J. Forest. 59: 83-87.
In the winter of 1958 and spring of 1959, T. L. James and Company direct-seeded 18,545 acres of cutover longleaf pine land in central Louisiana. This is probably the largest acreage seeded successfully in the United States in a single season. Loblolly was sown by airplanes on 14,340 acres at a cost of $5.67 an acre. Stocking at the end of the first year averaged 4,451 seedlings per acre. Loblolly was furrow-seeded by machine on 1,865 acres for $3.17 an acre. First year stocking averaged 1,070 seedlings per acre and 63 percent milacre distribution. Longleaf pine seed was broadcast on 2,360 acres at a cost of $5.82 per acre. Stocking averaged 3,610 seedlings at the end of I year. This large tract was regenerated at less than half the cost of planting. Moreover, capital outlay and manpower were substantially smaller and supervisory problems were simpler.

Mann, W. F., Jr., and Derr, H. J. 1954. DIRECT SEEDING OF SOUTHERN PINES. Southern Lumberman 189 (2369) : 115117. Recommendations for longleaf, slash, and loblolly pines.

Mann, W. F., Jr., and Derr, H. J. 1955. NOT FOR THE BIRDS. U. S, Dep. Agr. Forest Serv. Tree Planters' Notes 20, pp. 3-6. *Also in* Forests and People 5 (3) : 32-33.
One of the principal hindrances to restocking longleaf pine stands by direct sowing has been the lack of a practical way of preventing birds from eating the seed. A cooperative project of the Southern Forest Experiment Station and the U. S. Fish and Wildlife Service found that the two most effective chemicals to be used as a bird-repellent seed dressing were Morkit and sublimed synthetic anthraquinone. Morkit, a mixture of anthraquinone and inert ingredients, is manufactured in Germany specifically as a bird repellent. It has no distinctive taste or odor, and the manner in which it acts to repel birds remains to be discovered. It is not known to be harmful to livestock, wildlife, or humans. Field tests with treated seed gave seedling catches of 3,000-4,000 per acre compared with 250 per acre for untreated seed. All anthraquinone compounds were good, but Morkit proved the most effective and cheapest ($0.40 per pound compared with $0.88 for sublimed synthetic anthraquinone and $2.15 for Quinizarine). Longleaf seed can be treated with Morkit for $0.15 per pound: this cost comprises all labor and materials, including an asphalt sticker. The necessary equipment can easily be made from two 55-gallon steel drums (illustrated). The method is described. FA

Mann, W. F., Jr., and Derr, H. J. 1956. DIRECT SEEDING: . . . OF LONGLEAF PINE . Forest Farmer 15 (6) : 4-6, 18.
See Mann, *1956.*

Mann, W. F., Jr., Derr, H. J., and Meanley, B. 1955. A BIRD REPELLENT FOR LONGLEAF SEEDING. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 99.
Morkit, a bird repellent manufactured abroad, may make it possible to direct-seed longleaf pine at low cost and with good assurance of success.

Mann, W. F., Jr., Derr, H. J., and Meanley, B. 1956. A BIRD REPELLENT FOR DIRECT SEEDING OF LONGLEAF PINE. J. Forest. 54 : 190-191.
Instructions for applying Morkit to pine seed.

Mann, W. F., Jr., Derr, H. J., and Meanley, B. 1956. BIRD REPELLENTS FOR DIRECT SEEDING LONGLEAF PINE. Forests and People 6(3): 16-17, 48.
Morkit has been withdrawn from the U. S. market, but several preparations are likely to be acceptable replacements. One of these is Arasan.

Mann, W. F., Jr., and Russell, T. E. 1956. RINGING STIMULATES LONGLEAF CONE PRODUCTION. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 103.
See entry below.

Mann, W. F., Jr., and Russell, T. E. 1957 . LONGLEAF CONE PRODUCTION DOUBLED BY RINGING. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 28, pp. 6-7.
A study was begun in 1952 on open-grown Pinus palustris, d.b.h. 6-12 inches. Ringing was done by cutting two half-circles through the cambium, on opposite sides of the bole, slightly above stump height, about 4 inches apart and overlapping by ca. 1 inch at each end. Incisions were ca. 1 inch wide and were made quickly with a bark hack of a kind used in resin tapping. Three years after treatment, the larger ringed trees produced significantly more cones than unringed (120 and 51 respectively for 12 inches, and 77 and 37 for 10 inch trees). Ringing was ineffective on trees<10 inches, probably because they were too small to bear cones abundantly. Seed tests showed that ringing had no effect on the number of sound seeds per cone or the germinability of the seed. Strangulation and treatment with 2,4-D had no effect on cone production. FA

Nestler, R. B . 1946. GERMINATION OF SEEDS OF SOME WILD AND CULTIVATED PLANTED AFTER 5½YEARS OF STORAGE. J. Forest. 44: 683-684.
Seeds tested in this experiment were obtained in 1939 stored in sacks in a dry place until June 1941, at room temperature, then kept in a cold storage chamber at 32° to 33° F. until June 1943, and at 0° F. from June 1943 until July 1945. They were then returned to room temperature until autumn, when they were tested for germination and hard seeds. Of the tree species tested Pinus palustris showed no germination. FA

North Carolina State University School of Forestry. 1965. N. C. STATE-INDUSTRY COOPERATIVE TREE IMPROVEMENT PROGRAM. Ninth Annu. Rep., 32 pp. N. C. State Univ., Raleigh.
Reviews current progress and presents interim data on seed production studies (loblolly, Virginia, white, slash, shortleaf, pond, and longleaf pines), progeny testing, wood properties, and quantitative genetic studies, including work on tropical pines. FA

Richardson, B. Y. 1967. SHAKING TREES TO COLLECT PINE CONES. Southern Lumberman 215 (2680) : 140-141.
Shaking machines designed for pecan trees appear suitable for use on pines, including longleaf.

Russell, T. E. 1958. THE DIRECT SEEDING OF SOUTHERN PINES. Amer. Pulpwood Assoc Tech. Pap. 58-P26, 8 pp.
Recommendations for longleaf, loblolly, and slash pines.

Shipman, R. D. 1955. PRELIMINARY TEST OF DIRECT LONGLEAF SEEDING . Nav. Stores Rev. 64(11): 8-9.
See entry below.

Shipman, R. D. 1955. PRELIMINARY TEST OF DIRECT SEEDING OF LONGLEAF PINE IN THE SOUTH CAROLINA SANDHILLS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 72, 2 pp.
Losses to birds and rodents of seed sown on unprotected spots were High-16 and 78 percent respectively on winter-sown and 26 and 60 percent on spring-sown plots. Even on plots protected by screen, losses to rodents were 31 and 48 percent for winter and spring sowing respectively. Critical soil moisture and temperature conditions coincided with low rainfall in May, and in 726 protected and undamaged spots 20 percent of winter-sown and 3 percent of spring-sown seed had produced established seedlings by the end of the growing season. Other less conclusive results suggested that better survival may be expected on sandy loam than on sand, and on old field sites than on scrub oak areas. Mulching seed spots with sawdust did not appreciably increase germination or survival. Further research is needed. FA

Shipman, R. D. 1963. SEEDING DEPTH-ITS INFLUENCE ON ESTABLISHMENT OF DIRECT-SEEDED PINE IN THE SOUTH CAROLINA SANDHILLS. J. Forest. 61: 907-912.
Field and greenhouse studies were undertaken to determine effects of seeding depth on the germination and establishment of longleaf and slash pines in the South Carolina sandhills. Under field conditions the recommended depth tolerance for longleaf pine was 1/4 to 3/4 inch, and for slash pine 1/2 to 3/4 inch. In the greenhouse, under a controlled environment, the optimum seeding depth for longleaf was between 1/8 and 1/2 inch, and for slash pine between I/8 and 3/4 inch. The differences between the field and greenhouse trials can be attributed primarily to seed displacement by wind and water.

Shoulders, E. 1959. ROOT PRUNING BOOSTS LONGLEAF SURVIVAL. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 120. *Also in* U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 36, pp. 15-19.
Recommends that pruning be done at a depth of approximately 7 inches and 2 or .3 months before the seedlings are lifted from the nursery bed.

Shoulders, E. 1960. CAUTION NEEDED IN FALL APPLICATIONS OF NITROGEN TO NURSERY STOCK. U. S Dep. Agr. Forest Serv. Tree Planters' Notes 38, pp. 25-27.
Late-season fertilization of nursery beds with heavy application of N is sometimes recommended to improve field survival of southern pine seedlings. A study in 1956 and 1957 by the Southern Forest Experiment Station showed, however, that though the practice is helpful in some circumstances (e. g., when there is a known nutrient deficiency) it must be used with great caution, since it can sometimes reduce survival (especially of longleaf pine) and height growth. FA

Shoulders, E. 1963. ROOT-PRUNING SOUTHERN PINES IN THE NURSERY. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-5, 6 pp. Southern Forest Exp. Sta., New Orleans, La.
In Louisiana, root pruning in the nursery bed usually improves field survival of longleaf pine and sometimes of loblolly and slash pine. Growth of large seedlings is retarded by pruning in August and September, but yields of plantable stock may not be greatly increased thereby, because reductions in oversize seedlings may be offset by increases in undersize stock.

Shoulders, E. 1965. ROOT PRUNING IN SOUTHERN PINE NURSERIES. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 70, pp. 12-15.
See entry below.

Shoulders, E. 1967. FERTILIZER APPLICATION, INHERENT FRUITFULNESS, AND RAINFALL AFFECT FLOWERING OF LONGLEAF PINE. Forest Sci. 13: 376-383.
Production of female strobili in heavily thinned and cultivated stands was influenced, in descending order of importance by (1) inherent ability to flower, (2) spring and early summer rainfall in year of flower bud formation, (3) annual rate of fertilizer application, and (4) flowering 2 years earlier.

Shoulders, E. 1967. LONGLEAF FIELD PERFORMANCE UNIMPAIRED BY NURSERY CLIPPING TO FACILITATE BROWN-SPOT

CONTROL . U. S. Dep. Agr. Forest Serv. Res. Note SO-60, 3 pp. Southern Forest Exp. Sta., New Orleans, La.
Neither field survival and growth nor size and grade of nursery stock were adversely affected when the needles of spring-sown seedlings were clipped to a length of 6 inches in late summer or immediately before lifting.

Silker, T. H., and Goddard, R. E. 1953. DIRECT SEEDING TESTS WITH SLASH, LOBLOLLY, AND LONGLEAF PINE IN SOUTHEAST TEXAS. Tex. Forest Serv. Tech Rep. 7, 36 pp.
Spot seeding appeared better than broadcast seeding. Pelleted seed gave average germination 60 percent below that of untreated seed. Stocking from broadcast sowing was better for slash pine than for loblolly.

Snyder, E. B., and Squillace, A. E. 1966. CONE AND SEED YIELDS FROM CONTROLLED BREEDING OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-22, 7 pp. Southern Forest Exp. Sta., New Orleans, La.
Over a 10-year period, survivals of cones from controlled cross-pollinations were less than 40 percent, and seed yields per cone averaged about half those from wind -pollinations. Self-pollinations produced about 15 percent as much seed as cross-pollinations. Interspecific pollinations were generally less productive than intraspecific pollinations.

Swofford, T. F. 1960. THE EFFECT OF AIR DRYING OF CONES UPON SEED GERMINATION. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 43, pp. 3-4.
Cones were collected ,from Pinus elliottii, P. taeda, and P. palustris in Florida, and in each case half of the cones (a) collected from each tree were placed in the usual well ventilated but unheated drying sheds, and half (b) were sent to the Tree Seed Testing Laboratory at Macon, Georgia, and placed in wire baskets in an air-conditioned room maintained at 72° C. Cones in lot (b) opened in 4 days and the seeds were immediately tested for germination; cones in lot (a) had opened at the end of 6 weeks and the seed was sent to the laboratory for testing. Germination percent of P. elliottii was not significantly different in (a) and (b), but in P. taeda and P. palustris it was considerably higher in (b) (90 and 67 respectively vs. 71 and 57). FA

USDA Forest Service. 1948. WOODY-PLANT SEED MANUAL, pp. 262, 391, 393. U. S. Dep. Agr. Misc. Pub. 654.
Statistics useful in collecting, extracting, storing, testing, treating, and sowing longleaf seed.

Wakeley. P. C. 1948. COLLECTING SOUTHERN PINE SEED. Forest Farmer 7 (12) : 1, 7. *Also in* AT-FA J. 11(1) : 9, 16.
Instructions for collecting cones and extracting seed.

Wakeley, P. C. 1949. PHYSIOLOGICAL GRADES OF SOUTHERN PINE NURSERY STOCK. Soc. Amer. Forest. Proc. 1948: 311-322.
The grading rules generally used for classifying 1-0 planting stock of .slash and longleaf pine are based on foliage, bud and bark development, and seedling size. It is shown that these morphological characters may be quite misleading. and the existence of physiological grades, based on ability to make new, root growth and maintain water intake, is lint forward. The possibility of (a) recognizing such grades, and (b) modifying them by special nutrition, differences in grater tension under which seedlings are grown, and application of sprays, protective coatings, etc., at lifting time are discussed. FA

Wakeley, P. C. 1951. STORING SOUTHERN PINE SEED. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 123, 13 pp.
Gives directions for cold storage of seed at not above 41' F. and preferably between 5 and .32°, at a constant moisture content of between 6 and 9 percent for longleaf and 9 and 12 percent for other southern pines, with special recommendations for storage longer than one winter, and for shipping seed abroad. FA

Wells, D. W., and Reines, M. 1965. VEGETATIVE PROPAGATION OF NEEDLE BUNDLES OF PINES. Ga. Forest Res. Counc. Res. Pap. 26, 8 pp.
Rooting ability of longleaf needle bundles was high without chemical treatment. Chemicals improved the rooting ability of loblolly and slash pine bundles.

232. 4 PLANTING

Allen, R. M. 1951. CLIPPING AND DIPPING REDUCE LONGLEAF MORTALITY. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 71.
Clipping the needles and dipping the tops in lanolin or wax reduced mortality of longleaf pine seedlings to 17 percent (l/3 of needle length removed) or 13 percent (2/3 of needle length removed) compared with 81 percent for controls. Dipping in wax without clipping gave l8 percent mortality. FA

Allen, R. M . 1953. CLIPPED LONGLEAF. Southern Lumberman 187 (2345): 140.
In three years of trials on a wide variety of sites, clipping the needles to 5 inches before planting the seedlings increased survival by 10 to 30 percent.

Allen, R. M. 1953. LARGE LONGLEAF SEEDLINGS SURVIVE WELL. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 14, pp. 17-18.
In a test of machine planting, large longleaf seedlings (which are easy to plant by machine but reputed to survive poorly) performed about as well as stock of small or medium size.

Allen, R. M. 1953. SURVIVAL OF MACHINE-PLANTED VS. BAR PLANTED LONGLEAF SEEDLINGS. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 14, pp. 16-17.
In a 1947 test survival after the second year in the field was 64 percent for machine planting and 71 percent for bar planting. In a 1948 test it was 44 percent for machine planting and 52 percent for bar planting. Differences between the two methods were not statistically significant.

Allen, R. M. 1954. INCREASING THE SURVIVAL OF PLANTED LONGLEAF PINE SEEDLINGS. La. State Univ. Third Annu. Forest. Symp. Proc. 1954: 64-65.
Clipping needles to 5 inches increases survival more than does application of wax foliage coatings.

Allen, R. M. 1954. SHADE MAY IMPROVE LONGLEAF SURVIVAL. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 90. *Also in* The Unit, News Letter 54, p. 6. *Also in* Forests and People 4 (3) : 31.
On a sandy site in south Mississippi artificial shade provided with palmetto fronds improved survival of planted seedlings. At the end of the first growing season survival was 27 percent for unshaded and 83 percent for shaded seedlings.

Allen, R. M. 1955. FOLIAGE TREATMENTS IMPROVE SURVIVAL OF LONGLEAF PINE PLANTINGS. J. Forest. 53: 724-727.
Recommends the clipping of planting-stock foliage to 5 inches near the time of lifting. Wax .foliage coatings (in this case Dowax, a compound of paraffin wax, lentonite, and NH_4 linoleate) require further trials. Reducing the storage period increases field survival. FA

Allen, R. M. 1955. GROWTH OF PLANTED LONGLEAF PINE ON CUTOVER LAND AND OLD FIELDS. J. Forest. 53: 587.
During a 10-year period, planted seedlings grew better on abandoned fields than on cutover forest land, but sur-

vival was about the same. Slower growth on cutover land was probably due to more intense brush and grass competition.

Allen, R. M., and Maki, T. E. 1951. FOLIAGE TREATMENTS REDUCE EARLY MORTALITY OF LONGLEAF PINE PLANTED ON ADVERSE SITES. J Forest. 49: 115.
Clipping and dipping needles significantly increased survival of 1-0 stock planted on an adverse site. Removal of two-thirds of the needles was better than removal of one third; a combination of clipping and dipping in a Dowax or lanolin coating gave best results.

Allen, R. M., and Maki, T. E. 1955. RESPONSE OF LONGLEAF PINE SEEDLINGS TO SOILS AND FERTILIZERS. SOIL Sci. 79: 359-362.
Pinus palustris is unique in that active height growth does not begin until ground-line stem diameter is ca, 1 inch, i.e., at 5 to > 7 years, depending on site factors. Thus the tallest 12-year pines on eroded and noneroded sandy loam plots were 0.8 and 14.6 feet respectively. Seedlings were sown in pots of three different soils and treated with no fertilizer, N, and NPK. At 12 months they were lifted for weighing, root pruned and transplanted into a sandy soil in a greenhouse for observation on transplanting survival and a drought test. Watering was done for the first 48 days, then withheld until the transplants were parched, and then resumed. Results (tabulated) show that seedlings differ in green weight and ability to survive transplanting with the media in which they are raised. The mean green weight of seedlings was doubled by NPK as compared with the means for N and for no fertilizer. FA

Bumgarner, G. 1967. SUMMER PLANTING IN THE SOUTHEASTERN UNITED STATES. Amer. Pulpwood Assoc. Tech. Pap. (Jan.): 21-22.
Reports successful mechanical planting of Pinus elliottii seedlings (age ^{3} 7 months) in north Florida and June-September, subject to careful handling, storage, and site preparation. Summer planting of P. palustris and P. clausa failed. FA

Derr, H. J. 1948. KEEP LATERAL ROOTS ON LONGLEAF PLANTING STOCK. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 54.
In January 1941, 200 longleaf seedlings, half with lateral roots nearly intact and half with them broken off in lifting, were planted in alternate 10-tree rows in central Louisiana . In July 1947 survival was 58 percent for seedlings with laterals, 20 percent for those without. Seedlings with laterals made better height growth.

Derr, H. J. 1955. BED DENSITY AFFECTS LONGLEAF VIGOR. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 97.
See entry below.

Derr, H. J. 1955. SEEDBED DENSITY AFFECTS LONGLEAF PINE SURVIVAL AND GROWTH. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 20, pp, 28-29.
Reducing nursery seedbed density from 30 to 10 seedlings per square foot improved survival and first-year growth of outplanted longleaf in Louisiana.

Derr, H. J. 1957. EFFECTS OF SITE TREATMENT, FERTILIZATION, AND BROWN SPOT CONTROL ON PLANTED LONGLEAF PINE. J. Forest. 55: 364-367.
In central Louisiana, burning, furrowing, or disking a 5year-old grass rough had little effect on survival or early growth of planted longleaf pine. Spraying the seedlings with bordeaux mixture controlled the brown-spot needle blight and thereby enabled more than 75 percent of the surviving stand to start height growth in the fourth and fifth years. Fertilizing seedlings at planting time depressed growth by stimulating competing grasses except on furrowed strips where the grasses were completely eliminated.

Derr, H. J. 1963. NEEDLE CLIPPING RETARDS GROWTH OF PLANTED LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 57, pp. 31-33.
Clipping the needles of Pinus palustris seedlings immediately before planting reduced vigor and rate of early growth in three tests in central Louisiana. Survival was unaffected in two tests but was reduced in the third when seedlings encountered an early summer drought. FA

Fassnacht, D. L. 1955. BAR-SLIT GOOD FOR SANDHILL HAND PLANTING. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 95.
In west Florida, longleaf and slash pine seedlings planted in slits made with a planting bar survived as well as those planted by hand in holes made with a post-hole digger.

Garin, G. I., and Livingston, K. W. 1950. SURVIVAL AND GROWTH OF PLANTED SLASH AND LONGLEAF PINES. Ala. Agr. Exp. Sta. Circ. 97, 15 pp.
A 12-year study in south Alabama determined survival and growth of pines planted on furrowed and burned sites. Longleaf survived better on sites unburned before planting. Later burning improved growth. Initial survival was best on furrowed areas but differences were not significant after 3 years. Height growth of longleaf was less on sod than in furrows. Slash pine survived better and grew faster than longleaf.

Hatcher, J. B. 1957. PRESCRIPTION PLANTING. Forest Farmer 16 (5) : 4-6.
Prescription planting, i.e., the allocation of specific grades of stock to specific sites, markedly improves survival of longleaf and slash pine on the Savannah River Project of the Atomic Energy Commission, in South Carolina. Prescriptions for sandhill sites are given.

Hodges, C. S. 1961. FREEZING LOWERS SURVIVAL OF THREE SPECIES OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 47, pp. 23-24.
When bundled seedlings of longleaf, loblolly, and slash pine were exposed to 20° F. for varying periods, survival of planted seedlings was virtually nil after 48 hours exposure. Loblolly showed hardly any, and slash pine little reduction in survival after 24 hours, but survival of longleaf, which was only 45 percent in controls, fell to 28 percent after 6, and 2 percent after 24 hours. FA

Jones, L. 1967. TUBED SEEDLINGS. Forest Farmer 26(13) 10-12.
A new planting technique for longleaf pine and other forest trees.

Kinne, S. B., Jr. 1954. REGENERATION OF SLASH AND LONGLEAF PINE. Ind. Forest Manage. Conf. Proc. 1954: 10-14.
Enumerates problems encountered by a large industrial company in regenerating slash and longleaf pine in south Georgia and north Florida. Mentions controlled burning, establishment of seed-production areas, planting, direct seeding, and natural regeneration.

Lotti, T., and Shipman, R. D. 1957. RETURN OF LONGLEAF TO THE SANDHILLS. Forest Farmer 16(4): 14-15.
It is planned to reforest 3 million acres of the Carolina-Georgia sandhill region with longleaf pine. Experience in South Carolina indicates that competing scrub oaks should be deadened not later than the third season after pines are planted.

Lyle, E. S., Jr., Gilmore, A. R., and May, J. T . 1958. SURVIVAL AND GROWTH OF 2-0 LONGLEAF AND LOBLOLLY SEEDLINGS IN THE FIELD. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 33, pp. 26-27.
In both species, 2-0 stock gave poorer survival but slightly better height growth than did 1-0 stock. Root pruning did not affect growth.

McGee, C. E. 1961. AGE OF STOCK AS A FACTOR IN SURVIVAL AND GROWTH OF LONGLEAF SEEDLINGS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 158, 2 pp.
As earlier studies had stressed the importance of large and vigorous planting stock for sandhill afforestation, 1-0, 1-1, and 2-0 stock were compared on two deep-sand sites in South Carolina. Both first- and fifth-year survival were best for the 1-0 stock, and its height growth was better than that of the 2-0 and little less than the 1-1. FA

McGee, C. E., and Scott, H. R. 1965. PLANTING LONGLEAF PINE. IN THE CAROLINA SANDHILLS. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 70, pp, 4-5.
Study reaffirms that dipping longleaf foliage improves survival, and that it is highly desirable from the growth standpoint to plant Grade 1 seedlings. Root pruning to 3 inches is not recommended, but more moderate pruning shows no significant reduction in survival or growth. Recommended practices are: allow at least 90 days between site preparation and planting, and plant after the period when hard freezes are expected.

Muntz, H. H. 1948. GOOD SURVIVAL FROM MACHINE-PLANTED PINES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 57. Also in Nav. Stores Rev. 58 (28) : 6. *Also in* Southern Lumberman 177 (2225) : 178. *Also in* Nav. Stores Rev. 58 (46) : 2. 1949.
In a test in central Louisiana, first-year longleaf survival was 86 percent for machine-planted trees and 89 percent for trees planted by hand.

Scarbrough, N. M., and Allen, R. M. 1954. BETTER LONGLEAF SEEDLINGS FROM LOW-DENSITY NURSERY BEDS. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 18, PD. 29-32.
In tests in south Mississippi, in which beds were sown in March and thinned to densities of 12, 24, 36, or 48 seedlings per square foot in May, planting stock from nursery beds with not more than about 24 seedlings per square foot was larger at lifting time (December), survived better in the field, and began height growth sooner than seedlings from denser beds. FA

Shipman, R. D. 1958. PLANTING PINE IN THE CAROLINA SANDHILLS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 96, 43 pp.
A paper based on published and unpublished research and experience on many experimental sites, dealing chiefly with the establishment of Pinus palustris, the original pine of the area, thought to be best in the long run, despite better survival and early growth of P. elliottii, P. taeda, and other species, e.g., Juniperus virginiana, Seed source, nursery treatment, site preparation, planting, and early tending are discussed. Prescriptions are given for- the spacing of seedlings of various grades for various soils and soil preparation to produce a given plant percent. Chief recommendations are to plant (by machine for preference) 1 + 0 high-grade seedlings root-pruned and with foliage clipped, in winter, on scrub oak sites after complete clearing or furrowing and on old fields after furrowing, plus chemical control of competing vegetation. FA

Shipman, R. D. 1960. SURVIVAL AND GROWTH OF GRADED LONGLEAF PINE NURSERY STOCK. J. Forest. 58: 38-39, 42.
Seedlings of Pinus palustris totaling 2.400 were divided into two grades by stem size and general appearance and planted in plots on Carolina-Georgia sandhills. Best survival (66-76 percent) resulted from planting grade-1 seedlings on sand or sandy loam, regardless of date in the dormant season. Since grade 2 failed on sand or when planted late, most effective use of stock was to plant both grades on sandy loam in mid-dormant season. On average, grade-1 seedlings maintained a 1.9 foot height advantage over grade 2; after five growing seasons 40 percent of grade 1 were > 7 feet high vs. 16 percent for grade 2. Clipping foliage had little or no effect on survival. FA

Slocum, G. K., and Maki, T. E. 1959. EXPOSURE OF LONGLEAF PINE PLANTING STOCK. J. Forest. 57: 825-827.
One-year-old seedlings were exposed to direct sunlight for periods of 0-180 minutes. Temperature averaged 73-80° F. Half of the 1,040 test seedlings had bare roots, the other half had roots covered with creamy clay mud before exposure . All seedlings were then planted and mortality was recorded throughout the first growing season. Seedlings with roots protected by the clay slurry suffered negligible damage from exposure up to 3/4 hour. Even after 3 hours of direct exposure, more than half of the large seedlings with clay-paddled roots survived. Large seedlings (I/4inch rootcollar diameter) withstood exposure approximately 65 percent better than small seedlings (5/32-inch rootcollar diameter).

Slocum, G. K., and Maki, T. E. 1960. EFFECTS of DESICCATION ON PUDDLED VERSUS BARE-ROOTED LOBLOLLY PINE AND LONGLEAF PINE PLANTING STOCK. J. Forest. 58: 528-531.
Longleaf and loblolly pine planting stock (a) bare-rooted and (b) with mud-coated roots, were subjected to desiccation in an unheated shed for 1½. 3, 6, or 12 days, after which they were planted in replicated randomized plots in the nursery . At the end of the first growing season it was found that survival of longleaf (b) stock averaged 94.8 percent, and of loblolly 100 percent vs. 80.4 and 92.8 percent respectively for (a). Duration of desiccation up to 12 days had no effect on (b); but for (a), survival of longleaf dropped to 74 percent after 6 days and 50 percent after 12 days. Loblolly (a) stock held up well through the sixth day (98 percent survival) but by the 12th day had dropped to 66 percent. Shoot growth of loblolly (b) stock [not measured on longleaf] was unaffected by duration of desiccation, but with (a) , 12 days of desiccation reduced current shoot growth 29 percent below (b). FA

Smith, L. F., Snyder, E. B., and Scarbrough, N. M. 1963. CARE OF PINE SEEDLINGS USED IN BREEDING AT INSTITUTE OF FOREST GENETICS. U. S. Dep. Agr. Forest Serv. Res. Note SO-2, 4 pp. Southern Forest Exp. Sta., New Orleans, La.
Describes methods developed for longleaf pine in Mississippi, giving 95-97 percent survival and improved growth. The essentials are: transplanting nursery stock to pots for a few months before planting out, clean cultivation of plantations, and control of insects and diseases. FA

Smith, M. B., Jr. 1954. LONGLEAF PINE SEEDLING SURVIVAL, AFFECTED BY DEPTH OF PLANTING. U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 17, pp. 13-14.
Preliminary results of experiments indicate that Pinus palustris seedlings should be planted with the root collar at, or within ½ inch below, ground level. FA

Wakeley, P. C. 1954. PLANTING THE SOUTHERN PINES. U. S. Dep. Agr., Agr. Monogr. 18, 233 pp.
Comprehensive discussion of planting policies: collection, extraction, storage, testing, and treatment of seed: nursery practice; planting practices; and plantation management.

Ware, L. M., and Stahelin, R. 1946. HOW FAR APART SHOULD PINES BE PLANTED? Southern Lumberman 173 (2177): 191-193.
See entry below.

Ware, L. M., and Stahelin, R. 1948. GROWTH OF SOUTHERN PINE PLANTATIONS AT VARIOUS SPACINGS. J. Forest. 46: 267274.
Reports yields from slash, longleaf, and loblolly plantations at spacings ranging from 4 by 4 to 16 by 16 feet. Apparently longleaf should be planted closer than slash or loblolly.

Woods, F. W., Hebb, E. A., and Fassnacht, D. L. 1956. MULCH NOT BENEFICIAL TO SEEDLINGS ON DEEP SANDS. J. Forest. 54 : 595.
In western Florida, a mulch of longleaf pine needles did not increase the survival of pines planted in the sandhills, and seems to have promoted excessive temperatures around the young stems.

24 TENDING OF STANDS AND TREES:

IMPROVEMENT, THINNING, PRUNING

Brasington, J. J. 1948. PULL-CUT-OR POISON? Forest Farmer 7 (5) : 14.
Three methods of eradicating scrub oaks from longleaf pine sites were tested: pulling with a crawler tractor, cutting with axes, and treating with a chemical. The chemical method was best. Pulling was too expensive, and felling induced sprouting.

Bruce, D. 1954. HOW EARLY CAN LONGLEAF BE PRUNED? U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes. 91.
Sapling longleaf pines can be pruned to half their height without loss of growth. Heavier pruning will reduce diameter growth. Small saplings can withstand more severe pruning than large ones, because they carry a greater proportion of their needles on the bole.

Bull, H. 1950. POINTERS ON THINNING SOUTHERN PINES. Southern Lumberman 181 (2273) : 259-260.
General rules for all southern pines, including longleaf.

Chapman, H. H. 19.51. EFFECT OF THINNING UPON YIELDS OF SECOND-GROWTH LONGLEAF PINE ON SITE 80 IN LA SALLE PARISH. LA. J. Forest. 49: 578-579.
A study in a well-stocked stand (on a site with an index of 80) indicated that thinning should be delayed until the trees are 25 to 30 years old. A heavy thinning should then be made, to remove half of the crown canopy.

Chapman, H. H. 1953. EFFECTS OF THINNING ON YIELDS OF FOREST-GROWN LONGLEAF AND LOBLOLLY PINES AT URANIA, LA. J. Forest. 51 : 16-26.
Early thinning (before age 25) reduced the total yields of longleaf pine. Longleaf yielded slightly more cordwood than loblolly at age .36. The financial aspects of a loblolly invasion of longleaf sites are discussed.

Derr, H. J., and Mann, W. F., Jr. 1953. COST OF PRUNING LONGLEAF PINE. J. Forest. 51: 579-580.
From experience in central Louisiana, pruning appears most practical on trees 4 to 6 inches in d.b.h. Longleaf trees of this size will exceed 30 feet in total height. They can be pruned to 17 feet in a single operation and will .still retain more than 40 percent of their live crown.

Evans, T. C., and Gruschow, G. F. 1954. A THINNING STUDY IN FLATWOODS LONGLEAF PINE. J. Forest. 52: 9-10.
Data frown 22 plots on longleaf pine soils in the Osceola and Olustee forests bear out experience elsewhere that maximum volume production of this species is obtainable over a wide range of stand density. They further suggest that fairly light densities favor vertical and lateral crown development and the production of resin or forage with less loss in volume production, than is generally supposed. FA

Farrar, R. M., Jr. 1961. AERIAL APPLICATION OF FOUR SILVICIDES IN SOUTH ALABAMA. Southern Weed Conf. Proc. 14: 198-201.
The butoxy ethanol ester of 2,4,5-T proved superior to three newer formulations for controlling scrub oaks with minimum damage to longleaf pine seedlings. Chemicals were applied at 2 pounds acid equivalent per acre.

Gaines, E. M. 1951. A LONGLEAF PINE THINNING STUDY. J. Forest. 49: 790-792.
Results of a 15-year study in southern Alabama suggest that 22-year-old longleaf stands should be thinned to 500 to 900 trees per acre. In very dense young stands (2,300 trees per acre) precommercial thinning may be desirable.

Gaines, E. M. 1951. GROWTH AFTER THINNING YOUNG LONGLEAF PINE. Southern Lumberman 183 (2297) : 168-170.
See entry above.

Hawley, N. R. 1953. MERCHANTABLE HEIGHT GREATER AFTER IMPROVEMENT CUT IN PILOT-PLANT MANAGEMENT TEST. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 33, 2 pp.
An improvement felling removing only 18 percent (four stems per acre) from young loblolly-slash pine saw timber stands was shown by successive inventories on 1 ,471 acres to increase average merchantable height in the larger diameter classes of reserved trees by up to 2½ feet, or 16 percent of one standard 16-foot log, and to increase average board-foot volumes by about 10 percent. Results are shown in graphs. FA

Malac, B. F., and Johnson, J. W. 1955. COOK TRACT THINNING STUDY, SLASH-LONGLEAF PINE STANDS. Union Bag Pap. Corp. Woodland Res. Note 1, 2 pp.
Results for the first 5 years of a study on thinning treatments in a 20-year-old mixed stand. An improvement thinning gave highest total volume production over the period; thinning from below gave greatest increase in basal area increment. FA

Russell, T. E., and Derr, H. J . 1956. LONGLEAF HEIGHT UNAFFECTED BY STAND DENSITY. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 101. *Also in* The Unit, News Letter 62, p. 6.
At age 20 years, pines in a plantation averaging 404 trees per acre were as tall as those in lighter stands.

Shoulders, E. 1967. GROWTH OF SLASH AND LONGLEAF PINES AFTER CULTIVATION, FERTILIZATION, AND THINNING. U. S. Dep. Agr. Forest Serv. Res. Note SO-59, 3 pp.
Volume growth of pulpwood and saw-log size trees was decreased by disking and heavy thinning and increased by fertilization. Diameter growth was increased by fertilization and heavy thinning but decreased by disking.

Smith, L. F. 1955. DEVELOPMENT OF SECOND-GROWTH LONGLEAF PINE IN SOUTH MISSISSIPPI. J. Forest. 53: 648-649.
Gives data at more or less 5-year intervals (13th to 42nd year) of stem number, mean d.b.h., basal area, and cords per acre for that part of the stand ³ 3.5 inches d.b.h., with a table of increment and mortality. Longleaf pine should be thinned at 25 years to 400 stems per acre, and thereafter at 5- to 10-year intervals. Here thinnings were delayed until the 36th year; production averaged one cord per acre per year. The site index was 80 feet in 50 years. FA

26 COMBINATIONS OF FORESTRY AND AGRICULTURE: GRAZI NG

Bond, W. E., and Campbell, R. S. 1951. PLANTED PINES AND CATTLE GRAZING--A PROFITABLE USE OF SOUTHWEST LOUISIANA'S CUT-OVER PINE LAND. La. Forest. Comm. Bull. 4, 28 pp.
Discusses economic aspects of combining cattle grazing with pine plantation management.

Brasington, J. J. 1948. CATTLE GRAZING IN SOUTH ALABAMA AND WEST FLORIDA FORESTS. Southern Lumberman 177 (2225): 183-186.
Most of the 400,000 cattle in the Coastal Plain of south Alabama and west Florida get all or part of their food from forest range. There are numerous conflicts between timber and cattle management. Results of a survey of woods grazing are presented for six areas: the longleaf pine hills, flatwoods, loblolly pine-hardwood hills, wiregrass, longleaf-shortleaf-loblolly, and Mobile river bottoms.

Brasington, J. J. 1949. FOREST GRAZING IN SOUTH ALABAMA AND WEST FLORIDA. Forest Farmer 9(31: 8.
See entry above.

Campbell, R. S. 1944. GRAZING CATTLE ON SOUTHERN PINE FORESTS. Southern Lumberman 169 (2129) : 188-191.
Interviews with 118 farmers grazing cattle on forest range showed that cattle do little damage to pine seedlings when ranges are moderately stocked. Grazing reduces the fire hazard by 27 percent. Opinion was almost unanimous that indiscriminate burning damages both trees and forage, but that prescribed burning in the longleaf pine type improves grazing and reduces fire hazard. Farmers estimated an average reduction of 2.5 percent a year in grazing capacity as the canopy of a fully stocked stand closes over.

Campbell, R. S. 1946. DETERMINATION OF GRAZING VALUES OF NATIVE VEGETATION ON SOUTHERN PINE FOREST RANGES. Ecology 27: 195-204.
In central Louisiana. studies in 1944 and 1945 showed approximately 1,389 pounds of green herbage per acre (airdry) on open grassland, 745 pounds in an oak type, and 626 pounds in an old-growth pine type, on unburned range in July. Production was about double this amount by October, but was less palatable and nutritious. Production on burned range in July was about one-third less but was considerably more available and edible. Nutritive values were far below maintenance for cattle in winter but were adequate for good gains during March and April, with 11 to 13 percent protein and a satisfactory mineral content. Values were sufficient for animal maintenance through summer and early fall. Development of a practical management system on southern pine forest ranges means making the most of relatively high forage values in spring and early summer. Then such ranges should be supplemented by other sources of forage and feed.

Campbell, R. S. 1955. INTEGRATION OF GRAZING AND TIMBER PRODUCTION IN THE DEEP SOUTH. Soc. Amer. Forest. Proc. 1954: 199-201.
Cattle grazing promises to continue as a permanent use of .forest land in the longleaf-slash pine belt. If properly managed, cattle will do little damage to pine regeneration, and they will utilize grass and other forage that might otherwise feed wildfires.

Campbell, R. S., and Cassady, J. T. 1951. GRAZING VALUES FOR CATTLE ON PINE FOREST RANGES IN LOUISIANA. La. Agr. Exp. Sta. Bull. 452, 31 pp.
Kind. amount, and nutritive value of forage are described. Weight gains and losses of range cattle are related to forage values and improved cattle management practices are discussed.

Cassady, J. T. 1949. UTILIZING FORAGE ON LONGLEAF PINE FOREST RANGES. Pap. presented at Assoc, Southern Agr. Workers, Forest. Sect. Symp. 10 pp. Baton Rouge, La.
Herbaceous vegetation in the longleaf-slash pine belt may be classed under two subtypes: wiregrass and bluestem.

Cassady, J. T. 1949. UTILIZING FORAGE ON SOUTHERN FOREST RANGE. Assoc. Southern Agr. Workers Proc. 46: 103-104.
See entry above.

Cassady, J. T. 1955. GRAZING ON FOREST LAND. Forest Farmer Manual. **Ed. 3**, pp. **144-146.** *Also in* **Ed. 4**, pp, 1**44-146**. 1956. *Also in* **Ed. 5**, pp. **128-129**. 1957. *Also in* (Sixth Manual ed.) 17 (7) : **132-133**. 1958. *Also in* (Seventh Manual ed.) 18(8): **126-127**. **1959**.
Properly managed herds will cause essentially no damage to the timber or watershed. Generally, forest grazing should be limited to the Coastal Plain. especially the longleaf-slash pine belt.

Cassady, J. T., and Campbell, R. S. 1951. PINE FOREST RANGES IN LOUISIANA. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta., 7 pp.
Describes pine forest ranges of Louisiana anal estimates average forage production and carrying capacity.

Duncan, D. A., and Epps, E. A., Jr. 1958. MINOR MINERAL ELEMENTS AND OTHER NUTRIENTS ON FOREST RANGES IN CENTRAL LOUISIANA. La. Agr. Exp. Sta. Bull. 516, 19 pp.
Longleaf pine-bluestem native forest ranges in central Louisiana seem to contain ample trace minerals for cattle nutrition. Of major nutrients, potassium is abundant and calcium is adequate, but phosphorus is deficient at all seasons and crude protein is seriously lacking except in spring and early summer.

Duvall, V. L. 1966. REACTIONS OF LONGLEAF PINE-BLUESTEM RANGE TO GRAZING AND BURNING. Proc., IX Int. Grassland Congr., pp. 1339-1343.
In a 12-year test in Louisiana. grazed range yielded 465 pounds more dry grass per acre annually than ungrazed. Yearly grass production was unaffected by prescribed burns at intervals of 4 or 5 years.

Duvall, V. L., and Linnartz, N. E. 1967. INFLUENCES of GRAZING AND FIRE ON VEGETATION AND SOIL OF LONGLEAF PINEBLUESTEM RANGE. J. Range Manage. 20: 241-247.
Herbage yield and density of cover were greater on moderately or heavily grazed than on ungrazed range. Botanical composition remained relatively constant under moderate use but changed markedly on ungrazed and heavily grazed ranges. Grazing compacted soils, but insufficiently to impair herbage growth or accelerate erosion. Fire had little long-range effect.

Duvall, V. L., and Whitaker, L. B. 1963. SUPPLEMENTAL FEEDING INCREASES BEEF PRODUCTION ON BLUESTEM-LONGLEAF PINE RANGES. La. Agr. Exp. Sta. Bull. 564, 18 pp.
A 5-year study in central Louisiana showed that cottonseed cake supplied in moderate amounts from October until May, salt and steamed bonemeal furnished free-choice yearlong, and a small amount of hay fed in late winter permit efficient, profitable beef production on forest ranges.

Grelen, H. E. 1967. COMPARISON OF CAGE METHODS FOR DETERMINING UTILIZATION ON PINE-BLUESTEM RANGE. J. Range Manage. 20 : 94-96.
Plucking herbage from caged quadrats to stimulate grazing resulted in lower estimates of yield and utilization than did monthly or yearly clipping of herbage from caged and open quadrats. At the end of the grazing season, estimates of

ungrazed herbage did not differ significantly by measurement technique.

Grelen, H. E., and Epps, E. A., Jr. 1967. HERBAGE RESPONSES TO FIRE AND LITTER REMOVAL ON SOUTHERN BLUESTEM RANGE. J. Range Manage. 20: 403-404.
Yield and nutrient content on burned plots differed little from that on plots that were closely mowed and raked. Thus the benefits of burning were attributed mainly to litter removal.

Grelen, H. E., and Epps, E. A., Jr. 1967. SEASON OF BURNING AFFECTS HERBAGE QUALITY AND YIELD ON PINE-BLUESTEM RANGE. J. Range Manage. 20: 31-33.
Burning different portions of a range in winter, spring, and summer provided adequate protein in herbage for a much longer period than winter burning alone. Phosphorus was deficient the year around regardless of burning schedule.

Halls, L. K. 1955. GRASS PRODUCTION UNDER DENSE LONGLEAF-SLASH PINE CANOPIES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 83, 2 pp.
In the wiregrass type of south Georgia, normal grass production of 1.000 pounds per acre (ovendry) on open forest ranges declined consistently as tree canopy increased from 5 to 35 percent but tended to level off at about 300 pounds per acre under canopies of 35 to 50 percent.

Halls, L. K. 1959. COORDINATION OF CATTLE GRAZING AND TIMBER GROWING ON SOUTHERN COASTAL PLAIN FORESTS. Soc. Amer. Forest. Proc. 1958: 192-195.
Longleaf and slash pine forests can grow livestock and timber at the same time, and thus contribute more to the economy than if managed for a single product. Compatible dual-use requires minimizing grazing damage to young pines, securing proper seasonal distribution of cattle, providing an adequate year-round grazing and feeding program, periodically burning the rough to reduce fire hazard and promote growth of higher quality forage, regulating timber stand density to insure healthy growth of trees and reasonable forage production, and controlling undesirable plants that compete with timber and forage.

Halls, L. K. 1966. FORAGE AND CATTLE PRODUCTION IN LONGLEAF SLASH PINE FORESTS. Proc., IX Int. Grassland Congr., pp. 1609-1612.
Requisites for success include feeding supplements to compensate for deficiencies in the range forage; selecting Brahman-cross cows; increasing forage quality and quantity through prescribed burning and controlling tree density; grazing at proper intensity; anal regulating cattle distribution, numbers, and season of grazing, so as to prevent damage to the trees.

Halls, L. K., Hale, O. M., and Knox, F. E. 1957. SEASONAL VARIATION IN GRAZING USE, NUTRITIVE CONTENT, AND DIGESTIBILITY OF WIREGRASS FORAGE. Ga. Agr. Exp. Sta. Tech. Bull. N. S. 11, 28 pp.
Wiregrass forage in longleaf-slash pine forests in the Lower Coastal Plain of Georgia had highest digestion coefficients for cattle in the spring. Digestibility did not decrease greatly between April through September but dropped perceptibly by December. Weight changes in cattle emphasized the nutrient limitations of the native forage.

Halls, L. K., Hale, O. M., and Southwell, B. L. 1956. GRAZING CAPACITY OF WIREGRASS-PINE RANGES OF GEORGIA. Ga. Agr. Exp. Sta. Tech. Bull. N. S. 2, 38 pp.
In studies between 1950 and 1954, steers made best weight gains on lightly stocked range. An average of 14.2 acres of burned forest range (equal to 8.5 acres of open range) produced gains of 160 pounds per steer from March to October. At 7.2 acres per steer, gains were 114 pounds. Forage utilization was closely related to acreage of burned range per steer. Grasses furnished 85 percent of the cattle diet. Herbaceous and shrubby vegetation was stable under annual burning, but gallberry and most herbs decreased in ground cover under continued grazing. Grasses decreased most where grazing intensity was greatest.

Halls, L. K., Hughes, R. H., Rummell, R. S., and Southwell, B. L. 1964. FORAGE AND CATTLE MANAGEMENT IN LONGLEAF-SLASH PINE FORESTS. U. S. Dep. Agr. Farmers' Bull. 2199, 25 pp.
Recommendations for maintaining a balance between cattle, forage, and trees for the bluestem and pineland threeawn range types.

Halls, L. K., Knox, F. E., and Lazar, V. A. 1957. COMMON BROWSE PLANTS OF THE GEORGIA COASTAL PLAIN. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap, 75, 18 pp.
Descriptions and chemical and mineral composition of common browse plants in the longleaf-slash pine type.

Halls, L. K., Southwell, B. L., and Knox, F. E. 1952. BURNING AND GRAZING IN COASTAL PLAIN FORESTS, A STUDY OF VEGETATION AND CATTLE RESPONSES TO BURNING FREQUENCY IN LONGLEAF-SLASH PINE FORESTS OF GEORGIA. Ga. Coastal Plain Exp. Sta. Bull. 51, 33 pp.
Cattle showed a definite preference for burned areas and made better gains on burned than on unburned ranges. On moderately grazed areas fires kept gallberry in check. Effects on the various grass, herbaceous, and shrubby species varied with timing of the burns, grazing intensity, and other factors. Burning appears essential for maximum cattle production.

Halls, L. K., and Suman, R. F. 1954 . IMPROVED FORAGE UNDER SOUTHERN PINES. J. Forest. 52: 848-851.
Improved forage species, Trifolium repens, Paspalum dilatatum, and Axonopus affinis, can be established under Pinus palustris/P. elliottii stands without tillage when litter is burned and fertilizer and lime applied. The relation between forage production and basal area per acre, the effect of needle cast, and the place that grazed sods can have in fire protection are discussed. FA

Hopkins, W. 1952 . GRAZING IN THE CUT-OVER LONGLEAF PINE REGION. J. Forest. 50: 384-386.
Cattle, unlike pigs, sheep, and goats, do comparatively little damage to pine regeneration, which they graze only in winter. Examination of grazed longleaf pine reproduction showed a reduction in growth but no increase in mortality. FA

Reid, V. H. 1954. MULTIPLE LAND USE: TIMBER, CATTLE, AND BOBWHITE QUAIL. J. Forest. 52: 575-578.
A detailed argument to show that with proper coordination timber and cattle can be grown together on longleaf pine land, of which there are ca. 15-20 million acres in the South. Fire is used both by foresters and graziers in this management and judiciously used fire can be beneficial in these woods for quail (Colinus virginianus) also. FA

Rummell, R. S. 1956. TREES AND CATTLE ON LONGLEAF-SLASH PINE LANDS. Consultant 1(4): 2-8.
Problems in using longleaf-slash pine lands for tree and cattle raising.

Shepherd, W. O. 1953. EFFECTS OF BURNING AND GRAZING FLATWOODS FOREST RANGES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 30, 2 pp. *Also as* EFFECTS OF BURNING AND GRAZING. Nav. Stores Rev. 63 (12) 17, 20.
See entry under Halls, Southwell, and Knox, 1952.

Shepherd, W. O., Southwell, B. L., and Stevenson, J. W. 1953.GRAZING LONGLEAF-SLASH PINE FORESTS. U. S. Dep. Agr. Circ. 928, 31 pp.
Results of a 5-year study of breeding herds on wiregrass range in southern Georgia; range use as influenced by burning; also range plants and forage quality, number and size of calves, factors limiting herd productivity, influences of fall and winter herd management practices.

Smith, L. F. 1949. TIMBER DENSITY IMPORTANT FACTOR IN FOREST GRAZING. Miss. Farm Res. 12 (12) : 6, 8.
In a longleaf pine forest of south Mississippi, density of timber was the most important influence on grass production. In 1947 maximum air-dry weights of grass were 585, 309. and 214 pounds per acre in open, medium, and dense pine stands.

Smith, L. F., and Blount, C. L. 1952. EXPERIMENT STATION STUDY SHOWS VALUE OF WOODLAND GRASS IN SOUTH MISSISIPPI. Miss. Farm Res. 15 (11) : 1, 6.
In a 2-year trial in southern Mississippi, a herd grazing longleaf pine forest pastures for a 4-month season gained more than a herd grazing 8 months.

Smith, L. F., Campbell, R. S., and Blount, C. L. 1955. FORAGE PRODUCTION AND UTILIZATION IN LONGLEAF PINE FORESTS OF SOUTH MISSISSIPPI. J. Range Manage. 8: 58-60.
Maximum yields per month over 3 years amounted to 850, 450, and 400 pounds air-dry grass per acre in open, moderate, and dense stands, respectively. The best quality of forage and the best cattle gains occurred in the early part of the growing season. A much higher utilization of grass occurred on fresh burns, owing to the removal of needle litter.

Smith, L. F., Campbell, R. S., and Blount, C. L. 1958. CATTLE GRAZING IN LONGLEAF PINE FORESTS OF SOUTH MISSISSIPPI. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 162, 25 pp.
A study of amount and nutritive value of forage under second-growth stands of varying ages and densities. Under the moderate to light grazing of the study, damage to pine reproduction was light except on local areas of cattle concentration, but planted areas of Liriodendron tulipifera needed fencing to prevent serious browsing. FA

Southwell, B. L., and Halls, L. K. 1955. SUPPLEMENTAL FEEDING OF RANGE CATTLE IN LONGLEAF-SLASH PINE FORESTS OF GEORGIA. J. Range Manage. 8: 25-30.
Grade Hereford cows were grazed on native range except for a 6-weeks' period in February and early March. During the off-range period the cows were fed a maintenance ration. While on the range, some cows were given a supplement of cottonseed meal or furnished some improved pasture, and these measures increased the calf crop and calf size.

Williams, R. E. 1952. BETTER MANAGEMENT ON LONGLEAF FOREST RANGES. J. Range Manage. 5: 135-140.
Good range management practices implement woodland development and permit efficient use of improved pastures.

27 ARBORETA

Kraus, J. F. 1963. THE OLUSTEE ARBORETUN-PERFORMANCE OF 67 SPECIES OF FOREST TREES. U. S. Dep. Agr. Forest Serv. Res. Pap. SE-4, 47 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
The Olustee Arboretum was started in north Florida in 1954 as an introduction and breeding garden of exotic pines used by the naval stores industry. Survival and growth are *described. Hybrids of Pinus palustris and P. elliottii var. elliottii are included.*

Schmitt, D., and Namkoong, G. 1965. PINE SPECIES 1. THE HARRISON EXPERIMENTAL FOREST ARBORETUM. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-18, 18 pp. Southern Forest Exp. Sta., New Orleans, La.
Pines of 45 species, five native and 40 non-native, were planted between 1955 and 1962. Of the non-natives, 20 failed, and none have approached slash pine in growth, although some have become reproductively mature.

28 HUSBANDRY OF OTHER PRODUCTS: NAVAL STORES

Bengtson, G.W., Larson, P.R., Clements, R. W., and Schopmeyer, C. S. 1959. NEW SHORT-SEASON METHOD PRODUCES GOOD YIELDS FOR GUM FARMERS. Nav. Stores Rev. 68 (11) 6-7.
Short-season chipping and acid treatment give good results. Chipping should begin in mid-April on longleaf but may be delayed until early May on slash pine. The final stock should be applied in September.

Clements, R. W. 1948. RESULTS OF 1947 PILOT PLANT TESTS OF CHEMICAL STIMULATION. Nav. Stores Rev. 58 (31) : 15-16.
On both longleaf and slash pines chemical stimulation saved labor, prolonged the life of the working faces, and reduced loss of wood in the butt log.

Clements, R. W. 1949. GOOD GUM GRADES OBTAINED WITH ACID TREATMENT. AT-FA J, 11 (10) : 9. *Also in* Nav. Stores Rev. 59 (40) : 17, 26-27.
In a 3-year test, grade yields from acid-treated longleaf and slash pines equaled those from the untreated trees.

Clements, R. W. 1950. RESULTS OF 1949 PILOT-PLANT TESTS OF CHEMICAL STIMULATION. Nav. Stores Rev. 60(27) : 15, 26-27.
Methods tested in 1949 were: (1) freshening of the lower part of the stem (`bark chipping') with acid treatment on Pinus caribaea and P. palustris, and (2) freshening of the upper part of the stem (`bark pulling') with acid treatment on P. palustris, both on a 2-weekly basis and with 50 percent H_2SO_4 *These methods were compared with the regular weekly freshening without acid. On a basis of yield per freshening per 1,000 faces, treated P. palustris yielded 136 percent and 131 percent more resin under (1) and (2) respectively than untreated. Results with P. caribaea were variable but, on the same basis, treated freshenings averaged twice as much resin as the untreated. Cos's of equipment and labor at present rates are discussed with special reference to the saving effected by the 2-weekly acid treatment method. FA*

Clements, R. W. 1954. NAIL THAT EXTRA GUM PROFIT. Nav. Stores Rev. 64 (5) : 14. *Also in* AT-FA J. 16 (11) : 13.
In pilot plant tests, longleaf pines with tins nailed on produced 74.4 barrels more gum per crop over a 2-year period than did similar timber with tins inserted in broadaxe incisions.

Clements, R. W. 1959. POSSIBILITIES OF GUM PRODUCTION IN SOUTH FLORIDA. Nav. Stores Rev. 69 (6) : 8-9.
Results are presented of resin-yield studies made in stands of Pinus elliottii var. elliottii and P. palustris in south Florida. Yields from a total of 17 streaks on trees of 10-12 inches d.b.h. in each of the three stand types, compared favorably with those recorded from comparable slash and longleaf pine in north Florida and south Georgia. The late season yields were exceptionally good. Monthly yield data indicate that in pure stands of South Florida slash pine it

is not profitable to apply streaks before mid-March. For mixed slash and longleaf the first streak may be applied some time after March 1. Transport and labor, however, both present some problems in this region. FA

Clements, R. W. 1961. AIR TEMPERATURE AND GUM YIELD. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 168, 2 pp.
In a study covering the tapping months April to November (in southern Mississippi), 1958 to 1960, resin yield of longleaf pine rose and fell with mean monthly temperatures. The first four months, contrary to accepted belief, yielded <50 percent of the total. July and August were the months of greatest flow. FA

Clements, R. W. 1961. PROFITABLE GUM PRODUCTION FROM LIMITED-FACE-HEIGHT LEASES. Nav. Stores Rev. 71(2): 6-7.
A study was made of modified extraction methods in a longleaf pine stand with the object of producing a satisfactory yield of resin from a 3-year lease with a face-height limitation of 54 inches. Fortnightly bark freshening with streaks 1 inch high treated with 60 percent H_2SO_4 *produced 6 percent more resin over the 3-year period than weekly freshening with ½ inch streaks and 50 percent* H_2SO_4*. It was also easier for laborers to maintain the correct streak height. An efficient technique and good planning are essential in this type of short-term operation. FA*

Clements, R. W. 1961. SCRAPE YIELD FROM LONGLEAF, SLASH GREATER THAN OTHERS. Nav. Stores Rev. 71(6): 4-5.
Pilot-plant tests at the Lake City Research Center indicate that 20-24 percent of the season's total yield from longleaf pine is in the form of scrape, vs. 1-8 percent from slash pine. The difference is due to the chemical composition of the resin. Recommendations are briefly given for the collection of scrape and for the elimination of clogging around the tins. FA

Clements, R. W. 1962. LOUISIANA PINE FORESTS PRODUCE LIQUID GOLD. Nav. Stores Rev. 72 (6) : 4-6, 18.
Commercial production of oleoresin is possible from second growth longleaf and slash pine plantations in Louisiana.

Clements, R. W. 1963. FOUR YEARS OF GUM PRODUCTION ON POLE TIMBER. Southern Lumberman 207 (2585) : 131-133.
Intensive chipping--2 years on the front face and 2 years on the back face--is economically feasible and reduces face height on trees to be used for poles.

Clements, R. W. 1964. FOUR YEARS OF GUM PRODUCTION WITH A TOTAL FACE HEIGHT OF ONLY 45 INCHES. AT-FA J. 26(4) : 5-8. *Also as* BACK CUPPING PRODUCES MORE GUM AND REDUCES TOTAL FACE HEIGHT. Nav. Stores Rev. 73(11): 8-9, 17..
See entry above

Clements, R. W. 1965. SULFURIC ACID PASTE SHOWS PROMISE AS MEANS OF REDUCING PRODUCTION COSTS. Nav. Stores Rev. 75 (3) : 7, 11.
Presents the results of 2 years' tests in Florida in tapping slash and longleaf pine, using H_2SO_4 *paste as a stimulant. Comparative yields are given from (1) standard fortnightly freshenings, (2) 3-weekly freshenings with paste, and (3) monthly freshenings with paste. Yields from (3) were 88 percent of those from (1) for both species, a slight reduction that would be offset by the large reduction in labor costs. FA*

Clements, R. W. 1967. ACID PASTE METHOD HIGHLY SUCCESSFUL IN COMMERCIAL OPERATIONS. Nav. Stores Rev. 77 (6) : 4, 6, 9. *Also in* AT-FA J. 30 (1) : 4, 6-7.
In a 2-year evaluation on slash and longleaf pines, 22 paste streaks produced as much gum as 32 acid-spray streaks. By using paste at 21-day intervals, each chipping laborer increased his gum production per streak by 46 percent.

Clements, R. W., and Cross, J. K. 1964. BACK CUPPING PRODUCES MORE GUM THAN FRONT FACES IN MISSISSIPPI TEST. Nav. Stores Rev. 74(3): 4, 6.
Two methods were tested in a natural longleaf pine stand on all trees ³10 inches d.b.h.: (1) freshening every 2 weeks, using 60 percent H_2SO_4 *and a 1-inch streak height, and (2) weekly freshening, using 50 percent* H_2SO_4 *and a 1/2-inch streak height. All trees were worked for 3 years on the front, and 3 years on the back. Excellent yields were obtained but (2) gave no advantage over (1). No more than 17 freshenings should be made in a single year, and a 4-inch interspace must be maintained over the backcupping period. FA*

Clements, R. W., and Harrington, T. A. 1965. GUM NAVAL STORES FROM PLANTATION. In A Guide to Loblolly and Slash Pine Plantation Management in Southeastern USA, pp. 199-210 . W. G. Wahlenberg (ed.). Ga. Forest Res. Counc. Rep. 14.
Pine gum and timber are compatible products from good management of forest plantations in the Southeast.

Croker, T. C., Jr. 1950. WIDE FACES B00ST GUM YIELD. Forest Farmer 9 (11) : 14. *Also in* Nav. Stores Rev. 60 (31) 22-23.
Increasing width of naval stores faces from 9 to 14 inches increased gum production from 126 barrels per crop (10,000 faces) to 199 barrels. Results are from a 40-acre longleaf-slash pine tract in south Alabama.

Ferguson, J. H. A. 1948. RESIN AND TURPENTINE PRODUCTION IN THE U.S.A. Tectona 38 (1) : 3-11.
Chiefly a review of recent work by the Southeastern Forest Experiment Station on resin-tapping of longleaf and slash pines, with special reference to the use of chemical stimulants and work on selection and breeding. FA

Harrington, T. A. 1964. NEW RESEARCH IN GUM EXTRACTION METHODS AT NAVAL STORES AND TIMBER PRODUCTION LAB. Nav. Stores Rev. 74 (2) : 6-7, 16.
Outlines two studies in progress at the Southeastern Forest Experiment Station: (1) A 2 percent aqueous solution of 2,4-D has been successful on slash pine, but will kill longleaf. In comparative tests over 4 years, slash pine treated with 2,4-D produced 4 percent more resin than trees treated with H_2SO_4*; this treatment did not corrode gutters and cups, and maintained a high-grade product over the second and third years, while* H_2SO_4 *treatments gave progressively lower grades. (2)* H_2SO_4 *applied as a paste, instead of a liquid, reduces corrosion of metal gutters and cups and, because of its direct and more lasting contact, is more effective, offering the possibility of lengthening the intervals between freshenings from 2 to 3, or even 4 weeks. FA*

Harrington, T. A. 1965. PLANNING FOR THE FUTURE OF GUM NAVAL STORES. AT-FA J. 28 (3) : 9-12.
Prospects for improved efficiency through research-developed mechanization of chipping, and gum-collection methods.

Harrington, T. A. 1966. USING ACID PASTE-A NEW GUM PRODUCTION TECHNIQUE. AT-FA J. 28(8): 9-11.
A new stimulant for oleoresin production, sulfuric acid paste, works equally well on slash and longleaf pine. The paste remains potent for 4 weeks, thus reducing labor needs for chipping.

Hawley, N. R. 1959. ANOTHER LOOK AT THAT SMALL TREE. AT-FA J. 21(12) : 11.
Discusses yields of oleoresin in relation to d.b.h. and crown-

length ratios for longleaf and slash pines. Impressive gains in yield are shown for larger trees with high crown-length ratios.

Hawley, N. R. 1966. GUM NAVAL STORES, AN ANCIENT FOREST INDUSTRY. AT-FA J. 28 (4) : 4, 6-7.
Brief history of the industry in the Southeastern U. S. Potential returns from gum farming are discussed.

Lane, J. M. 1967. 366 BARRELS OF GUM FROM 8 MONTHLY PASTE STREAKS. Nav. Stores Rev. 77 (2) : 4, 8.
In a 4-year study at Olustee, Florida, first-season resin yields obtained by applying (a) 60 percent H_2SO_4 paste to eight streaks at 28-day intervals and (b) 50 percent aqueous solution of H_2SO_4 to 16 streaks every 2 weeks were, on Pinus elliottii and P. palustris respectively, (a) 280, 366, and (b) 315, 418 barrels. Details of the acid-paste treatment are described, and its merits (economy of labor, reduced iron contamination of resin) are discussed. FA

Larson, P. R., and Clements, R. W. 1953. MORE GUM WITHOUT BROADAXE INCISIONS. Nav. Stores Rev. 63 (20) : 12, 13. *Also in* AT-FA J. 16 (1) : 8-9.
Gum yields of longleaf pine have been increased by as much as 60 barrels per crop merely by nailing on gutters and aprons instead of inserting tins in broadaxe incisions.

Llang, J.-H. 1965. [INVESTIGATION AND STUDY ON THE YIELD OF TURPENTINE AND OTHER SOME THINGS ABOUT PLANTATION OF EXOTIC PINES WHICH ARE PLANTED IN TAIWAN.] Taiwan Forest. Res. Inst. Bull. 107, 20 pp.
Lists exotic pines grown in Taiwan (with a key) and gives figures for diameter and height at different ages for Pinus palustris, P. rigida, P. radiata, P. insularis, P. densiflora, P. echinata and, with additional figures for resin yields, P. elliottii, P. luchuensis, P. thunbergii, and P. taeda. FA

Moore, W. H. 1949 . RESULTS FROM USING SULPHURIC ACID TO PROLONG GUM FLOW. Nav. Stores Rev. 59 (22) : 12, 18-19.
Some practical conclusions reached by the Southern Resin and Chemical Co., Glen Saint Mary, Florida, on sulphuric acid stimulation, after using the method on a commercial scale since 1945. Acid stimulation was found very adaptable to low-yielding longleaf pine (Pinus palustris), 20 acid streaks producing about the same total yields as 32 regular nonacid streaks. It is particularly useful in stands requiring thinning, where trees to be eliminated can be selected for tapping 3 or 4 years before they are felled, the larger trees remaining for future tapping. Freshening twice every .3 weeks was found preferable to once every 2 weeks, the face being extended by only ½ inch each time. FA

Page, R. H. 1963. IMPACT OF NAVAL STORES ON UTILIZATION OF LONGLEAF AND SLASH PINE TIMBER. Forest Prod. J. 13: 361-364.
Briefly reviews the effect of resin tapping by modern methods of quality and uses, including preservative treatment., and reports on an inquiry among five southern pulp mills and seven sawmills. This indicates that prices paid for pulpwood from bark-hacked, acid-treated trees are no lower than for unworked trees, provided that they are free of metal (from lips) and excessive bark ingrowth, but that some sawmillers have trouble with embedded metal and complain that hard rosin dulls saws and knives. FA

Quinn, G. M., and Bengtson, G. W. 1957. GUM YIELD TABLES FOR INTENSIVELY WORKED SLASH AND LONGLEAF PINES. AT-FA J. 19 (12) : 4, 5. *Also in* Nav. Stores Rev. 67 (5) : 6-7.
In overstocked stands, trees 8 inches and smaller in diameter yielded less than 200 barrels of gum per crop. Presents gum-yield tables by diameter and by crown-length percentage.

Schopmeyer, C. S. 1948. EFFECT OF 2,4-D ON YIELDS OF OLEORESIN FROM SLASH AND LONGLEAF PINES. Sci. Mon. 67(6): 440-443.
Among chemicals tested in search of a noncorrosive harmless substance to replace H_2SO_4 for treating faces on Pinus palustris and P. caribaea, 2,4-dichlorophenoxyacetic acid is one of the most promising. Applications of the morpholine salt of 2,4-D gave yields equal to those usually obtained commercially with H_2SO_4. Results of these tests are tabulated. Research on the commercial value of 2,4-D treatment, and its effect on the tree, will be continued. FA

Schopmeyer, C. S. 1954. ACID-TREATMENT--THE CHIPPER'S HELPER. AT-FA J. 16 (8) : 10.
A description of the resin ducts of slash and longleaf pine trees and how acid treatment prolongs gum flow from then.

Schopmeyer, C. S., and Larson, P. R. 1954. GUM-YIELD TABLES FOR SLASH AND LONGLEAF PINE ON POORER THAN AVERAGE SITES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 69, 2 pp. *Also in* Nav. Stores Rev. 65(1): 14-15. 1955.
Tabulates yields for slash pine (site index 70) and longleaf pine (site index 65) from (1) d.b.h. and crown-length ratio and (2) d.b.h, and number of rings in last inch of radial growth.

Schopmeyer, C. S., and Larson, P. R. 1954. PREDICTING GUM YIELDS FROM TREE MEASUREMENTS. AT-FA J. 17(1) 8-9. *Also in* Nav. Stores Rev. 64 (7) : 10-11, 17.
The relationships of gum yields to tree diameter, crown size, and growth rate are given for slash pine and longleaf pine worked with bark chipping and treated with sulfuric acid.

Schopmeyer, C. S., and Larson, P. R. 1955. EFFECTS OF DIAMETER, CROWN RATIO, AND GROWTH RATE ON GUM YIELDS OF SLASH AND LONGLEAF PINE. J. Forest. 53: 822-826.
In a local study, using bark-chipped, acid-treated streaks, the regression equations for yield were: Pinus elliottii, $Y = - 242.7 +28.49 D + 390.6 CR$ and $Y = -241 .3 + 28.44 D + 1094 RW$; Pinus palustris, $Y = - 223 + 25.13 D + 366.7 CR$ and $Y = 190.1 + 26.66 D + 1163 RW$, where Y = mean annual yield in barrels of 435 pounds per 10,000 faces; D = d.b.h. (ins.); CR - crown length per total height of tree; and RW - mean ring width (in.) of the outermost inch. Using D alone gave higher significant correlations but, owing to the wide range with D of CR, which is strongly affected by stand density, such equations are unlikely to be of wide application. The introduction of RW did not increase precision, but may be useful in examining the effect of site. The silvicultural and economic implications of these facts are discussed. On sites poorer than average the present minimum diameter of 9 inches should be raised to at least 10 for a profitable tapping operation. FA

Schopmeyer, C. S., and Maloy, O. C. 1960. DRY FACE OF NAVAL STORES PINES. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 51, 7 pp.
Describes the condition and its more serious form, pitch-streak, on Pinus elliottii and, less frequently, P. palustris, and discusses causes (chiefly moisture stress through drought, an inadequate crown, or poor techniques impairing water conduction), prevention and control. Though no fungus has been proved a primary cause, certain species are thought to accelerate extension and aggravate the condition. FA

Snow, A. G., Jr. 1948. EFFECT OF SULFURIC ACID ON GUM YIELDS FROM SLASH AND LONGLEAF PINES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Tech. Note 68, 35 pp.
Summarizes, through 1946. intensive experiments begun in 1944.

Snow, A. G., Jr. 1948. TURPENTINING AND POLES. Southern Lumberman 177 (2225) : 276, 278-279.
Pines tapped on two faces by the modern method of bark depth freshenings plus acid treatment, yield in 3 years the equivalent of 5 years by the old method. The reduced tapping period produces poles of greater diameter and, since the faces are considerably shorter, less of the butt has to be cut off, so that the poles are also longer. Preservative penetration tests showed that in slash pine, penetration behind the modern face was satisfactory; but faces of longleaf pine required to be incised. The reason for this specific difference is not yet known. FA

True, R. P., and McCulley, R. D. 1945. DEFECTS ABOVE NAVAL STORES FACES ARE ASSOCIATED WITH DRY FACE . Southern Lumberman 171(2153) : 200-202, 204.
Pitch-soak, stain, dry wood, and rot are frequently found in pine in the log cut from, just above faces worked out for turpentine and resin. These defects are most pronounced above faces that have been burned, but are also found above unburned faces. It was found that most of the defects occurred above those faces or parts of faces that had been affected by dry face at the time chipping stopped. The prompt felling of worked out timber would limit the spread of pitch-soak and prevent the development of extensive rot; it would not reduce the stain.

True, R. P., and Snow, A. G., Jr. 1949. GUM FLOW FROM TURPENTINE PINES INOCULATED WITH THE PITCH-CANKER FUSARIUM. *J. Forest 47: 894-899. (Abstr.) Phytopathology 38: 572:573. Treating freshly cut virgin faces with the pitch-canker fungus, Fusarium lateritium f. pini, prolonged the period of commercially adequate resin flow (normally 1 week) to an average of 5 weeks for slash pine (P. caribaea) and 3 weeks for longleaf pine (P. palustris). Later freshening and retreatment of the same faces prolonged adequate flow for an average of 3 weeks with P. caribaea and for usually not more than 2 weeks with P. palustris. No reason is known to account for the difference between the prolongation induced by the initial and by later treatments. FA*

USDA Forest Service, Southeastern Forest Experiment Station. 1964. EFFECT OF 2,4-D ON GUM YIELDS FROM SLASH PINE. *In 1963* research at the Southeastern Forest Experiment Station, p. 34.
In a 3-year trial, 2 percent 2,4-D in water has produced as much slash pine resin as 50 percent H_2SO_4. *The 2,4-D did not corrode lips and cups, so that resin quality was better. All 2,4-D treatments killed longleaf pine. FA*

USDA Forest Service. Southern Forest Experiment Station. 1946. AVERAGE GUM YIELD FROM LONGLEAF PINE AND SLASH PINE OF DIFFERENT DIAMETERS FOR GOOD AND POOR SITES. AT-FA J. 8 (4) : 10.
Gum yields in units per crop per season.

Wahlenberg, W. G. 1946. LONGLEAF PINE. V--NAVAL STORES OPERATIONS. Southern Lumberman 172 (2158) : 36-38.
Various aspects of naval stores operations. Growth and yield are discussed under three headings: growth after partial cutting, natural limits, and determination of volume and growth.

4. FOREST INJURIES AND PROTECTION

42 INORGANIC INJURIES

Jones, W. N. 1952. FUSED NEEDLE DISEASE IN PINUS PALUSTRIS. Empire Forest. Rev. 31: 325-326.
In spring 1950, 65 plants of P. palustris sown in 1948 were transplanted from the nursery to the forest (Wareham, England). There was no trace of fused-needle disease during the period in the nursery, but several instances were noted during 1951 and, by May 1952, 41 of the 62 surviving plants were showing clear symptoms of the disease. Affected needles were restricted to those produced towards the end of the 1950 growing season and still unshed in 1952. It is suggested that the sudden and transitory development of the symptoms is related to reduction in the root's normal capacity for water absorption, caused by the removal of the plants to a new site. FA

Muntz, H. H. 1947. ICE DAMAGE TO PINE PLANTATIONS. Southern Lumberman 175 (2201) : 142-145.
The upper half of Louisiana is an area of high risk for ice storms. As storms in 1944 and 1947 demonstrated, slash pine is more seriously damaged than the native loblolly and longleaf. For short rotations, slash may still be a good choice for planting in this area, but loblolly or longleaf should be planted if poles and saw logs are to be grown.

Poynton, R. J. 1966. THE DROUGHT RESISTANCE OF COMMERCIAL TIMBER SPECIES IN THE TRANSVAAL. Bosb. Suid-Afr. 6: 87-106.
Data are presented to illustrate the severity of the 1964 drought in the E. and N. Transvaal. Important commercial species in the area may be grouped into the broad classes: (1) resistant-Eucalyptus maculata, E. paniculata, and Pinus roxburghii; (2) moderately resistant--E. cloeziana, E. grandis, P. montezumae, P. elliottii, P. patula, P. pseudostrobus, and P. radiata; and (3) somewhat susceptible-E. fastigata, E.microcorys, P. palustris, and P. taeda. FA

43 FOREST FIRES: DAMAGES, PRESCRIBED BURNING

Bickford, C. A., and Newcomb, L. S. 1947. PRESCRIBED BURNING IN THE FLORIDA FLATWOODS. U. S. Dep. Agr. Forest Serv. Fire Contr. Notes 8 (1) : 17-23.
This paper describes methods of prescribed burning developed and used on the Osceola National Forest in northeast Florida in the longleaf-slash pine type. Fire protection in this type results in the extension of the more valuable slash pine, but it also leads to the accumulation of inflammable material and increased fire hazard. Slash pine about 6 feet in height and longleaf pine over 1 year old can stand slow-burning prescribed fire in the dormant season. The necessary measures of analysis, planning, preparation, and burning are described. The importance of thorough planning and preparation, training of crews, and obtaining reliable weather forecasts is stressed. FA

Bruce, D. 1947. THIRTY-TWO YEARS OF ANNUAL BURNING IN LONGLEAF PINE. J. Forest. 45: 809-814.
In 1915 the Roberts Plots were established near Urania, Louisiana, to test the effect of annual burning and grazing on longleaf pine seedlings .The following facts are presented: (1) Hogs destroy longleaf seedlings and can prevent

regeneration. (2) After the age of one year, longleaf seedlings (at least those on the better sites) can survive annual winter fires, and grow past the size at which they are retarded by these fires. (3) Exclusion of fire from longleaf land within the range of loblolly and shortleaf pines allows these species to encroach, even with heavy longleaf seedling stands. Annual fires killed all loblolly and shortleaf seedlings and permitted the development of a fully stocked longleaf stand.

Bruce, D. 1951. FIRE RESISTANCE OF LONGLEAF PINE SEEDLINGS. J. Forest. 49: 739-740.
Fire resistance of 1-year longleaf pine seedlings was found to be closely related to vigor classes (all vigorous seedlings and 75 percent of those in fair vigor, but none of the weak seedlings, survived). Vigor classes in turn were fairly closely related to groundline diameter. The older the seedlings were at the time of the fire, the better they survived: survival at 9 months was less than 10 percent, at 16 months 30 percent, and at 26 months 40 percent. The better survival of seedlings first burned at 2 years of age is probably due to their greater thickness (0.2-0.4 inch diameter compared with 0.1-0.2 inch for yearlings). FA

Bruce, D. 1951. FIRE, SITE, AND LONGLEAF HEIGHT GROWTH. J. Forest. 49: 25-28.
In a test started in south Mississippi in 1935, light and severe fires in 4-year-old longleaf pine regeneration caused no more mortality in the following 4 years than occurred on unburned plots. Both summer and winter fires, however, killed 46 percent and 26 percent respectively of trees in 9-year-old plots. Light fire when the seedlings were 4 years old stimulated height growth, probably by controlling brown-spot disease. Summer fires were more beneficial than winter ones. In another study on poorer soils in north Florida, it was found that the more frequent and more severe the fires, the lower the survival and the poorer the height growth. The best growth there was on unburned plots. Local differences in soil conditions had more influence on height growth than the fire treatments. No evidence was found that fire in open grassy areas altered the soil in any way. FA

Bruce, D. 1954. MORTALITY OF LONGLEAF PINE SEEDLINGS AFTER A WINTER FIRE. J. Forest 52: 442-443.
After a moderately intense grass fire in 3-year-old Pinus palustris, the percent mortality was graphed against seedling height for 4 degrees of defoliation by Scirrhia acicola. Controlled burning before many seedlings are 1/3 defoliated is recommended. The 0-6 inch class survives best even when 2/3 defoliated. FA

Bruce, D. 1955. LONGLEAF LED THE WAY. La. State Univ. Fourth Annu. Forest. Symp. Proc. 1955: 79-83.
Longleaf pine was the first U. S. forest type in which fire teas used silviculturally. The species' natural fire resistance, and the fuels and soils characteristic of longleaf sites, make successful prescribed burning easier than in the loblolly-shortleaf type.

Bruce, D. 1956. EFFECT OF DEFOLIATION ON GROWTH OF LONGLEAF PINE SEEDLINGS. Forest Sci. 2: 31-35.
Natural seedlings of P. palustris are subject to defoliation by fire and fungus during the grass stage (2-30 years). The effect on the height anal diameter growth of 18-month nursery seedlings of clipping off 30, 60, and 90 percent of the foliage was investigated. Clipping was done once in July, November, or the following February, or twice in various combinations. All defoliation caused loss of growth in rough proportion to severity; degree of clipping was more significant than the date, and two-stage clipping was generally worse than one 90 percent clipping. November was significantly worse than July clipping, and February clipping caused least damage, an endorsement of the practice of deferring controlled burning to January or February. FA

Byram, G. M. 1948. VEGETATION TEMPERATURE AND FIRE DAMAGE IN THE SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Fire Contr. Notes 9 (4) : 34-36.
Damage is related to initial temperature of vegetation; size of needles, buds, and branch ending; and wind.

Byram, G. M., and Nelson, R. M. 1952. LETHAL TEMPERATURES AND FIRE INJURY. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 1, 2 pp. *Also in* Nav. Sores Rev. 62 (20) : 18.
The relation of time and temperature to killing of loblolly, longleaf, slash, and pitch pine needles immersed in a water bath varied little among species.

Chapman, H. H . 1947. PRESCRIBED BURNING VERSUS PUBLIC FOREST FIRE SERVICES. J. Forest. 45: 804-808.
The author recounts the steps which have led to the conversion of most, though not all, American foresters to the belief that controlled burning is an essential part of the management of longleaf pine and attacks the arguments of those still unconverted. He is now in favor of careful, prescribed burning at intervals of about 3 years both in order to obtain establishment of regeneration and in order to reduce fire hazard.

Chapman, H. H. 1947. RESULTS OF A PRESCRIBED FIRE AT URANIA, LA., ON LONGLEAF PINE LAND. J. Forest. 45: 121-123.
Report on experiments on cutover lands. Mortality of seedlings still in the grass from a hot winter headfire is negligible, especially when there is a dense stocking of seedlings. At the most vulnerable height, 6 inches to 3 feet, nearly half the seedlings were killed. Mortality of the 6- to 12-foot class was 20 percent. Hardwoods too large to be killed (above 2-inches diameter) by fire should be cut down in August, and on bare areas burned the following August. Blackjack oak 30 feet high and up to 5 inches in diameter have been successfully controlled.

Chapman, H. H. 1957. FORTY-YEAR EFFECT OF A SUMMER FIRE ON 4-YEAR-OLD LONGLEAF PINE AT URANIA, LOUISIANA. J Forest. 55: 301-302.
A large number of 4-year pine seedlings were destroyed by a bad fire in summer 1917, and a second summer fire in 1924 killed many of the survivors. Measurements made at intervals on two permanent 1-acre plots showed that basal area (pines and hardwoods) increased from (a) 35.84 square feet and (b) 9.16 square feet in 1932 to (a) 146.42 square feet (ca. full stocking) and (b) 105.70 square feet in 1955. Controlled burns were done at 3-year intervals to prevent accidental fires. The plots now need thinning. FA

Dyer, C. D., and Brightwell, C. N. 1955. PRESCRIBED BURNING IN SLASH AND LONGLEAF PINE FORESTS OF GEORGIA. Univ. Ga. Colt. Agr. Ext. Serv. Bull. 594, 13 pp. *Also in* AT-FA J 24 (3) : 6-8. 1961.
Instructions for prescribed burning.

Fahnestock, G. R., and Hare, R. C. 1964. HEATING OF TREE TRUNKS IN SURFACE FIRES. J. Forest. 62: 799-805.
Compares the effects of fires advancing with the wind (1) and against it (2), in a pole-size Pinus palustris stand, unburned for 8 years and carrying 14 tons litter per acre, in south Mississippi. In (1), 60 percent of the litter was burned, vs. 49 percent in (2). Temperatures decreased generally with height above ground and reached 1600° F. briefly on the bark, where they were lower in fissures than oil plates and higher on lee than on windward sides of stems, the difference increasing with height. With increasing

height, temperatures were slightly greater on lee sides, but much greater on windward sides, in (1) than in (2). Crown scorching was also more severe in (1). Cambial injury occurred extensively only on lee sides of some trees in (1). FA

Hare, R. C. 1965. CONTRIBUTION OF BARK TO FIRE RESISTANCE OF SOUTHERN TREES. J. Forest. 63: 248-251.
Time required to kill cambium in situ with a propane flame was a function of both thickness and thermal properties of the overlying bark; resistance was directly correlated with tree diameter. Of 14 pine and hardwood species longleaf and slash pine were most resistant, and sweetgum, cherry, and holly least resistant.

Hare, R. C. 1965. SIMPLE HOT STAGE FOR STUDYING CRITICAL CELL TEMPERATURES. Can. J. Bot, 43: 777-778.
Trials with an easily constructed stage indicate that cells of longleaf pine stem tissue may be more heat-tolerant than cells of white pine.

Hills, J. T. 1957. PRESCRIBED BURNING TECHNIQUES IN LOBLOLLY AND LONGLEAF PINE ON THE FRANCIS MARION NATIONAL FOREST. U. S. Dep. Agr. Forest Serv. Fire Contr. Notes 18: 112-113.
Instructions for making checkerboard or spot fires, burning in strips, and using flanking fires.

Jorgensen, J., and Derr, H. J. 1958. YEARLING LONGLEAF SURVIVES A WILDFIRE. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 114.
If weather is favorable during the first year, longleaf seedlings may reach a size that enables them to survive some accidental fires.

McCulley, R. D. 1948. EFFECT OF UNCONTROLLED FIRES ON LONGLEAF PINE SEEDLINGS. U. S_ Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. News 3.
In a study in northern Florida repeated severe fires killed many seedlings and reduced the growth of those that survived.

Miller, S. R., Malac, B. F., and Johnson, J. W. 1961. A CASE HISTORY OF SLASH AND LONGLEAF PINE SURVIVAL FOLLOWING A WINTER WILDFIRE. Union Bag-Camp Corp. Woodland Res. Note 11, 3 pp.
On sample plots established after a severe fire in Georgia, 72 percent of trees showing healthy cambium near the base survived after 3 years as against 43 percent showing injured cambium. Of dominants and codominants, 75 percent survived; of inferior classes, 35 percent. Of trees more than 6 inches d.b.h, 75 percent survived against 25 percent of those less than 6 inches. Mortality of both species was equal, but slash pine succumbed faster. FA

Muntz, H. H. 1947. PRESCRIBED BURNING OF LONGLEAF PLANTATIONS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 49.
See Wakeley and Muntz, 1947.

Reifsnyder, W. E., Herrington, L. P., and Spalt, K. W. 1967. THERMOPHYSICAL PROPERTIES OF BARK OF SHORTLEAF, LONGLEAF, AND RED PINE. Yale Forest. Bull. 70, 41 pp.
Barks of these three pines have no peculiarities in their thermal properties that would make them unusually effective in protecting the cambium from the heat of a fire. Bark thickness appears to be the primary factor in determining a tree's fire resistance.

Storey, T. G., and Merkel, E. P. 1960. MORTALITY IN A LONGLEAF-SLASH PINE STAND FOLLOWING A WINTER WILDFIRE. J. Forest. 58: 206-210.
Describes a study of 475 dominant and codominant Pinus palustris and P. elliottii trees in largely even-aged 60-year mixed stands after the Buckland wildfire in Florida, March 1956. It was found that mortality could be estimated by the amount of crown consumed. About the same number of large and small trees of both species died from equal percents of crown consumption; 87 percent of trees died when> I/2 their needles were consumed by flame, and 42 percent when < 1/2 were consumed. Even 100 percent needle browning caused no tree death. Presumably this was because initial temperatures of the buds and cambium were low (air temperature was ca. 45` F. at the time of the fire) and were not raised to .fatal level by the fire. Height of bark charring on the stem also was related to deaths: 88 percent died when ~_ 80 percent of the stem length was charred, and 39 percent when 60-80 percent was charred. There were very few deaths when < 60 percent was charred. Beetle attack was light. FA

USDA Forest Service. 1950. EFFECT OF BACKFIRES AND HEADFIRES ON LONGLEAF SEEDLINGS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. News 12.
In a test of the relative effects of backfires and headfires on longleaf pine seedlings, five pairs of plots were selected and one of each pair was burned with a headfire and the other with a backfire. The seedlings were about 3 years old with root collars from 0.2 to 0.3 inch in diameter. In plots burned by backfires 57 percent of seedlings died. In those burned by headfires 35 percent died.

USDA Forest Service. 1950. LONGLEAF SEEDLINGS WITHSTAND FIRE MUCH BETTER ON A COLD DAY. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. News 8.
With air temperature at 92° F, a longleaf pine seedling can tolerate a rise in temperature (as during a prescribed burn) of only 30° F. With air temperatures at 40° F, it can tolerate a rise of 100° F.

Wahlenberg, W. G. 1946. LONGLEAF PINE. IV--PROTECTION FROM FIRE. Southern Lumberman 172 (2156) : 33-34.
Discusses effects of fire, forest fuels, protective burning, and costs of protection. Also protection from insects, brownspot needle disease, and other diseases. Climatic injuries are mentioned briefly.

Wakeley, P. C., and Muntz, H. H. 1947. EFFECT OF PRESCRIBED BURNING ON HEIGHT GROWTH OF LONGLEAF PINE. J. Forest. 45 : 503-508.
Longleaf pines planted on a 40-acre tract in central Louisiana during 1935 were control-burned in January 1938 and again in February 1941 , the purpose being to control brown spot needle disease. A similar 60-acre stand was left unburned. By 1946, survival in the two plantations was the same but height growth was much better in the burned plantation.

44 DAMAGE BY PLANTS: DISEASES

Berry, C. R., and Hepting, G. H. 1959. PITCH CANKER OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 35, 3 pp.
Symptoms, a description of the pathogen, its importance, and control measures.

Boyce, J. S., Jr. 1951. LOPHODERMIUM PINASTRI AND NEEDLE BROWNING OF SOUTHERN PINES. J. Forest. 49: 20-24.
The fungus is probably not pathogenic to pines in the southeastern U. S., but readily invades needles attacked or weakened by other agencies.

Boyce, J. S., Jr. 1958. NEEDLE CAST OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 28, 4 pp.
Symptoms, causes, and control for pine needle blights, espe-

cially those caused by Scirrhia acicola and Hypoderma lethale.

Boyce, J. S., Jr. 1962. GREENHOUSE INOCULATIONS OF CONIFEROUS SEEDLINGS WITH FOMES ANNOSUS. (Abstr.) Phytopathology 52: 4.
When seed of Pinus taeda, P. palustris, P echinata, P. elliottii, and P. strobus was sown over infected pine roots buried 2-3 inches in the soil, infection was confirmed within a year only on the roots of two dying P. echinata seedlings and one apparently healthy P. palustris. When 1- or 2-yearold seedlings of P. taeda, P. strobus, and Juniperus Virginiana were planted in pots containing infected root pieces, infection occurred in all species within a year--mostly in roots 1-2 mm. thick. In some inoculum pieces, F. annosus was still alive after I year in the soil. FA

Bryan, W. C., and Zak, B. 1961. SYNTHETIC CULTURE OF MYCORRHIZAE OF SOUTHERN PINES. Forest Sci. 7: 123-129.
A pure-culture technique for mycorrhizal synthesis demonstrated mycorrhizal formation by eight fungi in association with roots of southern pines.

Campbell, W. A. 1949. NEEDLE CAST OF SOUTHERN PINES. Forest Farmer 9 (1) : 4, 10.
Needle cast can be caused by any of several fungi, the most common of which is Scirrhia acicola (Dearn.) Siggers. Outbreaks occur at irregular intervals, but there is no evidence that the disease causes appreciable damage.

Campbell, W. A. 1951. THE OCCURRENCE OF PHYTOPHTHORA CINNAMOMI IN THE SOIL UNDER PINE STANDS IN THE SOUTHEAST. Phytopathology 41: 742-746. *Also in* Rev. Appl. Mycol. 31: 41.
The abundance of the fungus was determined in 61 plots outside the littleleaf area. Isolations were obtained from soil of 48 percent of the 61 plots, regardless of the type of stand, and from 52 percent of 50 plots in stands containing shortleaf or loblolly pine, either pure or in mixtures. P. cinnamomi was present in the soil in only 14 percent of seven plots in stands containing slash and longleaf pine.

Cole, D. E. 1963. MANAGEMENT OF PINE SEED PRODUCTION AREAS. Seventh Southern Conf. on Forest Tree Impr. Proc. 1963: 44-49.
Cone rust may cause heavy losses of slash and longleaf conelets on the Gulf Coast and in north Florida. Methods for controlling it in seed-production areas are given.

Croker, T. C., Jr. 1967. CROP-SEEDLING METHOD FOR PLANNING BROWN-SPOT BURNS IN LONGLEAF PINE. J. Forest. 65: 488 .
Brown-spot infection and expected fire damage on crop seedlings are better indicators of the need for prescribed burning than are such data taken on average seedlings.

Crosby, E. S., Jr. 1966 . STUDIES IN THE MORPHOLOGY, LIFE HISTORY, AND PATHOGENICITY OF SCIRRHIA ACICOLA (DEARN.) SIGGERS. Diss. Abstr. 27B: 1352.
Describes the endospores and discusses factors affecting the germination of conidia. The ascospore stage was found on dead needles at Aiken, South Carolina, each month from February 1964 to April 1965, most abundantly in late spring and early summer: laboratory studies of ascospore ejection are described. Most attempts to produce infection of seedlings of longleaf pine failed. but inoculations with conidial suspensions on seedlings in outdoor beds were successful. FA

Foster, A. A . 1959. NURSERY DISEASES OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 32, 7 pp.
Causes, symptoms, and control of brown spot, black root rot, nematode injury, fusiform rust, and chlorosis in forest tree nurseries.

Hendrix, F. F., Jr., Kuhlman, E. G., Hodges, C. S., Jr., and ROSS, E. W. 1964. FOMES ANNOSUS-A SERIOUS THREAT TO REGENERATION OF PINE. IJ. S. Dep. Agr. Forest Serv. Res. Note SE-24, 4 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Studies were made in plantations in North and South Carolina: (a) mixed pines on the site of a white pine plantation clear-felled because of severe F. annosus root rot; (b) loblolly pine on the site of a slash pine plantation clear-felled because of fusiform rust, but not known to be infected with F. annosus; (c) slash pine on the site of a clear-felled longleaf pine/scrub oak stand. Results indicate that the fungus must be considered a serious problem on former forest lands. In (a) 2 years after planting, mortality attributable to F. annosus was 2 percent for shortleaf, 1.5 for Virginia, 0.7 for Scots and 0.6 for white pine, but only 0.4 for natural white pine regeneration. In (b) mortality of loblolly pine from this cause averaged 2.68 percent per annum 4 years after planting, and in (c)] 5 percent killed slash pine were counted 2 years after planting on the most seriously infected plots, plus 11-17 percent infected living trees. Spread was from infected stumps, and from seedling to seedling. FA

Henry, B. W. 1953. A ROOT ROT OF SOUTHERN PINE NURSERY SEEDLINGS AND ITS CONTROL BY SOIL FUMIGATION. Phytopathology 43: 81-88.
A root rot occurring at a U. S. Forest Service nursery near Brooklyn, Miss., killed large numbers of Pinus taeda and damaged P. echinata and P. palustris, P. caribaea was less susceptible. The cause of the rot was not discovered, but applications of 24 gallons per acre of a 20 percent-by-volume solution of ethylene dibromide, 2-3 weeks before spring sowing, gave excellent control, and two to three successive annual treatments eliminated all damage to following pine crops. FA

Henry, B. W. 1953. EFFECTS OF ETHYLENE DIBROMIDE ON NEMATODES ASSOCIATED WITH A ROOT ROT OF SOUTHERN PINE SEEDLINGS. (Abstr.) Phytopathology 43 : 474-475.
See entry above.

Henry, B. W. 1954. NEW LIGHT ON SPREAD OF BROWN SPOT. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 90.
Ascospores, one of the two kinds of spores that transmit the brown-spot needle blight of longleaf pine seedlings, have recently been found to occur at all seasons of the year.

Henry, B. W. 1954. SPORULATION BY THE BROWN SPOT FUNGUS ON LONGLEAF PINE NEEDLES. Phytopathology 44: 385-386.
In an attempt to determine the role of ascospores of Scirrhia acicola in the epidemiology of brown-spot disease, the frequency was investigated of ascospore occurrence on longleaf pine needles in nature. Ascospores were found every month from February 1952 to January 1953 on dead needles and necrotic distal portions of needles. FA

Henry, B. W. 1959. DISEASES AND INSECTS IN THE SOUTHWIDE PINE SEED SOURCE STUDY PLANTATIONS DURING THE FIRST FIVE YEARS. Fifth Southern Conf. on Forest Tree Impr. Proc. 1959: 12-17.
Two pests have been of major importance. Tip-moth injury is severe in most shortleaf and loblolly plantations, irrespective of seed source, and is impeding height growth. Intensity of fusiform rust is variable among the slash and loblolly plantations. Its incidence consistently differs between seed sources in loblolly plantings, but in only one case with slash pine.

Henry, B. W., and Hepting, G. H. 1957. PEST OCCURENCES IN 35 OF THE SOUTHWIDE PINE SEED SOURCE STUDY PLANTATIONS DURING THE FIRST THREE YEARS. U. S. Dep. Agr. Forest

Serv. Southern Forest Exp. Sta., 7 pp.
Drought has caused most of the mortality so far. Fusiform rust is building up rapidly. The Nantucket tip moth is widespread in loblolly and shortleaf plantings, and may be retarding height growth appreciably. Brown-spot needle disease is being controlled in longleaf plantations with fungicides, but it and Hypoderma needle blight may be causing growth loss on loblolly. No other pests yet appear serious.

Henry, B. W., and Wells, O. O. 1967. VARIATION IN BROWNSPOT INFECTION OF LONGLEAF PINE FROM SEVERAL GEOGRAPHIC SOURCES. U. S. Dep. Agr. Forest Serv. Res. Note SO-52, 4 pp. Southern Forest Exp. Sta., New Orleans, La.
In plantings in southern Mississippi, seedlings from seed sources near the western extremity of the range were generally more heavily infected than seedlings from the central part.

Hepting, G. H. 1959. DISEASE LOSSES IN SOUTHERN PINE SEED DURING CONE PRODUCTION. In Direct Seeding in the South, 1959, a Symposium, pp. 36-39. Duke Univ.
The most important cone disease is a rust caused by Cronartium strobilinum. It afflicts slash and longleaf pines; oaks are alternate hosts. Some control measures are mentioned.

Hepting, G. H. 1962. THE TOP FIVE AMONG FOREST DISEASES OF THE SOUTH. Forest World 1(3) : 35-38.
The five most serious forest tree diseases in the South are hardwood decays, fusiform rust, littleleaf disease, brownspot needle blight, and annosus root rot.

Hepting, G. H., and Fowler, M. E. 1962. TREE DISEASES OF EASTERN FORESTS AND FARM WOODLANDS. U. S. Dep. Agr. Forest Serv. Agr. Inform. Bull. 254, 48 pp.
Comprehensive review.

Hepting, G. H., and Lindgren, R. M. 1950. COMMON SOUTHERN FOREST TREE DISEASES. Forest Farmer 9 (5) : 31-33.
Brief descriptions and control measures.

Hodges, C. S., Jr. 1962. DISEASES IN SOUTHEASTERN FOREST NURSERIES AND THEIR CONTROL. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 142, 16 pp.
Describes the more common diseases, including those caused by nematodes and by Cylindrocladium scoparium, Cronartium fusiforme, Scirrhia acicola, Rhizoctonia, Phomopsis juniperovora, and Cercospora sequoia, and their control, covering general methods of application and including lists of formulations and application rates, and of suppliers. FA

Jewell, F. F. 1963. HOW CAN GENETIC CONTROL OF DISEASES AID THE FOREST MANAGER? Seventh Southern Conf. on Forest Tree Impr. Proc. 1963: 25-26.
Disease-resistant trees may be among the earliest practical results of forest genetics research.

Kals, A. G. 1964. GERMINATION AND GROWTH OF SCIRRHIA ACICOLA IN LIQUID CULTURE INHIBITED BY CYCLOHEXIMIDE SEMICARBAZONE. U. S. Dep. Agr. Plant Dis. Reporter 48: 553-556.
Dry weights of mycelium indicated no significant differences among concentrations of the antibiotic (0.1, 1.0, 10.0, or 100.0 p.p.m.), but differences were significant between the antibiotic treatments and a water control, between the antibiotics and an alcohol control, and between the water and alcohol controls. Spore germination and subsequent growth decreased as the concentration of the antibiotic was increased. Germination and growth of the antibiotic-treated spores resumed when the spores were transferred to potato-dextrose agar.

Lightle, P. C. 1960. BROWN-SPOT NEEDLE BLIGHT OF LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 44, 7pp
Hosts, distribution, symptoms, life history, pathogenicity, and control.

Lindgren, R. M. 1948. THINNING PINES CANKERED BY FUSIFORM RUST. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 55. *Also in* Nav. Stores Rev. 58 (9) : 6.
Rules for thinning trees cankered by fusiform rust. Longleaf is generally much more resistant than slash or loblolly pines but 20 to 30 percent infection may occur in areas of high rust hazard.

Lindgren, R. M. 1951. THE DISEASE PROBLEM IN RELATION TO TREE IMPROVEMENT. First Southern Conf. on Forest Tree Impr. 5 pp.
Discusses the possibilities of alleviating disease problems through tree improvement, with special emphasis on the dangers involved. There is strong evidence that strains of longleaf pine resistant to brown spot could be selected.

Lindgren, R. M., and Henry, B. W. 1949. PROMISING TREATMENTS FOR CONTROLLING ROOT DISEASE AND WEEDS IN A SOUTHERN PINE NURSERY. U. S. Dep. Agr. Plant Dis. Reporter 33: 228-231.
At the W. W. Ashe Nursery near Brooklyn, Miss., two fumigants, chloropicrin and ethylene dibromide, were outstandingly successful in controlling root disease.

Maloy, O. C., and Matthews, F. R. 1960. SOUTHERN CONE RUST: DISTRIBUTION AND CONTROL. U. S. Dep. Agr. Plant Dis. Reporter 44: 36-39.
See abstract under Matthews and Maloy, 1960.

Mann, W. F., Jr., and Scarbrough, N. M. 1948. CLOSE SPACING REDUCES FUSIFORM RUST. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 53. *Also in* Forest Farmer 7 (5) : 12. *Also in* Nav. Stores Rev. 58 (34) : 6 .
Longleaf and slash pines were planted in alternate rows in southern Mississippi. After 11 years, 1.5 percent of the longleaf were infected with rust, as contrasted with 22 to 43 percent of the slash pines.

Matthews, F. R. 1967. SOUTHERN CONE RUST, CRONARTIUM STROBILINUM (ARTH.) HEDGC. AND HAHN. *In* Important forest insects and diseases of mutual concern to Canada, the United States and Mexico. Can. Dep. Forest. and Rural Develop. Pub. 1180, pp. 225-227.
Longleaf pine is listed as a host.

Matthews, F. R:, and McLintock, T. F. 1958. EFFECTS OF FUNGICIDES ON POLLEN GERMINATION OF SLASH AND LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 122, 2 pp.
Of four fungicides tested at 2 or 0.2 pounds (or pints) per 100 gallons of water in connection with Cronartium strobilinum control, Puratized Agricultural Spray (an organic mercurial) was 100 percent lethal. Captan and Basi-cop (tribasic Cu sulphate) markedly inhibited germination, but ferbam actually stimulated it, the higher concentration being better on longleaf, the lower on slash. Whether ferbam is effective against the fungus is still under investigation. FA

Matthews, F. R., and Maloy, O. C. 1960. WHAT TO DO ABOUT CONE RUST. Forest Farmer 19 (4) : 8, 14-15.
Cone rust destroys first-year cones of slash and longleaf pine. The main area of infection extends from central Florida to the southernmost counties of Georgia, and westward along the Gulf Coast through southern Mississippi.. Since evergreen oaks are the alternate host, isolation of pines from them would eliminate the danger. This course may not be practical, however, for the spores spread more than 1,800 feet. Ferbam sprays will control the disease but more economical methods are needed

Muntz, H. H. 1947. PRESCRIBED BURNING OF LONGLEAF PLANTATIONS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 49.
Prescribed burning in a young longleaf pine plantation in central Louisiana reduced brown-spot infection and accelerated height growth.

Platt, W. D., Cowling, E. B., and Hodges, C. S., Jr. 1965. RESISTANCE OF CONIFEROUS ROOT WOOD AND STEM WOOD TO DECAY BY FOMES ANNOSUS. (Abstr.) Phytopathology 55: 130131.
Decay resistance of sapwood from roots and stems of eight coniferous species was determined in a complete factorial experiment with 16 tissue isolates of Fomes annosus from the same eight species. Juniperus virginiana was most resistant; Pinus resinosa, P. virginiana, and P. palustris were intermediate; and P. echinata, P. elliottii var. elliottii, P. strobus, and P. taeda were least resistant. Stem wood of all species was more resistant than root wood.

Powers, H. R., Jr., and Boyce, J. S., Jr. 1963. ANNOSUS ROOT ROT IN EASTERN PINES. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 76, 7 pp.
Covers distribution of Fomes annosus, hosts, signs and symptoms, means of spread, type and extent of damage, and control. FA

Siggers, P. V. 1945. CONTROLLING THE BROWN SPOT NEEDLE BLIGHT OF LONGLEAF PINE BY PRESCRIBED BURNING. AT-FA J. 8 (1) : 11. *Also in* Nav. Stores Rev. 55 (25) : 4, 8. *Also in* Forest Farmer 5 (1) : 8.
If infection averages 35 percent, fire should be applied in late winter after the second growing season. Value of the burn depends on size of area burned. A single 45-acre burn within an 800-acre area of badly infected seedlings was effective for only one growing season.

Snow, G. A. 1958. CULTURAL DIFFERENCES IN ISOLATES OF SCIRRHIA ACICOLA FROM PINUS PALUSTRIS AND P. TAEDA. (Abstr.) Phytopathology 48 : 398.
No significant differences were found.

Snow, G. A. 1961. ARTIFICIAL INOCULATION OF LONGLEAF PINE- WITH SCIRRHIA ACICOLA. Phytopathology 51: 186-188.
Longleaf pine was infected with Scirrhia acicola isolated from loblolly as well as longleaf pine trees. About 8-11 weeks were required for expression of .symptoms. Infection occurred only on immature longleaf needles .3-6 inches long, and not on loblolly pine. Cultural characters varied widely from isolate to isolate, and were instable following successive transfer. No correlation was found between cultural differences and percentage of infection, types of symptoms, or time of symptom expression on longleaf pine. Isolates from longleaf were, in general, more infective than those from loblolly.

Snow, G. A. 1961. SEMICARBAZONE OF CYCLOHEXIMIDE FOR CONTROLLING BROWN SPOT NEEDLE BLIGHT. (Abstr.) Phytopathology 51: 645.
Early results warrant further tests.

Snow, G. A., Czabator, F. J., and Sorrels, S. S. 1964. CYCLOHEXIMIDE DERIVATIVES FOR CONTROLLING BROWN SPOT ON LONGLEAF PINE. U. S. Dep. Agr. Plant Dis. Reporter 48: 551-553.
One spray of semicarbazone or Bordeaux mixture in May or June gave significant control of Scirrhia acicola. The Bordeaux mixture (4-4-50) was more effective than semicarbazone (25 p.p.m.), and methyl hydrazone (25 p.p.m.) was less effective than either. Semicarbazone gave better control at 50 p.p.m. than at 25. Infection on plants treated with the cycloheximide derivatives increased between 3 to 6 months after spraying.

Thomas, A. A. 1956. THE CHRISTMAS EVE BURN. Amer. Forests 62(3): 28-29, 60. *Also in* U. S. Dep. Agr. Forest Serv. Fire Contr. Notes 17 (4) : 9-12.
A prescribed burn to control brown spot in longleaf seedling stands was made on the Escambia Experimental Forest in south Alabama. The cost of the burn-including diagnosis, prescription, preparation, treatment, and appraisal--- was less than $100. At least $2,000 worth of seedlings were saved.

Verrall, A. F. 1967. BROWN SPOT NEEDLE BLIGHT, SCIRRHIA ACICOLA (DEARN.) SIGGERS; (SYSTREMMA ACICOLA (DEARN.) WOLF AND BARBOUR). *In* Important forest insects and diseases of mutual concern to Canada, the United States and Mexico, pp. 237-238. Can. Dep. Forest. and Rural Develop. Pub. 1180. *Also as* BROWN SPOT NEEDLE BLIGHT. *In* Important forest diseases of mutual concern to member countries of the North American Forestry Commission, pp. 64-65. Compiled by Working Group on Forest Insects and Diseases, N. Amer. Forest. Comm., FAO. 1963.
Distribution, hosts and description of damage, life history, and control measures. Problems of control have caused widespread planting of other pines on sites that formerly supported longleaf.

Verrall, A. F. 1967. SOUTHERN FUSIFORM RUST, CRONARTIUM FUSIFORME HEDGC. & HUNT EX CUMM. *In* Important forest insects and diseases of mutual concern to Canada, the United States and Mexico, pp. 221-223. Can. Dep. Forest. and Rural Develop. Pub. 1180.
Longleaf is resistant to attack, and hence should be favored over other pines for planting in areas where the disease is severe.

Weber, G. F. 1943. NEEDLE RUSTS OF PINE TREES IN FLORIDA CAUSED BY COLEOSPORIUM SPECIES. Proc. Fla. Acad. Sci. 6: 131-142.
Each of the eight indigenous pines of Florida (Pious australis, P. caribaea, P. clausa, P. echinata, P. glabra, P. palustris, P. serotina, and P. taeda) is susceptible to infection by heteroecious needle-rust fungi of the genus Coleosporium. The alternate hosts of the fungi are generally broadleaved plants, a large number of which belong to the family Carduaceae. Infection of pine seedlings is widespread in Florida and occasionally severe enough to be of economic importance. Saplings up to 10 feet in height are also commonly infected, but, as a rule, the disease produces no serious effects at this stage. The symptoms of needle rust are described and the taxonomy and morphology of the causal fungi are discussed. Attention is drawn to the development of the fungi in relation to their host plants. Control of the disease on pines can be brought about by the elimination of the alternate host or by spraying with a copper fungicide. FA

Zak, B., and Bryan, W. C. 1963. ISOLATION OF FUNGAL SYMBIONTS FROM PINE MYCORRHIZAE . Forest Sci. 9: 270-278. (Abstr.) Phytopathology 52 : 34. 1962.
Describes techniques that permitted isolation of fungal symbionts directly from mycorrhizae of southern pines, including longleaf.

45 DAMAGE BY ANIMALS: MAMMALS, BIRDS, INSECTS, OTHER

Allen, R. M., and Coyne, J. F. 1955. REDUCING LONGLEAF CONE LOSSES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest Notes 98.
In southern Mississippi, first-year cone losses were reduced by spraying with BHC. Most of the damage prevented was that from the cone beetle Ernobius granulatus. Losses due

to a pitch moth, possibly Dioryctria amatella, were not reduced, presumably because of late first spraying.

Allen, R. M., and Coyne, J. F. 1956. INSECT PROBLEMS IN FOREST-TREE GENETICS. J Forest. 54: 193.
Spraying with 0.5 percent BHC in water emulsion in March, immediately after removing the pollination bags, and in April, June, and August, afforded considerable protection to first-year cones of P. palustris and P. elliottii, which suffer damage attributed to the beetle Ernobius granulatus and to a less extent a pitch moth Dioryctria amatella. A pollen eater, bark weevils, and a beetle attacking seed trees, seedlings and grafts, some of which have been controlled with BHC, are mentioned. FA

Arata, A. A. 1959. EFFECTS OF BURNING ON VEGETATION AND RODENT POPULATIONS IN A LONGLEAF PINE-TURKEY OAK ASSOCIATION IN NORTH-CENTRAL FLORIDA. Quart. J. Fla. Acad. Sci. 22 (2) : 94-104.
Vegetative development following a mid-winter burn in a longleaf pine-turkey oak (Pinus australis-Quercus laevis) association is briefly traced. Wiregrasses (Sporobolus spp.) formed the major plant cover on the unburned area, but were removed from the burned section, and affected at least part of the rodent population. Comparison of trapping results prior to and following the burn, indicated that fire was not detrimental to the rodent population over the whole area, but caused a shifting of populations after the fire as a result of change in the habitat. Cotton rats (Sigmodon hispidus) moved from the burned to the unburned portions of the field following the burn whereas population densities of old field mice (Peromyscus polionotus) and Florida deer mice (P. floridanus) remained essentially at pre-burn levels within the burned portion.

Bennett, W. H. 1961. COMMON INSECT ENEMIES OF PINES IN THE SOUTHERN UNITED STATES. J. S. African Forest. Assoc. 39, pp. 13-18.
Brief descriptions.

Bennett, W. H. 1966. PUPAL MORPHOLOGY OF EXOTELEIA CHILLCOTTI FREEMAN (LEPIDOPTERA, GELECHIIDAE). Proc. Entomol. Soc. Wash. 68 (3) : 181-183.
Pupal morphology of this needle miner, which attacks Pinus palustris, is similar to that of E. pinifoliella. FA

Bennett, W. H. 1967. DIELDRIN FOR PROTECTING DIRECT-SEEDED LONGLEAF PINES FROM THE WHITE-FRINGED BEETLE, GRAPHOGNATHUS PERIGRINUS (BUCHANAN). J. Econ. Entomol. 60: 1186.
Mortality of direct-seeded pines was reduced when 10 percent dieldrin granules were applied at the rate of 3 pounds technical per acre.

Boyer, W. D. 1958. LONGLEAF PINE ESTABLISHMENT AND FIRST-YEAR SURVIVAL UNAFFECTED BY MODERATE GRAZING. J. Forest. 56: 655.
The study was in south Alabama. Cattle stocking was one cow to 60 acres.

Boyer, W. D. 1958. LONGLEAF SEEDLINGS ENDURE MODERATE GRAZING. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 113.
See entry above.

Boyer, W. D. 1964. LONGLEAF PINE SEED PREDATORS IN SOUTHWEST ALABAMA. J. Forest. 62: 481-484.
A 3-year study in southwest Alabama showed that predators caused 93 to 99 percent of the seed and seedling losses during the first 3 months after spot seeding in November. Predator pressure was about equal in forest stands, seed-tree stands, and clearcut areas except for one year when the seed crop was much better than the other two years. That year the losses in the stands were significantly lower than in the openings. Small mammals were responsible for an average of 58 percent of the losses for all years; birds plus large mammals, 33 percent; and insects, chiefly ants, 9 percent. Losses to mice peaked before seeds germinated. Losses to birds and large mammals occurred before, during, and after germination. Losses to ants peaked during germination. Losses to all predators virtually ended when primary needles emerged.

Boyer, W. D. 1964. LONGLEAF SEED LOSSES TO ANIMALS ON BURNED SEEDBEDS. U. S. Dep. Agr. Forest Serv. Res. Note SO-6, 3 pp. Southern Forest Exp. Sta., New Orleans, La.
Losses in well-stocked, second-growth stands (age 40 to 60 years) of southern Alabama were about the same on fresh fall burns as on old roughs, but worse on winter burns than on old roughs. Predators were mostly mice.

Boyer, W. D. 1967. GRAZING HAMPERS DEVELOPMENT OF LONGLEAF PINE SEEDLINGS IN SOUTHWEST ALABAMA. J. Forest. 65: 336-338.
After the seedlings' second year, grazing was by far the most serious cause of loss. Over 5 years, light grazing killed 23 percent of the trees and reduced rootcollar diameter growth of survivors by 13 percent.

DeBarr, G. L. 1967. T WO NEW SUCKING INSECT PESTS OF SEED IN SOUTHERN PINE SEED ORCHARDS. U. S, Dep. Agr. Forest Serv. Res. Note SE-78, 3 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Two insects, Tetyra bipunctata and Leptoglossus corculus, causing damage to seeds of Pinus palustris and P. elliottii have been found in north Florida. T. bipunctata nymphs and adults feed on the nearly mature second-year cones. Third-instar nymphs and the older stages of L. corculus feed upon the seeds of both pine species. FA

Ebel, B. H. 1961. THRIPS INJURE SLASH PINE FEMALE FLOWERS. J. Forest. 59: 374-375.
Damage to cones and seed of slash and longleaf pine, formerly ascribed to various causes is caused by thrips.

Ebel, B. H. 1963. INSECTS AFFECTING SEED PRODUCTION OF SLASH AND LONGLEAF PINES: THEIR IDENTIFICATION AND BIOLOGICAL ANNOTATION. U. S. Dep. Agr. Forest Serv. Res. Pap. SE-6, 24 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
An account of insects collected and reared in north Florida in 1956-60, with a habitat list, annotations on the insects, and a key to flower and cone damage to slash and longleaf pines. FA

Ebel, B. H. 1964. THE OCCURRENCE OF ERNOBIUS GRANULATUS LECONTE IN ABORTED FIRST-YEAR CONES OF LONGLEAF PINE. J. Forest. 62: 404-405.
In northeast Florida many dead first-year cones containing larvae of Ernobius granulatus LeConte were observed. This paper presents data indicating that E. granulatus is a secondary invader in the already dead cones.

Ebel, B. H. 1965. THE DIORYCTRIA CONEWORMS OF NORTH FLORIDA PINES (LEPIDOPTERA: PHYCITIDAE). Ann. Entomol. Soc. Amer. 58: 623-630.
Details the biologies of the three Dioryctria coneworms as they occur in cones and vegetative parts of Pinus elliottii Engelm. and P. palustris Mill.

Ebel, B. H. 1966. REARING AND OCCURRENCE OF XYELID SAWFLIES ON SLASH AND LONGLEAF PINES IN NORTH FLORIDA (HYMENOPTERA: XYELIDAE). Ann. Entomol. Soc. Amer. 59: 227-229.
Soil-filled clay pots, sunk in the ground, were used for rearing Xyela pini Rohwer from mature larvae taken on slash pine, and X. minor Norton and X. bakeri Konow from larvae found on both slash and longleaf pine. Some individuals of X. minor and X. bakeri spent a second year as

dormant larvae before pupating. Two discrete populations of adult X. pint were noted in the field. One, in January, fed on pollen of slash pines, which produce pollen earlier in the season than other local pine species; the other, in the second half of February, fed on pollen of loblolly pines (Pious taeda). None were found feeding on other pines that produce pollen at intermediate times.

Freeman, T. N. 1963. TWO NEW SPECIES OF CONIFEROUS NEEDLE MINERS FROM LOUISIANA AND THE DESCRIPTION OF A NEW GENUS (LEPIDOPTERA: GELECHIIDAE). Can. Entomol. 95: 727-730.
Describes a new species of leaf miner, Exoteleia chillcotti, that feeds on longleaf pine (P. palustris Mill.).

Hopkins, W. 1947. HOGS OR LOGS? Southern Lumberman 175 (2201) : 151-153. *Also in* Nav. Stores Rev. 57 (43) 12-13. 1948.
Free-ranging hogs uproot pine seedlings and chew the bark off the taproot. Longleaf pine is the most susceptible species, especially when in the grass stage.

Hopkins, W. 1947. PERHAPS THE HOG IS HUNGRY. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 50. *Also as* HUNGRY HOGS? Forest Farmer 6(11): 5.
Longleaf pine seedling roots are a nutritious, but expensive, food for hogs. They are 85 percent starch with, very little fiber. A hog can destroy 400 pine seedlings in a single day.

Hopkins, W. 1947 . PIGS IN THE PINES. Forest Farmer 7 (1) : 3, 8. *Also in* Nav. Stores Rev. 57 (48) : 16-17. 1948.
A description of the central Louisiana woods hog and its management. Editor's note summarizes the damage hogs do to longleaf pine seed and seedlings.

Hopkins, W. 1947. PINEY WOODS HOG HUNT. Forest Farmer 7(2): 3, 7.
Narrative of a hog roundup in central Louisiana in 1947.

Hopkins, W. 1951. WOODS HOGS VS. PINE LOGS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta., 14 pp.
Woods hogs cause great damage to Louisiana's longleaf pine forests.

Kowal, R. J. 1960. SOUTHERN PINE BEETLE. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 49, 7 pp.
Distribution, hosts, life history, and control. Shortleaf, loblolly. Virginia, and pitch pines appear preferred over slash and longleaf pines.

Kowal, R. J., and Coyne, J. F. 1951. THE BLACK TURPENTINE BEETLE CAN KILL TREES. AT-FA J. 13(9): 7, 14-15.
Describes the beetle (Dendroctonus terebrans) and its control with benzene hexachloride sprays. Two photos show beetle damage to longleaf pine.

Langdon, O. G., and LeGrande, W. P. 1965. RODENT DEPREDATION-A DIRECT SEEDING PROBLEM. U. S. Dep. Agr. Forest Serv. Res. Note SE-39, 3 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
In South Carolina, tree establishment one year after direct sowing of pine seed (mainly Pinus palustris), unscreened against rodents, was not increased by pre-treatment with Arasan-75 plus endrin 25 W, at 2.6 percent and 2.0 percent of dry seed weight respectively, or anthraquinone plus endrin 25 W at 15.0 percent anal 2.0 percent. Untreated but screened sowings gave 42.8 percent establishment, while nnscreened sowings, treated and untreated combined, gave only 5.2 percent. Higher concentrations are being tested. Nearly all depredation was by rodents, probably mainly Peromyscus maniculatus. FA

Linnartz, N. E., Hse, C. Y., and Duvall, V. L. 1966. GRAZING IMPAIRS PHYSICAL PROPERTIES OF A FOREST FOIL IN CENTRAL LOUISIANA. J. Forest. 64: 239-243.
Describes studies of the effect on soil properties of 10 years' spring and summer grazing by cattle on Pinus palustris clear fellings of the Andropogon type in central Louisiana, for three grazing intensities: (a) ungrazed, (b) moderate, and (c) heavy. Results, tabulated for texture, moisture constants, specific gravity, bulk density, porosity, and percolation rate, showed that the compaction caused by (c) seriously reduced infiltration (from 1.86 to 0.77 inch per hour) and percolation (from 0.242 to 0.133 inch per hour at a depth of 12-16 inches). FA

Maki, T. E., and Mann, W. F., Jr. 1951. SOME EFFECTS OF SHEEP GRAZING ON LONGLEAF PINE. J. Forest. 49: 278-281.
The open range in southern Mississippi tends to be an unfavorable environment for longleaf pine seedlings. One reason is the presence of the piney woods sheep--a nondescript offshoot of the Spanish Merino, introduced to this country some 375 years ago.

Mann, W. F., Jr. 1947 . SHEEP DAMAGE TO LONGLEAF PINE SEEDLINGS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 52. *Also in* Southern Lumberman 175(2201) : 125. *Also in* Nav. Stores Rev. 57(37) : 2.
During a recent 2-year test in south Mississippi, sheep grazing at a rate of 100 per 1,300 acres, on land stocked with 2- to 48-inch longleaf pine seedlings at 1,442 per acre, damaged 86 percent of all seedlings under 4 feet high. More than half the injured seedlings were browsed two or more times during the test, total height growth was 25 percent less than on ungrazed control plots, and more than 15 percent of the injured seedlings appear to be permanently deformed. Mortality was 4.6 percent compared with 2.3 percent in controls. FA

Meanley, B., and Blair, R. M. 1957. DAMAGE TO LONGLEAF PINE SEEDLINGS BY COTTON RATS. J. Forest. 55: 35.
Heavy damage by cotton rats (Sigmodon hispidus) was found near Oakdale in central Louisiana, in the spring of 1956. About 10 percent of the seedlings on 400 acres were killed or injured by the rats. Prescribed burning is recommended to control damage found in late fall. Spring and summer damage will require control by use of poison baits.

Meanley, B., Mann, W. F., Jr., and Derr, H. J. 1956. COTTON RATS DAMAGE LONGLEAF SEEDLINGS. Forests and People 6(4): 42-43.
See entry above.

Meanley, B., Mann, W. F., Jr., and Derr, H. J. 1957. NEW BIRD REPELLENTS FOR LONGLEAF SEED. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 105. *Also in* The Unit, News Letter 66, p. 11. *Also in* U. S. Dep. Agr. Forest Serv. Tree Planters' Notes 28, p. 8.
The bird repellent Morkit has been withdrawn from the U. S. market, but several other chemicals are good substitutes.

Merkel, E. P. 1963. A NEW SOUTHERN PINE TIP MOTH. J. Forest. 61 : 226-227.
A new species of pine tip moth (Rhyacionia subtropica Miller) was described in 1960. Its geographic distribution coincides closely with the range of slash pine and it is a potential pest of slash and longleaf pine plantations in the Deep South.

Merkel, E. P., and Ebel, B. H. 1961. CONE AND SEED INSECTS AND THEIR CONTROL. Sixth Southern Conf. on Forest Tree Impr. Proc. 1961: 137-141.
Some progress has been made in developing methods to

control slash and longleaf pine cone and seed insects. Hydraulic spray applications of 0.5 gamma BHC water emulsion have controlled Dioryctria spp. The same emulsion failed to control Laspeyresia anaranjada but guthion shows promise. Flower thrips have been controlled with heptachlor.

Morgan, E. 1952. IN A PIG'S EYE. Forests and People 2 (2) 10-14.
Discusses damage to longleaf pine seedlings by hogs.

Neunzig, H. H., Cashatt, E. D., and Matuza, G. A. 1964. OBSERVATIONS ON THE BIOLOGY OF FOUR SPECIES OF DIORYCTRIA IN NORTH CAROLINA (LEPIDOPTERA: PHYCITIDAE). Ann. Entomol. Soc. Amer. 57: 317-321.
A study, mainly on Pinus palustris and P. taeda, of four species whose larvae damage cones (particularly), terminal shoots, and the cambium of stems and branches. D. amatella was found on P. palustris and P. taeda; D. disclusa on these and on P. virginiana; and D. zimmermani and D. clarioralis on P. taeda. Some parasites of these cone moths are described. FA

Peevy, F. A. 1953. HOGS STILL PREFER LONGLEAF. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 87. *Also in* Southern Lumberman 187 (2345) 111. *Also in* Forests and People 4(1) : 35. 1954.
In central Louisiana hogs destroyed 80 percent of the seedlings in 1 month in a 3,000-tree longleaf plantation. In a 2,500-tree slash pine plantation in the same hog pasture less than 1 percent of the trees were killed.

Ruehle, J. L. 1965. HOST RANGE STUDIES OF SEVERAL PLANT-PARASITIC NEMATODES FOUND IN SOUTHERN PINE FORESTS. (Abstr.) Nematologica, Leiden 11(1) : 45.
In the pot tests described, Pinus echinata, P. elliottii var. elliottii (1), P. palustris (2), and P. rigida (3) were excellent or good hosts for Helicotylenchus dihystera; P. taeda (4) and P. serotina (5) were poor hosts, and P. virginiana (6) and P. strobus (7) were not hosts. Criconemoides xenoplax reproduced well on (1), (4), and (5), and poorly on (3) which, with (6), was also a poor host for Scutellonema brachyurum; (4) was not a host for the last. Of several other species tested, only Meloidogyne incognita went through some stages of development on (3), (6), and (7). FA

Smith, R. H. 1957. HABITS OF ATTACK BY THE BLACK TURPENTINE BEETLE ON SLASH AND LONGLEAF PINE IN NORTH FLORIDA. J. Econ. Entomol. 50: 241-244.
Dendroctonus terebrans has some peculiarities possibly useful in its control. The investigation described showed that an average of five attacks per tree were made in the first month after attacks started, and these were confined to the basal 18 inches of the bole. Subsequent attacks, spread over 5-7 months with a peak in the second and third month, increase in number and in height up the bole, and eventually average 28 per tree, 85 percent of which are in the basal 36 inches and only 3 percent above 72 inches. The number of attacks increases with d.b.h., but the height distribution of attack is unaffected by diameter in the range 9 to 17 inches d.b.h. The habits of the beetle were the same on both hosts, and for tapped and untapped trees. FA

Smith, R. H., and Lee, R. E. 1957. BLACK TURPENTINE BEETLE. U. S. Dep. Agr. Forest Serv. Forest Pest Leafl. 12, 7 pp.
The most severe attacks of the black turpentine beetle, Dendroctonus terebrans (Oliv.), occur on slash pine, loblolly pine, and, to a lesser degree on longleaf pine. Methods of detection, life history, and control are discussed.

Thatcher, R. C. 1960. BARK BEETLES AFFECTING SOUTHERN PINES: A REVIEW OF CURRENT KNOWLEDGE. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 181D, 25 pp.
Species characteristics, environmental influences on populations, predators and parasites, controls, research needs.

Wilkinson, R. C. 1964. ATTRACTION AND DEVELOPMENT OF IPS BARK BEETLE POPULATIONS IN ARTIFICIALLY INFESTED PINE BOLTS EXPOSED ON FIRETOWERS AND TURNTABLES IN FLORIDA. Fla. Entomol. 47: 57-64.
While uninfested bolts of longleaf and slash pine exposed on fire towers were not attacked, slash pine bolts artificially infested with _ of I. grandicollis or I. calligraphus were attacked by _s and _ of the respective species up to at least 91 feet from the ground. The attraction of _s introduced into bolts appeared to be weaker, but it was not known whether they had already mated. In one test, longleaf pine logs artificially infested with _s of I. calligraphus retained their attraction for at least 3 weeks. FA

Yates, H. O., III. 1962. INFLUENCE OF TIP MOTH LARVAE ON OLEORESIN CRYSTALLIZATION OF SOUTHERN PINES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 174, 2 pp.
To discover whether the difference in physical state observed between the oleoresin exuded from shoots of different species of southern pine infested by Rhyacionia frustrana and R. rigidana was due to different reaction to exposure or to some larval substance, 20 tips were cut from trees of four species. On half of them, large larvae were put into the oleoresin that had collected 2 hours after cutting. After 24 hours, the oleoresin on Pinus echinata and P. taeda with larvae had crystallized, while that on P. palustris and P. elliottii var. elliottii (two resistant species), and that on all uninfested tips, remained sticky. The difference could still be observed after 4 days. FA

Yates, H. O., III. 1965. THE INFLUENCE OF OLEORESIN ON SOUTHERN PINE INJURY BY RHYACIONIA (LEPIDOPTERA, OLETHREUTIDAE). Diss. Abstr. 26: 567.
Pupal and adult characters for separating R. frustrana and R. rigidana are outlined. Loblolly (a) and shortleaf (b) pines are seriously injured by these insects, oleoresin produced by these hosts crystallizing at the lesion, whereas that produced by slash (c) and longleaf pines remains sticky and prevents further injury. There is no preference for egg-laying between (a) and (c), but subsequent larval growth is faster on (a), and the last two instars, normally spent within the shoot, are rarely found on (c). Behavior of the larvae when they encounter sticky oleoresin is discussed and measurements of amount and weight of oleoresin exuding from the four pine species are compared. The ability of the insect to bring about accelerated oleoresin crystallization is considered to be the primary factor in successful attack. Loss of terpenes from exuding oleoresin is associated with crystal formation; oleoresin from (c), unlike that from (a) and (b), shows no loss of terpenes and does not crystallize. FA

Yates, H. O., III. 1966. SUSCEPTIBILITY OF LOBLOLLY AND SLASH PINES TO RHYACIONIA SPP. OVIPOSITION, INJURY, AND DAMAGE. J. Econ. Entomol. 59: 1461-1464.
Oviposition and initial larval feeding (injury) by R. frustrana and R. rigidana were found on neighboring Pinus taeda (a) , P. echinata (b) , P. palustris (c) , and P. elliottii (d). Shoot and bud killing (damage) occurred mostly on (a) and (b). Studies on (a) and (d) showed that differential larval survival following oviposition and initial shoot feeding was responsible for differences in shoot and bud killing. FA

46 DAMAGE BY MAN: LOGGING

Boyer, W. D. 1964. LOGGING DAMAGE TO LONGLEAF SEEDLINGS. J. Forest. 62: 338-339.
When medium longleaf pine overstories were clearcut, half the mortality in advanced grass-stage reproduction resulted directly from the togging and half occurred among apparently undamaged seedlings during the first year after logging. Total seedling losses were 51 percent when log landings were on the cut area, and 33 percent when they were located elsewhere.

Croker, T. C., Jr. 1956. LONGLEAF PINE SEEDLINGS DAMAGED WHEN SEED TREES ARE TRACTOR-LOGGED. J. Forest. 54: 401.
Though logging conditions were good, the stocking of longleaf seedlings in an Alabama forest was reduced from 83 to 76 percent, and many survivors were damaged. Those that had emerged from the grass were the most vulnerable.

5. FOREST MENSURATION.

INCREMENT. STAND STRUCTURE. MAPPING

52 MEASUREMENTS: TREES AND STANDS

Afanasiev, M. 1958. SOME RESULTS OF THE USE OF THE BITTERLICH METHOD OF CRUISING IN AN EVEN-AGED STAND OF LONGLEAF PINE. J. Forest. 56: 341-343.
In cruising 296.4 acres of even-aged, 35-year-old, second growth longleaf pine in south Mississippi, three methods of timber estimating were used (a) total enumeration of strips 1 chain wide; (b) 10 percent enumeration by 1 /5-acre plots; and (c) angle-count cruising with points at the center of each 1/ 5-acre plot. The basal area obtained by the Bitter Lich method (c) was within 1.5 percent of the actual basal area determined by (a), when the whole area was considered, but in individual compartments basal area errors ranged from -22.7 percent to + 103.8 percent. The accuracy of (c) compared favorably with that of (b). Cruising intensity by the Bitterlich method is discussed, with reference to the size of trees when using 3.00 diopter prisms. FA

Bennett, F. A. 1953. TOPWOOD VOLUME TABLES FOR SLASH AND LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 42, 2 pp.
Rough cordwood volumes for trees 9 to I8 inches d.b.h.

Bryan, M. B., and McClure, J. P. 1962. BOARD-FOOT AND CUBIC-FOOT VOLUME COMPUTING EQUATIONS FOR SOUTHEASTERN TREE SPECIES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 145, 10 pp
The equations presented are based on d.b.h. (or diameter 1.5 feet above butt swelling), estimated diameter under bark at the top of the lower stem section (the saw log portion of timber trees), and height to and from this point (to a 4-inch top diameter over bark). Constants are presented for 20 species. FA

Cooper. R. W.. and Olson, D. F., Jr. 1958. VOLUME DETERMINATIONS FOR SECOND-GROWTH SLASH AND LONGLEAF PINE IN NORTHEAST FLORIDA. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta.. Sta. Pap. 92, 11 pp.
Cubic- and board-foot volume tables. A combined variable D2HF proved best (D= d.b.h.., H = total tree height in feet. F = form class), but the use of the single variable D2H did not appreciably reduce the coefficient of determination.

Croker, T C., Jr. 1951. CHECKED YOUR POLE VOLUME TABLES LATELY? U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 75.
Local cubic- arid board-foot tables were constructed from measurements on approximately 4000 longleaf and slash pine poles cut in south Alabama. Volumes of poles derived from these tables were higher than volumes for identical poles shown in currently published tables.

Page, R. H., and Bois, P. J. 1961. BUYING AND SELLING SOUTHERN YELLOW PINE SAW LOGS BY WEIGHT. Ga. Forest Res. Counc. Rep. 7, 9 pp.
A study was made to determine the ratio of weight to volume of slash, loblolly, shortleaf, and longleaf pine saw logs in Georgia, and it is concluded that weight gives an accurate measure of cubic-foot volume and, within wider limits, of board-foot volume. Since board-foot volume is greatly affected by log size, weight conversions to board feet should be adjusted to allow for log size. FA

Scarbrough, N. M. 1953. LONGLEAF TOPWOOD VOLUME. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 83.
A sample of 114 tops left by two loggers in south Mississippi indicated that the amount of pulpwood in tops could be estimated from tree diameter by the formula: V (cubic feet, peeled) = 0.3 (d.b.h. -4).

Taras, M. A. 1967. WEIGHT SCALING: ITS PAST-PRESENT-FIITURE. Wood Measurement Conf. Proc. 1967: 143-156. Fac. Forest., Univ. Toronto Tech. Rep. 7.
The development of weight scaling of wood products in the United States, with particular emphasis on work in the South. Gives pound-per-cord equivalents, regression equations for estimating board-foot contents of logs from weight, and pound-per-M b.f. equivalents for numerous southern species including longleaf.

Todd, A. S., Jr. 1955. HOW MUCH WOOD IN A CORD OF PINE SLABS? U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 87, 1 p.
Tables for determining the volume (cubic feet) of bark-free wood in slabs from southern pine logs.

53 SPECIAL MEASUREMENTS

Evans, M. J. 1967. APPLICATION OF RANKED-SET SAMPLING TO REGENERATION SURVEYS IN AREAS DIRECT-SEEDED TO LONGLEAF PINE. M. F. Thesis. La. State Univ- Baton Rouge.
Ranked-set sampling gave an unbiased estimate of true population mean. Variance was significantly lower than for random sampling, but because the number of seedlings was small the ranked-set method did not materially improve efficiency of the survey.

McCormack, M. L., Jr. 1964. A STUDY OF TECHNIQUES FOR DETERMINING ROOT EXTENSION USING RADIOACTIVE TRACERS. Diss. Abstr. 25: 732-733.
A study to develop equipment and techniques was carried out in plantations or pure stands of longleaf or slash pine.

Minor, C. O. 1951. STEM-CROWN DIAMETER RELATIONS IN SOUTHERN PINE. J. Forest. 49: 490-493.

Linear regression equations have been prepared, describing the relations between d.b.h. and crown diameter for Pinus taeda and P. palustris in southeastern Louisiana. High degrees of positive correlation were found for both species. The effect of stand density, in terms of trees per acre, upon the d.b.h. per crown-diameter relation was analyzed for P. taeda, and was found to be negligible for practical purposes, probably because of stabilization of basal area per acre within the saw log stands sampled. Some practical applications of these results to the interpretation of air photos are described. FA

Snyder, E. B., and Allen, R. M. 1963. SAMPLING, NURSERY AND YEAR-REPLICATION EFFECTS IN A LONGLEAF PINE PROGENY TEST. Forest Genet. Workshop Proc. 1962: 26-27. Southern Forest Tree Impr. Comm. and Soc. Amer. Forest. Tree Impr. Comm.
Ten-year results from a comprehensive test illustrated the possibility of error or inefficiency from unrepresentative sampling, persisting effects of nursery environment, and indiscriminate replication by years.

54 ASSESSMENT OF SITE QUALITY

Bennett, F. A. 1953. SITE INDEXES OF THE SOIL SERIES ON THE GEORGE WALTON EXPERIMENTAL FOREST. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 34, 2 pp.
The site indexes show that the "drains" or poorly drained areas are the best sites for slash pine and that on identical soils slash pine has a higher site index than longleaf. FA

Coile, T. S. 1952. SOIL PRODUCTIVITY FOR SOUTHERN PINES. PART II OF II--LONGLEAF, SLASH AND POND PINES. Forest Farmer 11(8): 11-12.
Tables giving longleaf pine site index in relation to texture of the soil, moisture equivalents, and depth to mottling.

Cruikshank, J. W. 1954. SITE INDEX OF MAJOR PINE FOREST TYPES IN THE SOUTHEAST. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 50, 1 p.
Gives site-index averages for longleaf and four other southern pines for Coastal Plain and Piedmont sites.

Hodgkins, E. J. 1956. TESTING SOIL-SITE INDEX TABLES IN SOUTHWESTERN ALABAMA. J. Forest. 54: 261-266.
Discusses the regression studies made on southern pine throughout the south-east in which environmental factors, notably soil properties, are related to site index, and tests them against the site indices established from height-growth in 24 stands in the upper and lower Coastal Plain of southwest Alabama. In each of these stands the selected factors, the (height-growth) site index, and the range of soil-site indices are shown and the two sets of indices are graphically compared for longleaf, slash and loblolly pines. It is concluded that these studies have yielded basic information of far greater value than the tables they have produced, the limitations of which are emphasized. They are no substitute for site indices based on height growth, which are particularly preferable when based on local and not on general height/age curves. FA

Hodgkins, E. J. 1961. ESTIMATING SITE INDEX FOR LONGLEAF PINE THROUGH QUANTITATIVE EVALUATION OF ASSOCIATED VEGETATION. Soc. Amer. Forest. Proc. 1960: 28-32.
In a test in southwest Alabama, the correlation between plant indicators and measured site index was significant.

Hodgkins, E. J., and Gemborys, S. R. 1966. EXPLORATORY WORK ON THE USE OF PLANT INDICATORS IN THE LONGLEAF AND LOBLOLLY PINE FORESTS OF ALABAMA. Bull. Ecol. Soc. Amer. 47(4): 192.
A site-quality scale, based on the abundance and cover of selected indicator plants (determined subjectively, but found sufficiently accurate when evaluated by objective methods) proved to be satisfactory in longleaf but of doubtful value in loblolly pine forests. FA

Johnson, E. W. 1962. AERIAL PHOTOGRAPHIC SITE EVALUATION FOR LONGLEAF PINE. Ala. Agr. Exp. Sta. Bull. 339, 26 pp.
In a trial in southern Alabama and northwest Florida site index could not be reliably estimated from aerial photographs.

Johnson, E. W. 1965. A SHORT-CUT METHOD OF ESTIMATING TREE SITE INDEX IN LONGLEAF PINE. J. Forest. 63: 195-200.
The method consists of obtaining and averaging indices of three to six trees of largest d.b.h. on a 0.2-acre plot.

Linnartz, N. E. 1961. PINE SITE INDEX IS RELATED TO SOIL CLASSIFICATION IN SOUTHEASTERN LOUISIANA. La. State Univ. LSU Forest. Notes 48, 2 pp.
A field guide for estimating the site index of longleaf, slash, and loblolly pines.

Linnartz, N. E. 1963. RELATION OF SOIL AND TOPOGRAPHIC CHARACTERISTICS TO SITE QUALITY FOR SOUTHERN PINES IN THE FLORIDA PARISHES OF LOUISIANA. J. Forest. 61: 434-438.
In southeastern Louisiana, depth to the least permeable layer in the soil profile, percent of sand in the subsoil, and the pH of the subsoil were related to the site index of loblolly pine. Site index of slash pine was related to depth to the least permeable layer, percent of sand in the topsoil and in the subsoil, and degree of internal drainage. Longleaf site index was related to the sand content of the subsoil, the slope, and the degree of surface drainage.

McClurkin, D. C. 1953. SOIL AND CLIMATIC FACTORS RELATED TO THE GROWTH OF LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Occas. Pap. 132, 12 pp.
Measurements were made on sample plots in 145 stands ranging from Mississippi to east Texas. Data on soils, position on slopes, percent slope, class of surface drainage, aspect and rainfall were analyzed statistically. The January-June rainfall was more important than any other single variable, and depth to the least permeable horizon was the most significant of the soil factors. A table is given for determining site index from these two factors. FA

McClurkin, D. C. 1954. ESTIMATING QUALITY OF LONGLEAF SITES. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 89.
See entry below.

McClurkin, D. C., and Covell, R. R. 1965. SITE INDEX PREDICTIONS FOR PINES IN MISSISSIPPI. U. S. Dep. Agr. Forest Serv. Res. Pap. SO-15, 9 pp. Southern Forest Exp. Sta., New Orleans, La.
Prediction equations have been developed for loblolly pine on 12 soil groups, for shortleaf on seven groups, and for longleaf on six.

Ralston, C. W. 1951. SOME FACTORS RELATED TO THE GROWTH OF LONGLEAF PINE IN THE ATLANTIC COASTAL PLAIN. J. Forest. 49: 408-412.
A number of soil, vegetation and other factors were sampled on 303 areas of even-aged Pinus palustris on the Atlantic Coastal Plain. Statistical analyses of the data indicated that age of stand, moisture equivalent of the B horizon, depth of soil to mottling (indicating poor drainage), stand density, resin tapping, and latitude, were significantly related to height growth. A rapid method for field estimation of site quality of Coastal Plain soils for longleaf pine is discussed. FA

Silker, T. H. 1965 . PLANT INDICATORS CONVEY SPECIES RANGE OF ACCOMMODATION AND SITE-SILVICULTURE-MANAGEMENT RELATIONS. Soc. Amer. Forest. Proc. 1964: 50-54.
Discusses and illustrates the uses of plant indicators on the basis of studies in the Lake States, ponderosa pine type of the Cascade Mountains of Oregon, and in the longleaf and pine-hardwood types of the Gulf Coastal Plain. FA

Wakeley, P. C., and Marrero, J. 1958. FIVE-YEAR INTERCEPT AS SITE INDEX IN SOUTHERN PINE PLANTATIONS. J. Forest. 56: 332-336.
The intercept was taken as the 5-year period during the first year of which the tree attained breast height, and was determined by counting the whorls of primary branches. The method is mainly for use with stands up to 20 years old. One of its advantages over the conventional total height-total age method of site evaluation is that age of the trees need not be known.

56 INCREMENT: DEVELOPMENT AND STRUCTURE OF STANDS

Bennett, F. A. 1963. GROWTH AND YIELD OF PLANTED CONIFERS IN RELATION TO INITIAL SPACING AND STOCKING. Soc. Amer. Forest. Proc. 1962: 22-26.
Yields from unthinned stands of Pinus elliottii, P. taeda, P. palustris, P. strobus, P. resinosa, and Pseudotsuga taxifolia are remarkably similar in relation to spacing; at ages 20-35 years the yield from an initial 200 trees per acre was >50 percent, and yield from 600 trees was 90-98 percent, of that from 1,000 trees per acre.

Cruikshank, J. W. 1952. 10-YEAR DIAMETER GROWTH OF SELECTED TREE SPECIES IN SOUTH GEORGIA. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 20, 1 p.
Averages for longleaf pine and other softwoods in the Coastal Plain of Georgia.

Curlin, J. W., and Box, B. H. 1961. ESTIMATING PAST ANNUAL HEIGHT GROWTH OF SLASH AND LONGLEAF PINES FROM LENGTH OF INTERNODES. J. Forest. 59: 372-373.
The techniques, for use in young stands, involves measuring the distance between primary internodes, using an extendable (to 45 feet) aluminum pole with a tape attached to the top. Results obtained in two plantations, when compared with annual measurement data for the same trees, showed an average error of 8-3 percent of the mean annual height growth, and a standard error of 10-3 percent. FA

Farrar, R. M., Jr. 1967. HOW DOES YOUR LONGLEAF GROW? Southern Lumberman 215(2680): 126-127.
On average sites near-maximum volume growth probably can be attained at basal areas of 60 to 80 square feet per acre. Growth is strongly related to site quality.

Goggans, J. F., and Schultz, E. F., Jr. 1958. GROWTH OF PINE PLANTATIONS IN ALABAMA'S COASTAL PLAIN. Ala. Agr. Exp. Sta. Bull. 313, 19 pp.
Reports a study of the correlation of soils and other site factors with the height growth of 5- to 16-year slash, loblolly, and longleaf pine. Regression equations for estimating the height of the tallest trees were developed, and for 8-to 16-year longleaf pine age alone proved as good a predictor of height as any. In no case were mineral-nutrient element concentrations of the top 6-inch soil layer found to be closely correlated with height growth. either when considered alone or with soil physical and climatic variables held constant. Regression equations developed for estimating the merchantable volume in cords of rough wood per acre are also presented. FA

Hawley, N. R. 1952. RAPID GROWTH RATES OF LONGLEAF-SLASH PINE SAW TIMBER IN THE MIDDLE COASTAL PLAIN OF GEORGIA. U. S. Dep. Agr. Forest Serv. Southeast Forest Exp. Sta. Res. Notes 17, 2 pp.
Understocked stands of small sawtimber on the George Walton Experimental Forest in south Georgia are increasing in board-foot volume at a calculated rate of 27 percent annually.

Judson, G. M. 1965. TREE DIAMETER GROWTH IN ALABAMA. U. S. Dep. Agr. Forest Serv. Res. Note SO-17, 3 pp. Southern Forest Exp. Sta., New Orleans, La.
Growth rates for 10 years of the major economic species are summarized by species, tree diameter class, site, and geographical area, on the basis of measurements of 2,572 trees in Alabama in 1951-53 and 1962-63. FA

Larson, R. W. 1957. HOW LONG DOES IT TAKE TO GROW PINE PULPWOOD OR SAWTIMBER IN NORTH CAROLINA? U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 106, 2 pp.
Average d.b.h. growth for longleaf, shortleaf, loblolly, Virginia, pond, and white pine in relation to age and site quality is given in a series of graphs. Values are based on analysis of forest survey data from 2,725 plots in North Carolina.

Smith, L. F. 1948. THIRTY-FIVE YEARS OF DEVELOPMENT IN SECOND-GROWTH LONGLEAF. Southern Lumberman 177(2225): 149-152.
A study of a typical second-growth longleaf pine (Pinus palustris) stand, well stocked but untended, and about 35 years old, on the McNeill Experimental Forest in Pearl River County, Mississippi. Tables include average diameters and heights, basal area and volume of merchantable trees, average annual growth and stumpage value in the years 1928, 1933, 1938, and 1947, on four types of plot: (1) unburned and ungrazed,(2) unburned and grazed, (3) burned and grazed, and (4) burned and ungrazed. The annual burning definitely retarded growth; grazing did not. FA

Smith, L. F. 1950. GOOD GROWTH FROM WELL-STOCKED LONGLEAF STANDS. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 67. *Also in* Nav. Stores Rev. 60 (9) : 30. *Also in* Forest Farmer 9 (10) : 10. *Also in* The Unit, News Letter 33, p. 19. *Also in* J. Forest. 48: 851.
On a good site in south Mississippi, a well-stocked second growth longleaf pine stand produced 40 cords per acre in 35 years. Growth estimates, based on these yields, indicate that this stand should produce as much in 70 years as virgin stands did in two centuries.

Smith, L. F. 1952. GROWTH OF RESIDUAL LONGLEAF PINE IN SOUTHERN MISSISSIPPI. J. Forest. 50: 132-133.
Analysis of 50 stems of longleaf pine, left standing after clear felling in 1902-03 as being too small and suppressed to be worth taking, confirmed previous findings that residual longleaf may be expected to recover after release. FA

Smith, L. F. 1953. LONGLEAF PINE CAN GROW FAST. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 87. *Also in* Forests and People 3 (4) : 33. *Also in* Southern Lumberman 187 (2345) : 130.
Well-stocked longleaf pine stands on the McNeill Experimental Forest in south Mississippi produced 45.3 cords per acre, including 12,000 board feet of sawtimber, by age 42.

Swinford, K. R. 1960. RELATIONSHIPS BETWEEN VARIOUS MEASURABLE STAND FACTORS AND VARIATION IN BASAL AREA IN LONGLEAF-SLASH PINE FLATWOODS FORESTS OF ALACHUA COUNTY, FLORIDA. Diss. Abstr. 21: 284-285.
Data were obtained from 41 separate stands in random loca-

tions with a sampling percent of 22.2 for all stands. Variables found to be significantly correlated with the dependent variable (coefficient of variation in basal area per plot) were: mean basal area per acre, mean number of trees per acre, coefficient of variation in number of trees per plot, crown closure percent (measured from individual plots on vertical aerial photographs), coefficient of crown closure percent and percent of total diameter classes having ³ 10 percent of the total number of trees.*

Taras, M. A., and Wahlgren, H. E. 1963. COMPARISON OF INCREMENT CORE SAMPLING METHODS FOR ESTIMATING TREE SPECIFIC GRAVITY. U. S. Dep. Agr. Forest Serv. Res. Pap. SE-7, 16 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Methods of predicting longleaf and slash pine specific gravity, by using all or part of increment cores from different locations in the stem, are listed in order of their relative precision. FA

58 SURVEYING

Willingham, J. W. 1957. ESTIMATION OF FOREST MANAGEMENT INVENTORY DATA FROM AERIAL PHOTOGRAPHIC MEASUREMENTS. Forest Sci. 3: 270-274.
Equations, obtained by multiple regression and claimed to be first of their kind, are presented to express Y_1, radial growth in inches at breast height during the last 5 years: Y_2 age at breast height; $Y_{3,}$ d.b.h. in inches; and $Y_{4,}$ merchantable volume in cubic feet (none of which can be read directly from photographs) in terms of X_1, tree height in feet; X_2, crown diameter in feet; X_3, crown density percent; and X_4, trees per plot (all of which can be read from photographs). Four equations are given (significant at 1 percent level) for Y_1 and Y_2 in terms of X_1 and X_2, and for Y_3 in terms of $X_{1,}$ X_2 and X_4. The fourth equation (for merchantable volume) is Y4= - 114.0 + 1.111X_3 + 3.030X, + 2.375X4. Assuming no bias in the residual variance, this equation allows of an actual volume estimate to an accuracy of 9.6 cubic feet from 29 photo plots with a fiducial probability of 95 percent. Accuracy of reading required is stated as $X1_1$ $X._2$ and $X._3$ to 10 feet, 3 feet and 10 percent respectively and X_4 to within 20 percent of actual, indicating the need for a competent interpreter, good photographs, and a minimum scale of 1:15,840. Sources of error and limits of applicability are discussed. FA

Willingham, J. W. 1957. THE INDIRECT DETERMINATION OF FOREST STAND VARIABLES FROM VERTICAL AERIAL PHOTOGRAPHS. Photogram. Eng. 23: 892-893.
See entry above.

6. FOREST MANAGEMENT

62 METHODS OF MANAGEMENT: REGULATION

Behre, C. E. 1945 . GROWING STOCK, CUTTING AGE, AND SUSTAINED YIELD. J. Forest. 43: 477-485.
This paper points out that for a given level of output the required growing stock is a function of cutting age and may be expressed as a multiple of the yield. Growing stock ratios, deduced from available yield tables and assumptions as to average cutting age, are given for several species including longleaf pine. Other tables show adequacy of present total timber stands and of present sawtimber stand. The author's calculations indicate that, contrary to popular opinion, the growing-stock deficit in the East is most serious in southern pine. Comment by A. E. Wackerman argues that a 60-year rotation is longer than is necessary for southern pine, and that substitution of 50 or 40 years greatly reduces the apparent deficiency. FA

56 SPECIAL BUSINESS PROBLEMS: COSTS AND RETURNS

Chappelle, D. E . 1962. VALUE GROWTH OF PINE PULPWOOD ON THE GEORGE WALTON EXPERIMENTAL FOREST. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 140, 14 pp.
A study in even-aged, naturally regenerated pulpwood stands of longleaf and slash pine in the Coastal Plain of Georgia. Volume growth and value growth percents were computed over a 5-year period by reference to d.b.h., crown ratio, crown class (dominant plus codominant, and intermediate plus suppressed) by site index classes of longleaf, and by mean stand d.b.h. for slash pine, so as to assist the application of the concept of financial maturity. FA

Croker, T. C., Jr. 1950. SMALL LONGLEAF TRACTS SHOW PROFIT. Forest Farmer 10(2) : 12.
Forest products worth $967 were harvested from a 40-acre longleaf tract during the first 2 years of management. On a poorer tract $314 worth of products were harvested during the same period.

Croker, T. C., Jr. 1951. TREE CROP BOX SCORE. Ala. Lumberman 3 (5) : 18-19. *Also as* AN ANNUAL TREE CROP. Forest Farmer 10(8): 9.
Over a 3-year span, $330 above all expenses was earned by harvesting an annual tree crop from a 40-acre tract of longleaf pine.

Croker, T. C., Jr. 1953. RESULTS OF GOOD MANAGEMENT SEEM LIKE WOODLAND MAGIC. Southern Lumber J. 57(10): 76. *Also in* Ala. Lumberman 5(5): 33-34. *Also as* RETURNS FROM A LONGLEAF PINE WOODLAND. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 83.
Two thousand dollars worth of forest products have been removed from a 40-acre longleaf pine tract in 5 years.

Croker, T. C., Jr. 1953. SIX YEARS OF MANAGEMENT ON THE ESCAMBIA FARM FORESTRY FORTY. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta., 4 pp. (Similar annual publications from 1954 to 1967.)
Annual costs and returns from intensive management of a typical 40-acre tract of longleaf-slash pine.

Croker, T. C., Jr. 1954. SEVEN YEARS OF MANAGEMENT ON THE ESCAMBIA FARM FORESTRY FORTY. AT-FA J. 17 (2) 14.
In 7 years, $2,800 worth of products have been removed from a 40-acre tract. There is more and better timber now than when management began.

Croker, T. C., Jr. 1954. TRAIL BLAZING FOR LONGLEAF INVESTMENT OWNERS. Southern Lumberman 189(2369) : 167-169.
A brief account of the Longleaf Investment Forest, a 640acre area in south Alabama. The forest was established to determine the net returns that can be expected from an investment in longleaf timberland, managed to provide current revenue while improving stand condition.

Krinbill, H. R. 1955. AN ANALYSIS OF FACTS CONCERNING LONGLEAF PINE. Southern Lumber J. 59(6): 20, 22, 76.
The author states that longleaf pine, the slowest growing of the southern pines, cannot compete on the lumber mar- kets with the other southern pines. Cutover lands should not be allowed to stay idle for 25 to 40 years. Accelerated activity in reforestation, including direct seeding to speed up the process, should start now.

8. FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

Berkley, E. E., and Woodyard, O. C. 1948. CERTAIN VARIATIONS IN THE STRUCTURE OF WOOD FIBERS. Textile Res. J. 18: 519-525.
X-ray diffraction patterns were obtained from the fibers of Sequoia, Trochodendron, and Taxodium root, and from Pinus palustris and P. ponderosa compression wood. Those front Pinus showed a random arrangement of fibers.

Cole, D. E., Zobel, B. J., and Roberds, J. H. 1966. SLASH, LOBLOLLY, AND LONGLEAF PINE IN A MIXED NATURAL STAND; A COMPARISON OF THEIR WOOD PROPERTIES, PULP YIELDS, AND PAPER PROPERTIES. TAPPI 49: 161-166. *Also as* SLASH, LOBLOLLY, AND LONGLEAF PINE IN A MIXED STAND; A COMPARISON OF THEIR WOOD PROPERTIES. Eighth Southern Conf. on Forest Tree Impr. Proc. 1965: 136-141.
In a Georgia study, no significant differences were found between the species in outerwood specific gravity, moisture content, years of corewood formation, or cellulose content; such differences as were found (tracheid length, corewood specific gravity, and corewood holocellulose content) were of low magnitude. When these species were cooked under the same conditions, loblolly pine gave higher pulp yields than longleaf pine; within trees, bolt 1 (the butt bolt) gave lower yields than bolt 2; bolt 1 also gave pulps with a lower burst factor and had lower moisture content than bolt 2. There was an inverse relationship between specific gravity and moisture content but no relationship between specific gravity and green density. Trees with high specific gravity gave slightly higher pulp yields than trees with low specific gravity even when yields were computed on the basis of ovendry chip weights on a volume basis, trees with high specific gravity gave markedly higher pulp yields.

Doerner, K., Jr. 1964. SOME CAUSES AND EFFECTS OF HORIZONTAL DENSITY VARIATION IN TREE STEMS. Forest Sci. 10: 24-27.
A mathematical analysis showing that, in the transverse section of a stein. the perimeter bending stress varies as the distance from the section to the point of application of the horizontal force: as the force itself varies: and also as $1/r:^3$ of a section of radius r. In youth, the large section modnlus required (because of the high ratio of height growth to diameter growth) is got by a combined radius and density increase. In old age, the Modulus resulting from the excessive radius is too large for the moment produced, and thus is balanced by the production of new cells of lower density. This analysis shows that new perimeter wood tends throughout the tree's life to react efficiently to stress stimuli. FA

Erdtman, H. 1943. TALLKARNVEDENS FENOLISKA SUBSTANSER. IV. 1 PHENOL, SUBSTANCES OF HEARTWOOD OF PINE. J. Svensk Papperstidn. 46: 532.
In this paper on membrane-forming substances some results are incidentally mentioned from a study of the heartwood of Pinus strobus, P. nigra, P. montana, P. banksiana, and P. palustris. All appear to contain phenols of the 'pinosylvin' type, sometimes with phenolic substances belonging to other groups (flavones). FA

Hamilton, J. K., Partlow, E. V., and Thompson, N. S. 1960. THE NATURE OF A GALACTOGLUCOMANNAN ASSOCIATED WITH WOOD CELLULOSE FROM SOUTHERN PINE. J. Amer. Chem. Soc. 82: 451-457.
A mixture of galactoglucomannans and araboxylans was extracted with 5 percent sodium hydroxide from wood cellulose produced from a combination of Pinus elliottii and P. palustris. The structure of an acetone- soluble galactoglucomannan acetate separated from the mixture is discussed. FA

Johnston, D. R. 1951. STRUCTURE DRAWINGS TO "SPECIMEN WOODS." Wood 16(10) : 386.
Detailed drawings and descriptions of the wood of four species, including longleaf pine.

McNaughton, G. C. 1944. IGNITION AND CHARRING TEMPERATURES OF WOOD. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 1464, 3 pp.
With prolonged exposure at all temperatures used there was a gradual darkening of the wood accompanied by loss of weight and shrinkage in the transverse dimensions. Chemical destruction was not associated with any one critical temperature. Samples changed color and characteristics but none ignited.

Marts, R. O. 1949. EFFECT OF CROWN REDUCTION ON TAPER AND DENSITY IN LONGLEAF PINE. Southern Lumberman 179 (2249): 206-209.
Presents the results of experiments begun in 1937 by the U. S. Forest Products Laboratory to study the relationship of crown size to wood formation in southern pines, especially its influence on springwood and summerwood proportions in the annual ring, and the distribution of each in the main stem. Crowns of five open-grown P. palustris were reduced by more than three-fourths in March 1947, and further reduced in January 1938, March 1939, and April 1941. In February 1948 these, with controls, were felled and analyzed. The crown reduction had a marked effect in reducing the taper of the trunks front the base to about the tower limit of the crowns. The redaction was primarily due to changes in the springwood /summerwood relationships. The average springwood widths in pruned trees were proportionately less of the total ring width at lower levels, and proportionately more at 24½ - and 36-foot levels. The greatest increase in specific gravity was found in the wood that was formed at ca. 8- and 12-foot heights after crown redaction. FA

Marts, R. O. 1950. WOOD QUALITY OF BUD-PRUNED LONGLEAF PINE. Southern Lumberman 181 (2273) : 197-199.
A preliminary examination was made of longleaf pine about 20 years old, from a small plantation in southern Louisiana, to ascertain the effect of tree spacing and of annual removal of lower lateral buds and shoots, no to 15-20 feet, on the form of the trunk, the width of the annual rings, and the density of the wood. Clear wood without knots was formed in the trunk from the pith outwards for the entire pruned length: the few defects could have been avoided by greater care in pruning. The wood of .five trees at 6 by 12 foot spacing (A) averaged 5.5 rings per inch at breast height and 0.54 specific gravity, and that of five trees at 4 by 6 foot spacing (B) 6.6 rings per inch and 0.52 specific gravity.

These specific gravity values are above the average for second-growth longleaf pine of similar ring width. Taper was less below lower crown limits for trees of (B) than of (A). Trees in this study had less taper than those pruned to a height of 30 feet. (A) had a somewhat higher specific gravity and a greater average diameter in the lower part of the trunk than trees of (B), but total height growth was greater in the latter. These early results indicate that green pruning up to a height of 20 feet did not harm later growth. FA

Marts, R. O. 1951. INFLUENCE OF CROWN REDUCTION ON SPRINGWOOD AND SUMMERWOOD DISTRIBUTION IN LONGLEAF PINE. J. Forest. 49: 183-189.
A study was made to determine the effect of reduction of crown size on tree growth, especially its effect on wood formation in longleaf pine (Pinus palustris). Severe and continued reduction of the lower hart of the crown resulted in greatly reduced ring width in the lower part of the trunk. Earlywood was reduced more than latewood at the lower levels, compared with controls. Higher in the tree, near the lower limit of the crown, proportions of early- and late-wood varied much less. The reduced formation of early wood in the lower trunk of pruned trees persisted for several years. FA

Mitchell, H. L. 1964. PATTERNS OF VARIATION IN SPECIFIC GRAVITY OF SOUTHERN PINES AND OTHER CONIFEROUS SPECIES. TAPPI 47 : 276-283.
Southern pines showed major differences in specific gravity between species and, for all species. a strong trend towards increasing specific gravity from northwest to southeast in the southeastern States-a trend well correlated with warm season rainfall. In southern yellow pines, tree age had the strongest effect on specific gravity. Other variables having a statistically significant effect include diameter, volume, basal area. growth rate. rainfall, latitude and longitude. Western species, especially Douglas-fir and ponderosa pine, appear to lack any strong patterns of variation with geographic location. For Douglas-fir, diameter, volume, volume/age ratio, and age have the most significant effects on specific gravity. FA

Mitchell, H. L. 1965. PATTERNS OF SPECIFIC GRAVITY VARI- ATION IN NORTH AMERICAN CONIFERS. Soc. Amer. Forest. Proc. 1964: 169-179.
Reviews the findings of a number of surveys of specific gravity in North American conifers made by the U. S. Forest Service and other organizations. FA

Mitchell, H. L., and Wheeler, P. R. 1959. WOOD QUALITY OF MISSISSIPPI'S PINE RESOURCES. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 2143, 20 pp.
Slash. longleaf, shortleaf, loblolly and spruce pines were subjected to in situ sampling, the main objects being: (1) to obtain better information on intrinsic wood quality of Mississippi pine resources; (2) to seek out living trees of superior wood quality, form and growth rate for breeding studies and nursery requirements; and (3) to study the effects of environmental factors on wood quality and to apply this information to the practical growing of higher value trees. FA

Neale, J. A. 1939. FIRE EXPOSURE TESTS OF LOADED TIMBER COLUMNS. Res. Underwriters' Lab. Bull. 13, 23 pp.
A report on tests made at the Chicago testing station of Underwriters' Laboratories Inc. using timber columns upon which a vertical load, in the form of a hydraulic press, was imposed during exposure to fire. In early tests failure occurred at the upper end of the column owing to rapid heating of the end in contact with a metal cap that was used; because of this local failure the full fire resistance of the timber cross-section was not developed. In more recent tests (using selected structural longleaf pine and Douglas fir columns of 12 X 12 inch nominal cross section, in ordinary lengths) the ends were protected by reinforced concrete bearing caps of special design. These caps were found to protect adequately the upper ends of the columns, and the timbers sustained the fire and load tests for as long as 78-112 minutes. Failure was due to the weakening of the shaft portion of the column with the progressive charring or combustion of the wood. FA

Paul, B. H. 1958. SPECIFIC GRAVITY CHANGES IN SOUTHERN PINES AFTER RELEASE. Southern Lumberman 197 (2465)
122-124.
Tests on longleaf, shortleaf, and loblolly pines showed good response in diameter growth, with sometimes an increase, sometimes a decrease, and sometimes a fluctuation of specific gravity, presumably depending on whether interacting factors (soil moisture, crown development, etc.) promote more early- or more latewood increment.

Paul, B. H., and Marts, R. O. 1954. CONTROLLING THE PROPORTION OF SUMMERWOOD IN LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 1988, 10 pp.
A fairly close correlation was found (1927-29) to exist between the current soil water supply and latewood formation in Pinus palustris trees in the deep, sandy soils of the Choctawhatchee National Forest. There was distinct evidence that water regularly supplied throughout the growing season greatly increased the relative proportion of latewood in the growth rings. A complete fertilizer, without artificial irrigation, seemed to increase diameter growth slightly, more so in the earlywood than in latewood; a nitrate fertilizer increased the latewood to a greater degree. FA

Paul, B. H., and Smith, D. M. 1950. SUMMARY ON GROWTH IN RELATION TO QUALITY OF SOUTHERN YELLOW PINE. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. D1751, 48 pp.
Summarizes some research results obtained in studies with loblolly, longleaf, shortleaf, and slash pines, and based on mechanical tests of old-growth and second-growth specimens. A considerable population of trees was analyzed for specific-gravity variation, and for site and stand relationships. The results from the analyses include the influence of site, of soil moisture (including irrigation), of stocking, of thinning, and of released growth following logging, on the specific gravity and related properties of the wood. FA

Sakornbut, S. S. 1951. DIFFERENTIATION OF WOODS OF SOUTHERN PINES BY CHEMICAL MEANS. J. Forest. 49: 109-111.
As a result of a number of tests, it was concluded that variation in percent of mineral constituents of wood could not be relied upon to identify the various southern pines since such variation is due much more to site than to species. Heartwoods of Pinus palustris, P. caribaea, P. taeda and P. echinata can be distinguished with a high degree of probability by absorption spectrophotometric determination in the ultra-violet region. For all species, heartwood can be differentiated from sapwood by the spectrophotometric method and also by color reaction with $FeCl_3$. *FA*

Saucier, J. R., and Taras, M. A. 1966. WOOD DENSITY VARIATION AMONG SIX LONGLEAF PINE SEED SOURCES GROWN IN VIRGINIA. J. Forest. 64: 463-465.
After eight growing seasons one source, from Florida, had lower specific gravity and was less frost-resistant than the others.

Shelbourne, C. J. A. 1967. STUDIES ON THE INHERITANCE AND RELATIONSHIPS OF BOLE STRAIGHTNESS AND COMPRESSION WOOD IN SOUTHERN PINES. Diss. Abstr. 27B (12, Pt. 1) : 4201.

Describes the techniques used for determining bole straightness (a) (measured on a scale where the lowest values denote the straightest trees) and amounts of different intensities of compression wood (b). A study of eight trees showed a positive relationship of (a) with severe (b), and weak negative relationships of (a) with mild (b). An extensive study of the percent of (b), (a), specific gravity and growth rate in Pinus elliottii, P. taeda, and P. palustris showed moderate positive relationships of (a) with severe (b), and weak negative relationships of (a) with slight (b). Narrow-sense heritabilities of 0.95 for (b), 0.73 for specific gravity, 0.34 for height, 0.28 for diameter and 0.05 for cellulose were found in 5-year open-pollinated progenies of P. taeda, and of 0.20 to 0.50 for (a) in P. taeda, age 18 months to 5 years, values varying with age and the straightness trait measured. These results suggest that the accepted hypothesis for the formation of (b) needs revision, and that the moderate heritability of (a) and the very high heritability of (b) should allow improvements in both properties by selection and breeding. FA

Taras, M. A., and Saucier, J. R. 1967. INFLUENCE OF EXTRACTIVES ON SPECIFIC GRAVITY OF SOUTHERN PINE. Forest Prod. J. 17 (9) : 97-99.
With unextracted cores, wood substance was overestimated by 6.0 to 7.5 percent. The authors present equations for predicting specific gravity of extracted material from values determined on unextracted material.

Thomas, R. J. 1967. THE STRUCTURE OF THE PIT MEMBRANES IN LONGLEAF PINE: AN ELECTRON MICROSCOPE STUDY. Amer. Wood-Preserv. Assoc. Proc. 63: 20-28.
Detailed ultrastructure study, with 16 micrographs.

Thompson, N. S., Heller, H. H., Hankey, J. D., and Smith, O. 1966. THE ISOLATION AND THE CARBOHYDRATE COMPOSITION OF THE EPITHELIAL CELLS OF LONGLEAF PINE (PINUS PALUSTRIS MILL.). TAPPI 49: 401-405.
A differential oxidative degradation of the bonds joining structural units of wood to each other may be achieved if the reaction is carried out under very mild, though prolonged, conditions with sodium chlorite at pH 4. The aggregates of epithelial cells bordering the resin canals were isolated. Examination of these canals showed many objects to be included in them.

USDA Forest Products Laboratory. 1955. WOOD HANDBOOK. U. S. Dep. Agr., Agr. Handbook 72. See pp. 29-30, 49, 70, 83, 112, 315, 322, 431, 440.
Characteristics, shrinkage values, strength properties, and related data on the wood of longleaf and other southern yellow pines.

USDA Forest Products Laboratory. 1965. SOUTHERN WOOD DENSITY SURVEY: 1965 STATUS REPORT. U. S. Dep. Agr. Forest Serv. Res. Pap. FPL-26, 40 pp. Forest Prod. Lab., Madison, Wis.
Mean specific gravities by State Forest Survey unit, and diameter class for each of the four major southern pines.

USDA Forest Products Laboratory. 1967. FOREST PRODUCTS LABORATORY LIST OF PUBLICATIONS ON THE GROWTH, STRUCTURE, AND IDENTIFICATION OF WOOD. 34 pp.
Lists several publications that include information on longleaf pine.

Wahlgren, H. E., and Fassnacht, D. L. 1959. ESTIMATING TREE SPECIFIC GRAVITY FROM A SINGLE INCREMENT CORE. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 2146, 24 pp.
Describes tests made to determine how increment-core specific gravity at breast height correlates with that of cross sections at successive heights throughout the merchantable volume of southern pines. Pulpwood bolts ca. 5.4 feet long were cut progressively from base to a minimum top diameter of 3 inches from 100 trees each of longleaf, slash, loblolly, and shortleaf pines (diameter range 5 to 16 inches), and complete cross sections, 1 to 2 inches thick, were cut from the trees between each two consecutive bolts. The d.b.h. was measured, and increment core extracted at this position, and the length from bark to pith measured to within 0.01 inch. Computations made for the mean specific gravity of each bolt are described and simple regression equations are given for estimating specific gravity. Progressive decrease in specific gravity with increasing height was confirmed, and significant relationship of increment core specific gravity at breast height to the mean specific gravity of the stem were found. Further work is needed (a) to develop optimum mensurational procedures for nondestructive determination of breast height segments of tree boles, and (b) on sampling of southern yellow pine forests to establish relationships between core sample and tree specific gravity for the full range of site, age, diameter, and specific gravity. FA

Wheeler, P. R., and Mitchell, H. L. 1959. SPECIFIC GRAVITY VARIATION IN MISSISSIPPI PINES. Fifth Southern Conf. on Forest Tree Impr. Proc. 1959: 87-96. *Also as* U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 2250, 10 pp. 1962.
Of the single variables tested to predict core specific gravity, the most important was the reciprocal of age. The four southern pines showed true variation in core specific gravity according to geographic location.

Wood, L. W. 1950. SOUTHERN PINE AND THE DENSITY RULE. Southern Lumberman 181(2273) : 236-238.
The density rule as applied to southern yellow pines requires one-third summerwood and not less than 6 rings per inch, or one-half summerwood with no restriction on rate of growth, these characteristics to be estimated by visual inspection of the ends of the piece. Pieces meeting these requirements are given a working stress for structural design one-sixth higher than that for unclassified material. Bending tests at Madison show that for shortleaf and loblolly pines nearly all values below 6,000 pounds per square inch are eliminated by the density rule. In longleaf pine the selection is less effective, but a tendency to eliminate low-strength material is apparent. Results are shown in graphs. Figures are also given showing that the application of the density rule to working stresses excludes low values; the basic stress for clear wood from all southern yellow pines without density selection is 2,200 pounds per square inch, and with density selection 2,500 pounds per square inch. FA

84 PRESERVATION AND SEASONING

Anonymous. 1946. REPORT OF COMMITTEE 7-10-DIVERSIFIED USES OF TREATED WOOD. Amer. Wood-Preserv. Assoc. Proc. 42: 255-265.
Research on the acid resistance of wood has shown that the temperature of the acid is very important. Life of untreated wood decreases 5 to 6 days for every 1° C. rise in temperature of a 30-percent HCl solution. Above approximately 35° C. the use of material other than wood is advisable. Southern cypress and longleaf pine are the best species for use in contact with acid: Sitka spruce, redcedar, and redwood next. Within any species the higher the dry-weight density, the greater the resistance to HCl.

Cockrell, R. A. 1949. FURTHER OBSERVATIONS ON LONGITUDINAL SHRINKAGE OF SOFTWOODS. Forest Prod. Res. Soc. Proc. 3 : 455-459.
Results of experiments on the longitudinal shrinkage of Pinus ponderosa, Abies concolor, Pinus echinata, P. palus-

tris,P. radiata, P. taeda, and Pseudotsuga taxifolia, confirm earlier results on P. ponderosa. Summerwood strips elongate slightly in drying from green to air-dry and shorten appreciably in drying to oven-dry. Measurements on blocks showing growth rings of different widths do not cause excessive longitudinal shrinkage in the species studied. FA

Davis, W. H., and Thompson, W. S. 1964. INFLUENCE of THERMAL TREATMENTS OF SHORT DURATION ON THE TOUGHNESS AND CHEMICAL COMPOSITION OF WOOD. Forest Prod. J. 14: 350-356.
In tests on longleaf pine, Douglas-fir, and southern red oak, which had been subjected to schedules of oven-heating at 150-200° C. for 20-60 minutes or steaming at 126-148° for 30-120 minutes, oak proved the most responsive species. Steaming reduced toughness and carbohydrate contents more than oven-heating did. Physical and chemical changes were roughly proportional with time or temperature, and were also correlated with each other. Variations in hemicellulose content appeared to have a larger influence on strength than is generally assumed. FA

Koch, P. 1964. TECHNIQUES FOR DRYING THICK SOUTHERN PINE VENEER. Forest Prod. J. 14: 382-386.
In the trials described, cants of southern pine (loblolly, plus some shortleaf and longleaf), 4-12 inches square, were flat-sawn to simulate sliced `veneers' 7/16 inch thick after surfacing, which were dried (a) in the open air, (b) in a kiln at a maximum of 186° F., (c) in a jet drier at 300°, (d) in a roller veneer drier at 300°, and (e) in a hotplate press, with ventilated cauls, at 300° and 82.6 pounds per square inch pressure. Of these methods (e) was fastest (23 minutes); it caused significant densification and thickness shrinkage, but little shrinkage in width and length, and gave the least distortion. Treatments (c) to (e) caused heavy resin exudations that would create difficulties in gluing unless removed by surfacing. Drying methods did not affect `veneer' stiffness, and laminated beams made from `veneers' dried by the different methods did not differ significantly in modulus of elasticity, modulus of rupture, or work to proportional limit. Treatment (e) appears best from a technical point of view, but economic considerations may favor (b) or (c). FA

Lindgren, R. M., and Erickson, E. C. O. 1957. DECAY AND TOUGHNESS LOSSES IN SOUTHERN PINE INFECTED BY PENIOPHORA. Forest Prod. J. 7: 201-204.
In exploratory tests, barked longleaf bolts, stored during summer in Mississippi under conditions resembling commercial practice, showed symptoms of decay attributable to P. gigantea in ca. 31, 58, and 62 percent of the cross section after respectively 6, 10, and 13 weeks. Corresponding mean losses in specific gravity were 0.6, 3.2 and 3.5 percent, and losses in toughness 16, 27 and 33 percent. Symptoms ranged from slight yellow discolorations in the early stages to softened patches of early wood after 13 weeks, but there were no open pockets. FA

Page, R. H., and Perry, J. H., Jr. 1962. PRETREATING TURPENTINED LONGLEAF PINE POLES TO IMPROVE PENETRATION AND RETENTION OF CREOSOTE. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 152, 13 pp.
Describes trials in which nearly 100 percent of bark-tapped, acid-treated longleaf poles showed adequate penetration and retention behind the face after air-drying to ca. 30 percent, incising, and steam conditioning. Slash pine generally required no incising. FA

Panek, E. 1957. PRESERVATIVE TREATMENT OF JACK PINE AND LONGLEAF PINE POSTS BY THE HOT-AND-COLD BATH AND ITS BOILING-IN-WATER ADAPTATION. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 2085, 10 pp.
Uninfected posts of both species showed low retentions and limited preservative penetration when given a hot bath for 1 hour and a cold bath for ½ hour. Preservative retention was more than sufficient and penetration was satisfactory when the hot bath lasted 1½ hours and the cold bath 2 hours. Mold infection caused excessive retentions in posts of both species. FA

Scott, M. H. 1946. THE USE OF CHEMICALLY TREATED WOODEN POLES FOR TELEPHONE AND POWER TRANSMISSION LINES IN SOUTH AFRICA. J. South Afr. Forest. Assoc. 13: 21-34.
The Forestry Department's plantations have provided excellent poles-including some of longleaf pine-from thinnings. FA

85 GRADING OF WOOD AND WOOD PRODUCTS

Anonymous. 1955. THREE NORTH AMERICAN "PINE" TIMBERS. Holz-Zentralbl. 81(114) : 1355-1356.
A description of Pseudotsuga taxifolia, Pinus echinata and P. palustris, including nomenclature, provenances, timber properties, uses and grading rules, preceded by a general explanation of North American log- and grading-rule principles. FA

Campbell, R. A. 1962. A GUIDE TO GRADING FEATURES IN SOUTHERN PINE LOGS AND TREES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta., Sta. Pap. 156, 23 pp.
Describes and illustrates the degrading features-knots and large holes, excess sweep, and conks (Fomes pini rot), the imperfections affecting log scale but not grade-cankers, crook and fork, insect and mechanical injuries, and other imperfections-compression wood, stain, etc. FA

Campbell, R. A. 1962. OVERRUNS-SOUTHERN PINE LOGS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 183, 2 pp.
Presents overrun and underrun data from a grade yield study of 1,491 logs of the four major species for logs 6-24 inches diameter under bark according to Doyle, Scribner, and International ¼ - inch rules. The logs were cut in efficient mills with circular saws. FA

Campbell, R. A. 1962. SOUTHERN PINE LUMBER GRADE YIELDS. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Res. Notes 182, 2 pp.
Presents, on the basis of mill studies in five States, tables for green lumber yields by grades for (a) slash and longleaf pine (log grades 11 to IV, diameter under bark 10-16 inches), and (b) loblolly and shortleaf (grades I to IV, diameter under bark 6-20 inches. FA

Campbell, R. A. 1964. FOREST SERVICE LOG GRADES FOR SOUTHERN PINE. U. S. Dep. Agr. Forest Serv. Res. Pap. SE11, 17 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
Specifications of a southern pine log grade system adopted by the U. S. Forest Service after 30 years of research. Both green and dry lumber yields are shown by log grade and species group.

Campbell, R. A. 1964. SOUTHERN YELLOW PINE LOG GRADES. Southern Lumberman 209(2600) : 28-30.
Sketches background of southern pine log grade development within the Forest Service. Lumber yields are shown by log grade, size, and species group, and the need for separate yields tables for loblolly-shortleaf and slash-longleaf is explained. Log grading specifications, grading procedures, and examples of uses and users of these log grades are presented.

86 PULP INDUSTRIES: CHEMICAL UTILIZATION OF WOOD

Anonymous. 1947. TURPENTINE RECOVERY IN PULP MILLS. Pulp Pap. Mag. Can. 48 (7) : 79-81.
Crude turpentine or pinene can be recovered from certain coniferous pulpwoods, particularly southern yellow pine (P. elliottii) and longleaf pine (P. palustris) during the cooking period of a wood charge in digesters. The extent of recovery varies from 1½ to 4 gallons per ton of pulp produced, depending on the type, age, and provenance of the wood. Details are given for the design and operation of a unit for recovery of turpentine. FA

Asunmaa, S., and Marteny, W. W . 1963. MORPHOLOGY OF REFINED PULPS OF SOUTHERN PINE (LONGLEAF PINE) AND BLACK ASH. TAPPI 46: 613-622.
Changes in the cellular structure of pulp fibers of longleaf pine and black ash in relation to the mechanical action of refining.

Gleaton, E. N., and Saydah, L. 1956. FIBER DIMENSIONS AND PAPERMAKING PROPERTIES OF THE VARIOUS PORTIONS OF A TREE. TAPPI 39: 157A-158A.
Experimental cooks of Pinus palustris branchwood (A), stumpwood (B) , rootwood (C) , topwood (D) , and centerlog wood (E), gave the following results (tabulated and graphed): the length of fibers decreased in the sequence B, E, D, C, A, the width of fibers in the sequence B, C, D, A, E; the length/width ratio and the pulp strength increased in the sequence A, B, C, D, E. FA

Harris, E. E., Beglinger, E., Hajnay, G. J., and Sherrard, E. C. 1944. HYDROLYSIS OF WOOD IN A STATIONARY DIGESTER BY SUCCESSIVE TREATMENTS WITH DILUTE SULFURIC ACID. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. 81455, 34 pp. (Abstr.) Pulp Pap. Mag. Can. 45 : 772.
Mill waste from 12 varieties of softwoods, four varieties of hardwoods, and the residue from the solvent extraction of longleaf pine stumps has been hydrolyzed in a pilot plant in 400-pound charges. Yields of total reducing sugars from softwoods such as Douglas-fir, spruce, and southern yellow pine range from 45 to 57 percent of the weight of the wood; from hardwoods such as oak and maple 45 to 52 percent; and from turpentine-spent chips 35 to 37 percent.

Jentzen, C. A. 1964. EFFECT OF STRESS APPLIED DURING DRYING ON SOME PROPERTIES OF INDIVIDUAL PULP FIBERS. Forest Prod. J. 14: 387-392.
Springwood and summerwood fibers of a longleaf pine holocellulose pulp were dried under various axial tensile loads. At commencement of drying, fibers underwent a sudden extension which was independent of the drying load. Drying under load caused an increase in Young's modulus, tensile strength, work-to-rupture, and crystallite orientation: it caused a decrease in ultimate elongation, and the crystallinity remained the same. In general, springwood fibers underwent much larger changes than summerwood fibers.

Jentzen, C. A. 1964. THE EFFECT OF STRESS APPLIED DURING DRYING ON SOME OF THE PROPERTIES OF INDIVIDUAL PULP FIBERS. TAPPI 47: 412-418.
See entry above.

Lawrence, W. P. 1947. CHLORITE BLEACHING OF SOUTHERN PINE KRAFT PULP. Pap. Trade J. 124 (21) : 38-40.
In specialized applications alkaline chlorite was very satisfactory as a finishing bleach for raising P. palustris kraft pulp to G. E. brightness 80 to 83, with good retention of strength characteristics.

Lehrbas, M. M. 1950. WOOD DENSITY INFLUENCES PULP YIELD. U. S. Dep. Agr. Forest Serv. Southern Forest Exp. Sta. Southern Forest. Notes 68.
The yield of screened kraft-type sulphate pulp that can be secured from southern pine wood of various densities has been determined by the Forest Products Laboratory, Madison, Wisconsin. Yields were found to increase from 10.2 pounds of pulp from 1 cubic foot of ovendry wood of 22 pounds per cubic foot density, to 17.4 pounds from wood of 36 pounds per cubic foot density. The approximate yield of moisture-free pulp per cubic foot of wood with any density from 22 to 36 pounds can be calculated by multiplying the density (in pounds per cubic foot ovendry) by 0.509 and subtracting 0.96 from the answer. The samples tested included Pinus taeda, P. palustris, P. echinata, and P. caribaea varying in growth rate and in amounts of summerwood and compression wood. No correlation was found between yield percent (pounds of pulp per 100 pounds of wood) and density. FA

Martin, J. S. 1962. KRAFT PULPING OF WEST FLORIDA SAND PINE AND LONGLEAF PINE. U. S. Dep. Agr. Forest Serv. Forest Prod. Lab. Rep. 2248, 12 pp.
Kraft pulps made from the open-cone form of Pinus clausa were higher in overall strength and brightness than those made from P. palustris from the same area, and essentially equal to them in cooking conditions, bleaching requirements, and yields by weight. P. clausa pulps are therefore considered suitable for unbleached and bleached kraft papers of high strength. FA

Skolnik, H., and Snow, A. G., Jr. 1946. RESIN IMPREGNATION OF CATFACES. Pap. Trade J. 122(12): 52-53.
Resin impregnation resulting from current turpentining practice renders the turpentined `catface' portion of turpentine-producing pines undesirable for paper pulp, thus preventing full utilization of two of the most important southern species, slash and longleaf pine. Recent research has developed new methods which apparently do not increase the resin content of the butt log beyond the limits of acceptability for pulp. FA

Spiegelberg, H. L. 1966. THE EFFECT OF HEMICELLULOSES ON THE MECHANICAL PROPERTIES OF INDIVIDUAL PULP FIBERS. TAPPI 49: 388-396.
Several pulps differing in hemicellulose (h.c.) content were obtained from Pinus palustris holocellulose pulp by selective alkaline extraction of latewood fibers. Measurements of elongation of fibers when dried under various loads or no load showed that removal of hemicellulose, besides making the fibers more crystalline, reduced breaking stress, modulus of elasticity, yield point stress and work-to-rupture of the fibers, but drying under load increased values for these properties. Evidence is presented indicating that the effect of hemicellulose content on fiber strength is to allow a greater internal redistribution of stress in fiber subject to external loads; removal of hemicellulose thus reduces flexibility and strength. A practical implication is that commercial pulps low in hemicellulose will tend to form papers differing appreciably in tensile properties in different directions, owing to large changes in fiber mechanical properties caused by drying under load. FA

89 OTHER FOREST PRODUCTS: OLEORESIN

Clark, C. K., and Osborne, J. G. 1948. THE PROPERTIES OF LONGLEAF PINE OLEORESIN AS AFFECTED BY TREE CHARACTERISTICS AND MANAGEMENT PRACTICES. U. S. Dep. Agr. Forest Serv. Southeast. Forest Exp. Sta. Tech. Note 70, 17 pp.
Tree factors studied were diameter, growth rate, and in-

herent yielding capacity. Management practices included frequency of dipping and height of face.

Fontes. L. F. 1954. PILAUS CARIBAEA, MORELET, PILAUS PALUSTRIS, MILLER: THEIR WOODS, CHEMICAL PRODUCTS, APPLICATIONS, STATISTICAL DATA. Serv. Florestal. do Estado. Sao Paulo, Ed. a Propag. 46, 15 pp.
In Portuguese.

Harris, G. C. 1948. RESIN ACIDS. V--THE COMPOSITION OF THE GUM OLEORESIN ACIDS OF PILAUS PALUSTRIS. J. Amer. Chem. Soc. 70: 3671-3674.
The composition of the acid fraction has been determined fully for the first time with such techniques as the amine salt method. In addition to the already known levopimaric and dextropimaric acids and a dihydroabietic acid, the oleoresin contains neoabietic, abietic, isodextropimaric, and dehydroabietic acids.

Harris, G. C., and Sanderson, T. F. 1948. RESIN ACIDS. VII--ISOLATION AND STRUCTURE OF ISODEXTROPIMARINAL, A POSSIBLE RESIN ACID PRECURSOR. J. Amer. Chem. Soc. 70: 3870-3872.
The aldehyde of isodextropimaric acid, termed isodextropimarinal, has been isolated from the neutral fraction of both wood and gum rosins. Its identity was proved by oxidation with chromic acid to obtain the pure resin acid in good yield.

Joye, N. M., Jr., and Lawrence, R. V. 1966. PRESENCE OF SANDARACOPIMARIC AND $\Delta^{8(9)}$ -ISOPIMARIC ACIDS IN PINE OLEORESIN. J. Organ. Chem. 31: 320-321.
Sandaracopimaric acid (a) was previously known from pine heartwood extractives and $D^{8(9)}$ -isopimaric acid (b) from resins of Tetraclinis and Callitris spp. It was suspected that acid used in stimulating resin flow might have caused the isomerization of isopimaric acid to (b), but it proved to be present in the same quantity in resin from freshly streaked trees on which no acid had been used, (a) was found in all pine oleoresins and rosins examined, and varied from 0.7 to 2.5 percent by weight of the sample, (b) was found in all samples of slash and longleaf pine resin and rosin. In most rosins it amounted to < 1 percent of the acid fraction but in a sample from Pinus edulis it was the major component (> 30 percent). FA

Loeblich, V. M., Baldwin, D. E., and Lawrence, R. V. 1955. THE ISOLATION OF A NEW RESIN ACID FROM GUM ROSIN-PALUSTRIC ACID. Amer. Chem. Soc. J. 77: 2823-2825.
A new primary acid of the abietic type, named palustric acid, has been isolated from gum rosin by means of partition chromatography. The presence of this acid in the oleoresin of Pinus palustris and Pinus caribaea has been established. The physical constants and ultraviolet absorption spectrum have been obtained. Palustric acid has been isolated as an intermediate product in the acid and heat isomerization of levopimaric acid to abietic acid.

Mellan, I., and Lubowe, I. I. 1959 . SANITIZERS BASED ON PINE OIL. Soap and Chem. Spec. 35 (4) : 74-75, 79, 105.
Outlines the commercial uses of pine oil as an emulsifying, wetting, and dispersing agent, a penetrant and an activator of pesticidal and germicidal properties in such formulations. Chipped stumps of Pinus palustris are processed by (7) steam distillation, (2) destructive distillation, and (3) extraction. T he oily layer appearing after (1) is fractionated to obtain pine oil and wood turpentine oil, and the chips are further treated with solvent to extract more pine oil, turpentine, and rosin by fractional distillation. Apart from the commercial significance of the oil per se, the mechanical extraction of the slow-rotting resinous stumps has also alleviated the formerly chronic problem of land clearance in pine forests of the southern U.S.A. FA

Mims, L. W., and Schopmeyer, M. C. 1947 . PROPERTIES OF OLEORESINS, ROSINS AND TURPENTINES FROM CHEMICALLY STIMULATED SLASH AND LONGLEAF PINE. Ind. Eng. Chem. 39: 1504-1506.
The chemicals used to stimulate the flow of oleoresins were 25 percent NaOH, 24 percent HCI, and 40 percent and 60 percent H_2SO_4 The results of the tests on oleoresins, turpentines, and resins are tabulated. There was no significant effect on either oleoresins or turpentines with any of the chemicals; neither HCl nor NaOH treatment affected resin color or transparency but 60 percent H,,$S0_4$ caused slight darkening of color and both 40 and 60 percent some clouding in the resin. FA

Mirov, N. T. 1961. COMPOSITION OF GUM TURPENTINES OF PINES. U. S. Dep. Agr. Tech. Bull. 1239, 158 pp.
Comprehensive treatise. Describes factors affecting variability of composition, and methods of chemical analysis. Presents physical and chemical data for 94 species.

Runckel, W. J., and Knapp, I. E. 1946. VISCOSITY OF PINE GUM. Ind. Eng. Chem. 38: 555-556.
Samples of three varieties of pine gum-slash gum, longleaf gum, and longleaf scrape-were diluted with freshly distilled gum turpentine (density 0.8605 at 26.8° C.) to concentrations of 25, 30, 35, and 40 percent turpentine by weight. Viscosities were then determined in a Stormer viscometer. FA

Schuller, W. H., Minor, J. C., and Lawrence, R. V. 1964. PHOTOSENSITIZED OXIDATION OF PINE GUM TO YIELD PEROXIDES. Ind. Eng. Chem. 3: 97-100.
Describes commercially promising tests with crude resin and rosins of slash and longleaf pine, yielding chiefly a mixture of peroxides from laevopimaric, palustric, and neoabietic acids. The derivation product from abietic acid gave a labile diperoxide. FA

9. FORESTS AND FORESTRY: NATIONAL VIEWPOINT

90 GENERAL: PROGRAMS, HISTORY

Anonymous. 1948. THE SOUTHERN RAILWAY'S DEMONSTRATION FOREST. Southern Lumberman 176 (2212) : 46, 48.
The Railway Lincoln Green Demonstration Forest near Dorchester, South Carolina, is designed to give object lessons to landowners in the management of pine. The forest is composed mainly of Pinus palustris, with some P. taeda and about 600 acres of P. elliottii.

Brown, C. L. 1964. THE PLACE OF LONGLEAF PINE IN SOUTHERN FOREST MANAGEMENT. Forest Farmer 24(3) : 6-8, 16, 18-19. Longleaf pine has many desirable traits but has been shunned because of its seedling growth habit and difficulty of regeneration. New nursery and planting techniques may increase longleaf's importance in the forest economy of the South.

Cassady, J. T. 1951. RESEARCHERS STUDY LOUISIANA'S CUTOVER PINELAND PRODUCTION. Forests and People 1(3) : 18-20.
At Alexandria, Louisiana, Forest Service research is concentrated on cutover longleaf pineland.

Chapman, H. H. 1951. AN ANCIENT AND ORIGINAL TRANSPORTATION SYSTEM FOR LOGS IN SOUTHERN ALABAMA. J. Forest. 49: 209-210.
Virgin longleaf timber in southwest Alabama and northwest Florida was logged to the mill with a unique system of board flumes constructed in small streams. Remains of the flower can still be seen.

Craig, R. B. 1949. THE MAJOR FOREST ECONOMIC PROBLEMS IN THE LONGLEAF-SLASH PINE-CYPRESS REGION. Southern Pulp and Pap. Manufacturer 12 (8) : 38, 40, 42, 50.
In the flatwoods of northeastern Florida and southern Georgia the main problems are: the integration of timber naval stores, and cattle production; reforestation of denuded areas; and control of fire.

Croker, T. C., Jr. 1962. LONGLEAF PINEY WOODS LABORATORY. Ala. Forest Prod. 5 (10) : 17, 19-20.
The Escambia Experimental Forest is a 3,000-acre field laboratory in south Alabama where research on longleaf pine has been conducted since 1947. The objective is to solve critical problems in regeneration and stand management.

Croker, T. C., Jr. 1963. CHALLENGE OF THE BRANCH BOTTOMS IN THE LONGLEAF FORESTS OF SOUTH ALABAMA. J. Ala. Acad. Sci. 34: 138-139.
South Alabama's longleaf forests are interlaced with narrow branch bottoms which occupy one-fifth of the gross longleaf area and probably account for a third of its total potential productive capacity. Improved management of these areas would add several million dollars annually to the economy of the region.

Dorman, K. W. 1966. FOREST TREE IMPROVEMENT RESEARCH IN THE SOUTH AND SOUTHEAST. U. S. Dep. Agr. Forest Serv. Res. Pap. SE-22, 90 pp. Southeast. Forest Exp. Sta., Asheville, N. C.
The amount and scope of research with both softwoods and hardwoods are reported for 36 agencies or combinations of agency and geographic location. There are 305 projects or studies involving 20 forest tree genera and 39 research subjects. Of all investigations, 65 percent are with the genus Pinus, 4 percent with other softwoods, and 31 percent with some 15 hardwood genera. Of the work with Pinus, 9 percent involves shortleaf pine, 27 percent slash pine, 9 percent longleaf pine, 26 percent loblolly pine, and 29 percent eight other pine species.

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Index of Authors

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