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FOREST DRAINAGE RESEARCH IN THE COASTAL PLAIN

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INTRODUCTION

More than one million acres of wetland forest in the coastal plain have been altered by drainage since 1950, and the tempo of activity is increasing rapidly. One of the primary functions of drainage is to improve the accessibility of large tracts of forest land for conventional types of motor vehicles (Fig. 1). It also enables landowners to replant their land with the young trees that will produce tomorrow's forests. Drainage ditches and the roads constructed on associated spoil banks also subdivide huge areas of land into smaller, more easily managed units, with better protection against loss from fire, insects, or disease.

Another purpose of forest drainage is to increase soil productivity. Slash pine and loblolly pine—the commercial pine species with which most wetlands are planted or seeded following drainage—seldom grow well where soils remain saturated throughout the year.

A good index to changes in soil productivity in wetland forests is the response of the tree itself. Unfortunately, little documentation of the changes in growth rates following drainage is available so that foresters, engineers, and others can make an economic evaluation of the alternatives. There is, however, some evidence of early improvement from drainage in thousands of acres of vigorous, young pine plantations on sites that were unsuitable before treatment (Fig. 2). It is difficult, however, to judge the future contribution of a pine plantation, newly established on drained forest land, to the pulpwood market twenty or thirty years hence because early growth patterns are not always indicative of the future yields of forest land converted from its natural state.

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A better indicator of the change in soil productivity that results from drainage may be the change in rate of height growth of dominant trees which are still young and vigorous enough to respond to the stimulus, but which are also old enough to give some measure of the productivity of the soil before

FIG. 1.—NEWLY CONSTRUCTED ACCESS ROAD AND DITCH INTO LARGE, UNDEVELOPED TRACT OF WETLAND FOREST

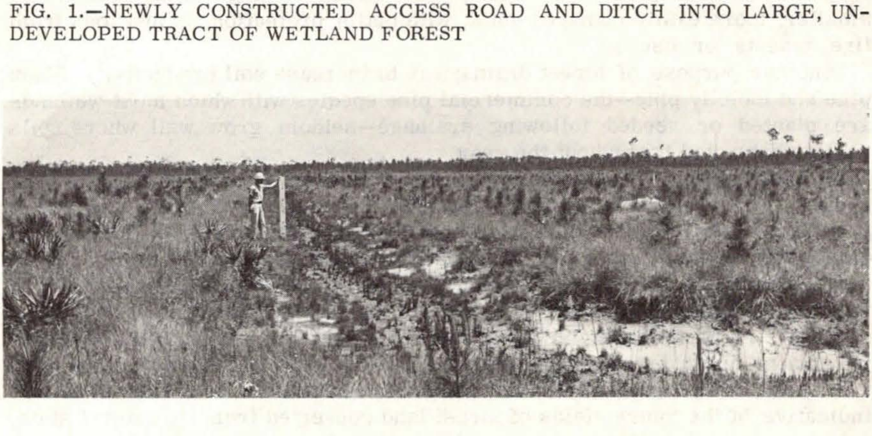

FIG. 2.—VIGOROUS SLASH PINE PLANTATION BEGINNING ITS THIRD YEAR OF GROWTH ON DRAINED PINELAND ONCE TOO WET TO PLANT

drainage. Use of these criteria in a cooperative drainage project between the Southeastern Forest Experiment Station, the National Forests in Florida, and the Soil Conservation Service on the Apalachicola National Forest in northwest Florida indicates that the wood-producing potential of some wet pinelands can be increased substantially.

FORT GADSDEN CREEK DRAINAGE PROJECT

A large part of the Apalachicola National Forest contains poorly drained pinelands where excessive water during rainy seasons has reduced timber growth and also value because of high logging costs. In 1960, Forest Service and Soil Conservation Service technicians located a typical wetland site at the headwaters of Fort Gadsden Creek. The area contained approximately 500 acres of flat to gently sloping land with several small swamps and drains occupying approximately 10% of the land. Fort Gadsden Creek, which runs along the north side of the area, provided a convenient outlet to the Apalachicola River.

The soils are Rains loamy fine sand, with finer-textured subsoils at depths ranging from 20 in. to 40 in., and Plummer loamy fine sand. Both soil series are widely distributed throughout the lower and middle coastal plain where they support moderately large acreages of forest land. Elevations vary from 10 ft to 25 ft above sea level with approximately 12 feet of fall between the outlet and the higher lands to be drained. Ninety percent, or approximately 10 ft, of this fall lies near the outlet.

Slash pine (Pinus elliottii Engelm.) occurred as widely scattered trees near the center of the area, grading to fairly thick stands of trees near the drains and swamps and on slightly elevated ridges. Various species of swamp trees, including cypress and hardwoods, grew profusely in the drains and swamps.

Drainage System Design and Tree Measurements.—By April, 1961, drainage of the area was underway. Approximately 3.5 miles of dragline ditches, spaced approximately 0.5 mile apart, and 4 miles of shallow collection ditches, at intervals of from 330 to 990 ft, were prepared (Fig. 3). Dragline ditches had a bottom width of 4 ft, 1 to 1 side slopes, and an average depth of 4 ft; collection ditches averaged approximately 1.5 ft deep with 3 to 1 side slopes. Planned rate of water removal from the watershed was 0.33 in. in 24 hr. This value follows recommended curves for woodland drainage in the southeast given by the Soil Conservation Service. Excavation for a ditch capacity of 22 cu ft per sec also provided adequate roadway construction spoil.

At the southeast corner of the drainage project, a study was begin on the effects of drainage on 61 scattered slash pine trees that averaged 19 yr of age at the beginning of 1961, as determined by ring counts of tree borings. Forty of the trees fell between ditches spaced 660 ft apart, and the remainder fell between collection ditches spaced 330 ft apart. Initial and annual change in tree heights were determined with a transit between growing seasons since 1961.

Growth Patterns Before and After Drainage.—Average annual height growth has ranged from a low of 1.2 ft in 1961 to a high of 2.0 ft in 1962 for trees within the 330-ft collection ditch spacing (Fig. 4). However, neither the differences in height growth between the 330 ft and 660 ft collection ditch spacings nor between years proved meaningful. This was established by first subjecting the data to a chi-square test, which demonstrated absence of interaction between ditch spacing and years, and then a "t"-test of the dif-

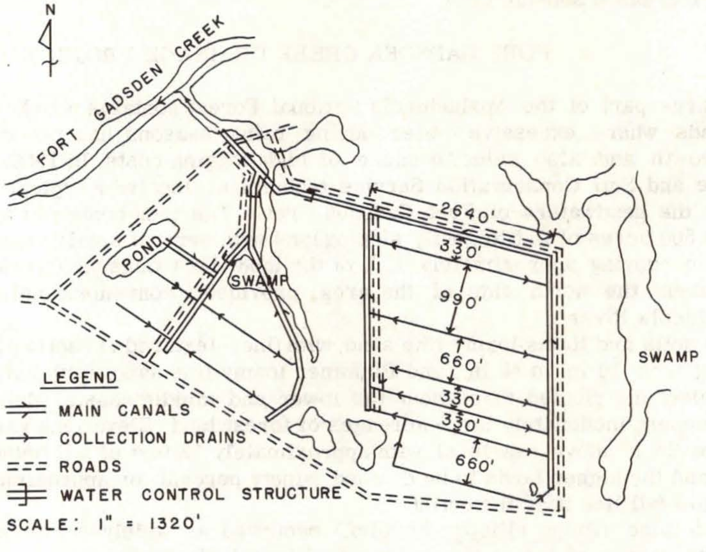

FIG. 3.—COMPLETED DRAINAGE SYSTEM ON THE FORT GADSDEN CREEK DRAINAGE PROJECT, APALACHICOLA NATIONAL FOREST

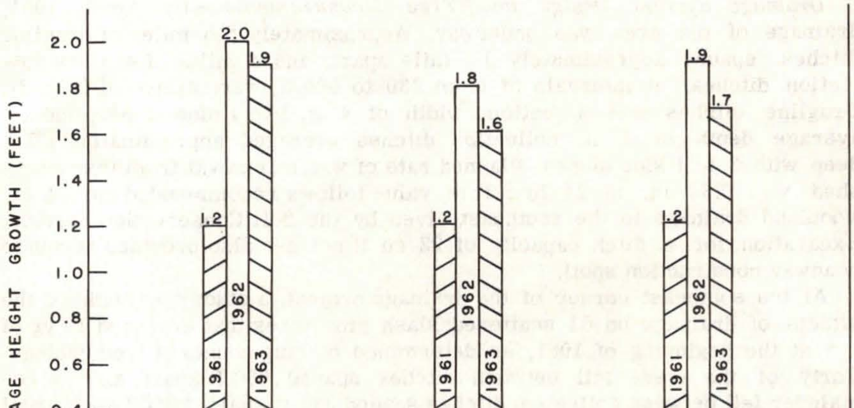

FIG. 4.—AVERAGE HEIGHT GROWTH OF SLASH PINE AFTER DRAINAGE FOR 1961, 1962, AND 1963 BY TWO COLLECTION DITCH SPACINGS AND BY THE AVERAGE OF THESE SPACINGS

ferences between yearly growth. Fig. 5 shows the condition of the slash pine study trees before drainage. Tree vigor improved considerably within 3 yr, as evidenced by the more luxuriant growth of needles in the tree crowns and their healthier coloration (Fig. 6).

Checks of the age and total height values of the study trees before drainage with published growth curves for natural slash pine[3] showed the expected total height at age 50 yr or site index at age 50 should be 55 ft. Between the ages of 20 yr and 25 yr, moreover, slash pine with a site index of 55 ft could be expected to grow at an average annual rate of 1.2 ft per yr, according to the growth curves. But the actual annual average growth rate of the study trees was 1.6 ft per yr, which is approximately the rate of growth expected on more productive soils with a site index rating of approximately 75 to 80 ft at age 50 yr. Further statistical comparison of the observed growth with that expected on trees with a site index of 55 ft indicated the increased rate of growth could be a result of drainage.

Site index ratings of 75 ft to 80 ft for slash pine on Rains and Plummer soils are not unusual. Soil and site index correlation data of the Soil Conservation Service for the coastal plain of Georgia[4] and South Carolina[5] show that average site index values in excess of 80 ft at 50 yr are possible on these soils. T. S. Coile,[6] in calculating site index for slash pine based on subsoil texture, estimated the site index of soils with the subsoil characteristics of Plummer and Rains soils as 75 ft and 80 ft, respectively.

The importance of a change of 20 ft in site index at age 50 in terms of pulpwood production can be gaged by reference to yield tables. One set of yield tables for well-stocked, natural, even-aged stands[7] predicts the volume pre acre of slash pine over 4.5 in. in diameter at breast height at age 30 for site index 55 as 16.4 cords and, at the same age, for site index 75 as 29.9 cords. In other words, slash pine stands similar to those used in construction of the yield tables can produce nearly twice as much pulpwood at age 30 on a site with an index of 75 ft as on a site with an index only 20 ft less. It can only be speculated, however, that the early growth responses will continue--they may be only temporary.

ESTIMATED EFFECTS OF DRAINAGE ON SOIL PRODUCTIVITY ELSEWHERE

Plummer, Rains, and other mineral soils similar to those on the Apalachicola National Forest occur along the lower southeastern coastal plain as far north as Virginia, well beyond the northern limit for natural stands of slash pine. Instead of slash pine, pond pine (or pond and loblolly pines

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3 "Volume, Yield and Stand Tables for Second-Growth Southern Pines," Miscellaneous Publication 50, Dept. of Agric., Washington, D. C., 1929.

4 Ritchie, Frank T., Jr., et al., "Soil Survey Interpretation for Woodland Conservation, Georgia Progress Report," U. S. D. A., Soil Conservation Service, Dept. of Agric., Washington, D. C., 1961.

5 Ellerbee, C. M., and Smith, G. E., Jr., "Soil Survey Interpretations for Woodland Conservation, South Carolina Progress Report." Vol. 1, U. S. D. A., Soil Conservation S., 1961.

6 Coile, T. S., "Soil and the Growth of Forests," Advances in Agronomy, Vol. IV, 1952, pp. 330-398.

7 Schumacher, F. X., and Coile, T. S., "Growth and Yields of Natural Stands of the Southern Pines," T. S. Coile, Inc., Durham, N. C., 1960.

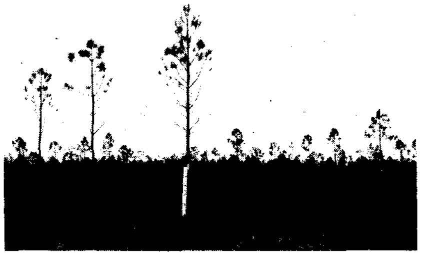

FIG. 5.—APPEARANCE OF THE SLASH PINE STUDY TREES BEFORE DRAINAGE

FIG. 6.—APPEARANCE OF THE SLASH PINE STUDY TREES AS IMPROVED AFTER 3 YR OF DRAINAGE

FIG. 7.—INDICATION OF LOW POTENTIAL FOR PINE PRODUCTION IN WETLANDS WITHOUT WATER AND SOIL MANAGEMENT

together) frequently occupies these northerly wet pinelands. In many cases, these lands support only low-growing heaths and degenerate pine forests (Fig. 7). Some of the potential of these wetlands can be judged by the performance of young loblolly plantations that have replaced slow-growing stands of scattered trees. But estimates of the change in soil productivity following controlled drainage are lacking because these plantations are not yet old enough to provide site index or yield estimates.

A recent survey of extensive wet pinelands in North Carolina provided a rough estimate of the possible change in soil productivity of various types of mineral soils following drainage. Previous classification of the land, plus evaluation of the soil characteristics, were used to establish site indexes for pond pine wetlands that ranged from 55 ft to 70 ft at age 50 yr. With drainage, increases in site index for loblolly (based on subsoil characteristics[6]) might range from 15 ft to 25 ft on treated sites. This estimate was based on improving the drainage state from poorly or very poorly drained to well or somewhat poorly drained.

CONCLUSIONS

Study of the changes in rates of growth of young slash pine trees after drainage on sandy wetlands in northwest Florida, as well as evaluation of the soil characteristics of wet pinelands in the lower coastal plain of North Carolina, indicates (initially at least) that an increase of approximately 20-ft in site index at 50 yr may be possible with adequate drainage. If growth is sustained, pulpwood yields on many wetlands throughout the coastal plain can be nearly doubled by drainage.

Ditching and road building in many wetland forests provide a type of water management. Access and protection are greatly improved, and the establishment of young timber stands is facilitated. Improved soil productivity apparently is also achieved through drainage, but little is known about the range and duration of responses and the degree of drainage necessary to achieve these responses.

Foremost, answers are sought to the following critical questions: What unique properties of soils that affect productivity are changed when water levels are lowered by drainage? What drainage techniques produce the most desirable combination of soil properties? And, what is the net effect of drainage on the hydrology of wetland forests?

KEY WORDS: ditches; drainage; pinewood; reclamation; research; trees (plants)

ABSTRACT: Tree measurements and soil evaluations indicate that drainage is responsible for nearly doubling the productivity of pine pulpwood in some forest wetlands in the coastal plain. Ditches also provide spoil for roads that subdivide large blocks of land into more easily managed units. Results from a drainage study on wet, sandy soils on the Apalachicola National Forest in northwest Florida demonstrated that the vigor of 20-yr old slash pine trees could be improved considerably in only 3 yr. Main ditches were dug 4-ft deep and 0.5-mile apart; collection ditches were dug 1.5-ft deep and at 330-ft and 660-ft intervals. Neither the differences in collection ditch spacings nor among years after drainage proved meaningful. The rate of tree growth after drainage did exceed expectance significantly based on comparison with the predrainage growth rate. Survey of soils and pond pine tree heights in North Carolina indicated that approximately the same degree of improvement in soil productivity could be obtained there with adequate drainage as in Florida.

REFERENCE: Klawitter, Ralph A., and Young, Cortland E., Jr., "Forest Drainage Research in the Coastal Plain," Journal of the Irrigation and Drainage Division, ASCE, Vol. 91, No. IR3, Proc. Paper 4456, September, 1965, pp. 1-7.