A challenging opportunity in forest management

WETLAND FORESTS

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Hardwood wet flats near Summerville, South Carolina, on land of the West Virginia Pulp and Paper Company. Stand is composed of red maple, sweetgum, water, willow and laurel oaks

FOREST research in the Southeastern Coastal Plain has solved many problems in the management of southern pines grown on upland sites. Now there is an interest in the management of wetland species—the bottomland hardwoods, cypress, and several pines—and research in this line is expanding.

Timberland owners and wood-using industries, along with federal and state agencies, have become aware of the value and importance of wetland forests. A large proportion of the coastal plain commercial forest land is in this category, probably not less than 35 percent. Drainage commands much interest; very large investments have been made and are currently being planned.

Drainage objectives include timberland accessibility for logging and general management, forest cover type conversion, and a general belief that the sites will benefit through drainage, with a consequent increase in timber growth. At present there is little well substantiated silvicultural information to guide these drainage investments. The broad classification termed "wetland forests" includes many kinds of woodland, and about all some of them have in common is a profuse supply of water. At least 60 commercial species are found in various combinations and mixtures, growing on dozens of soils.

In both research and management, we must know something of the characteristics of the forest populations with which we are dealing. A natural classification scheme that lends itself to gradual refinement is needed, which will include species composition, soils, and the physiographic location of major wetland types. The Charleston, S.C., Research Center of the Southeastern Forest Experiment Station has started such a classification.

The catch-all term "wetland forests" may be new to many readers, but in all probability it will conjure visions of deep swamp — baldcypress and tupelo festooned with Spanish moss, dark waters and deep shade, the abode of egrets, alligators, and cottonmouths. Rightly so; this is a major kind of wetland, although fortunately the reptiles are neither so spectacularly abundant nor so active as folklore would have it. One type of swamp is found along the large "red water" rivers that carry heavy silt loads from their Piedmont and mountain origins. These rivers overflow annually, flood the sloughs and backwater areas of their broad bottomlands, and deposit fine sediments that become heavy clay soils.

Swamps of another sort are associated with "black water" rivers and streams that start in the coastal plain. These rivers carry a light silt load but their waters are dark with suspended organic material. The soils are lighter-textured than in red river swamps, and swamp tupelo replaces water tupelo in these stands.

Both kinds of swamp have long been a source of fine cypress and gum logs.

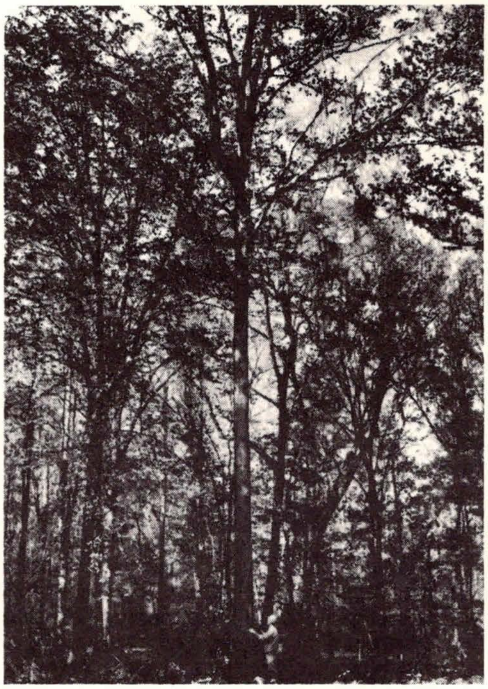
A third type is generally small in individual size, but the aggregate acreage is large. These are the stagnant upland ponds or swamps that dot the pine flatwoods, supporting rather poor stands of pond cypress and swamp tupelo.

In overflow bottomlands, slopes that are almost imperceptible to the eye grade into areas of higher land called first bottoms. Here cypress and tupelo give way to a variety of hardwood species. Actual species composition depends upon relative elevation and such soil characteristics as internal drainage. On terraces and second bottoms, which are rarely if ever flooded, yet another hardwood type is found. Here upland species that are intolerant of flooding, such as beech and yellow-poplar, are able to enter the stand. This type is characteristic of the "branch hardwoods" bordering coastal plain streams. They occupy terraces between the stream and the pine uplands.

On the lowest and geologically youngest marine terraces of the coastal plain are found areas, often thousands of acres in size, called pocosins. They typically have an overstory of pond pine and a dense understory of evergreen, ericaceous shrubs. Although the topography appears to be extraordinarily flat and featureless, pocosins are commonly slightly dome-shaped, and sometimes have lakes in their higher, central portions. Organic soils are the rule, and at the pocosin's salt water margin the underlying mineral soil may actually be below sea level. Mineral surface soils may also be present where fire has burned away the peat or muck layer. Frequent and catastrophic wild fire has been the nemesis of these lands. Their scattered stands of contorted, misshapen pond pine bear witness to this history.

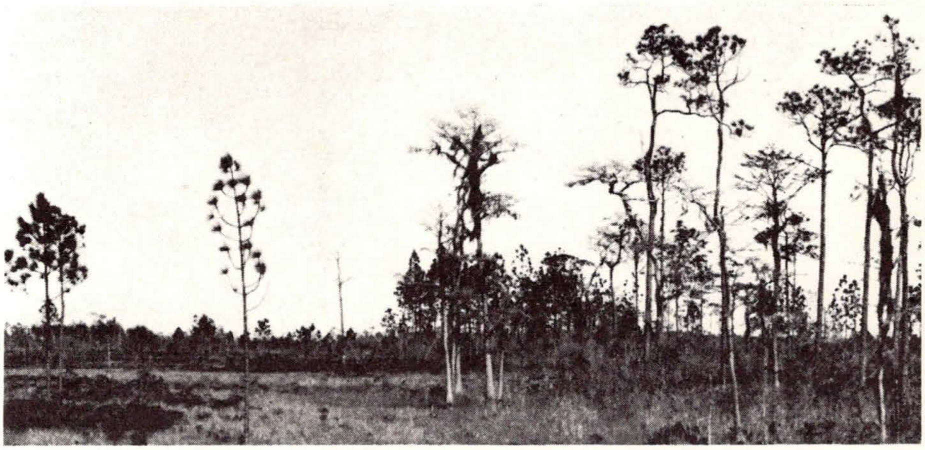
Aerial photographs of the coastal plain show land forms with remarkably regular elliptical shapes, varying in size from a few acres to several thousand. These are the famous Carolina Bays of mysterious origin. The theories of genesis range from meteor storms to stranded icebergs.

Bay vegetation is diverse but in general resembles that of pocosins—a nearly impenetrable thicket of evergreen shrubs, vines, and small trees, with a pond pine overstory of variable quality and density. As with pocosins, fire has been a prominent factor in the development of bay plant communities and soils. There are also areas with irregular shapes which have typical bay vegetation; sometimes these upland bogs develop in the troughs between old beach line ridges. Both bays

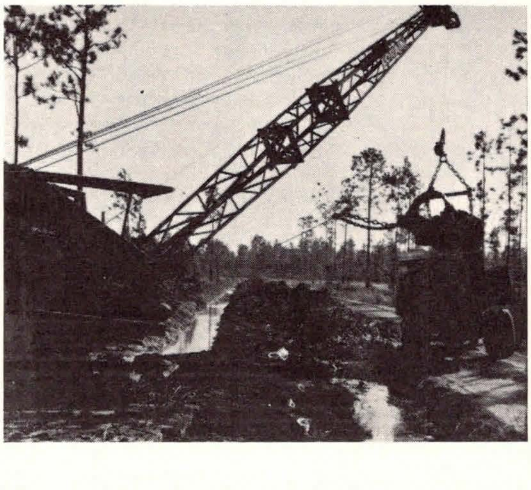


Terrace hardwoods on the Santee Experimental Forest near Charleston, South Carolina. Swamp chestnut oak is in center, with white oak, beech, yellow-poplar and hickory also present

At left, water tupelo timber in a "red water" swamp of the Santee River, South Carolina



This Florida wet flat is near Fort Gadsden Creek, Appalachicola National Forest. Scattered slash and longleaf pines on left—at right is small pond with slash pine and pond cypress



Drainage and access in a pine wet flat. Dragline moves backward on wooden mats as the ditch is dug, and the spoil is used to construct the road

and pocosins frequently have cypress-tupelo upland swamps within them.

Since the lower coastal plain has little elevation and the land surface is extremely young on a geologic time scale, stream evolution is immature and there are broad interstream areas with poorly developed drainage systems. The predominantly organic-soil pocosins are examples, but there are others with mineral soils which we call wet flats and savannahs.

In Georgia and Florida, slash pine, longleaf, or pond pine may dominate wet flats, with shrub understories of gallberry, titi, and St. John's wort. Pine dominated wet flats occur in the Carolinas too, and in addition pine-hardwood stands are common that have loblolly pine mixed with sweetgum, water and willow oaks, red maple, and other species.

Savannahs are extreme examples of the poorly drained interstream area. Repeated fires probably kept them open, and some may have been pocosins at one time. Sedges and reeds are the major cover, along with pitcher plants and many of the shrubs found in wet flats and bays. Protected from fire, many so-called savannahs have reverted back to pine woods. Most savannahs have a scattering of longleaf, slash, or pond pine present. Both wet flats and savannahs have a great variety of soils, but water-logged sandy loams or heavy clays are commonest.

Forest managers of wetlands are faced with problems that change or vary in degree from type to type. Accessibility, a case in point, is the backbone of management since without it forestry is at a standstill.

For most wetlands, roads with associated drainage ditches are the answer. One complements the other, in that the road is a necessity, and the ditch is dug alongside it to provide spoil material for road construction. With access, fires can be controlled and wood harvesting can begin, along with management activities like type conversion, prescribed burning, direct seeding, thinning, and harvest cuts for natural regeneration.

Pocosins, bays, pine wet flats, and savannahs in their natural state generally produce saleable products at a low to negligible rate. Drainage may improve the site for the existing trees, or in some instances make type conversion feasible and rewarding. On wet flats native brush or low-grade hardwoods may be replaced by pines. Other undrained wetlands may well range from moderate to high in productivity, but we have very little evidence in terms of quantitative data.

We have much to learn before we can prescribe methods for regenerating all wetland types and be assured of reasonable success. This applies to planting, direct seeding, and natural regeneration, along with complementary site preparation and control of competing vegetation.

Many managers of forest wetlands have resorted to drainage or "water control," and such programs have a host of peculiar problems such as pattern and spacing of ditches, design of control structures, and methods of ditch and road construction. These are essentially engineering problems that can be solved to a great extent with present know-how. Rate of flow can be manipulated by wing control structures in the ditches. The great unknowns in drainage programs are the effect on type conversion schemes, regeneration, and growth of existing stands. Silvicultural research must determine *what* conditions are needed and are feasible for a particular wetland type, and then drainage engineering can plan to bring about these conditions.

Our introductory excursion in wetland plant geography gave a broad picture of the great variety of forests included under wetlands. All are characterized by wet soil conditions or actual flooding during a significant portion of the year. All sorts of moisture regimes and hydrologic conditions interrelated with great soil diversity have resulted in many forest types, some of them very different. Obviously, the action and significance of water as an environmental factor will not be uniform in all these types. In assessing drainage or "water control" opportunities, we need information specific for the sites and species of each type.

Water itself is not detrimental. Given nutrients, aeration, and mechanical support, most trees will grow perfectly well in water—they *could* be produced hydroponically just as vegetables often are. It has been said that if wet soils could be aerated sufficiently in some way, drainage would be unnecessary. Such a solution is over-simplified, but there is much truth in it. Water-saturated soils have an oxygen deficit—oxygen is continually being used in the respiration of roots and soil organisms, while carbon dioxide is produced. Since gas diffuses through soil water much more slowly than through soil air, saturated soils are replenished at a low rate with oxygen from the atmosphere. Conversely, carbon dioxide cannot easily escape from wet soils, so it tends to build up.

A general discussion of the effects of poor aeration on plants should be viewed with caution; many common field crops differ significantly in their reaction to aeration conditions, and as yet not a great deal is known for tree species. However, as a rule, when oxygen is at a low level, root respiration is lowered and anaerobic respiration occurrs. In the latter, oxygen for respiration is obtained by rearrangement of atoms within the molecule oxidized, or from the breakdown of other organic compounds.

Anaerobic respiration has two principal drawbacks for plants. First, it is a less efficient producer of energy, and, since mineral absorption demands energy expenditure, fewer mineral nutrients are taken up. Second, some incompletely oxidized products of anaerobic respiration are toxic and may be detrimental to both root and shoot. Root growth is slowed under oxygen stress and eventually roots die. Poor aeration indirectly lowers water absorption because root mortality makes less root area available. Cell metabolism is adversely affected by reduced mineral absorption and respiration, and by the toxic byproducts of anaerobic respiration. Cell metabolism and permeability to water are closely correlated; plant root cells in poor condition cannot absorb water readily. We need not dwell on what happens to a transpiring plant when its water supply is cut off—it dies.

Carbon dioxide collects in wet soils, and it can have narcotic effects on roots, causing reduced water and nutrient absorption. If plant roots are experimentally subjected to high carbon dioxide concentrations, depressing effects are more immediate than when oxygen is lacking.

The chemical properties of poorly aerated soils differ radically from well aerated ones. Decomposition of organic matter is slowed down, and nitrogen is therefore bound in the accumulated organic material. In some wet soils, ferrous iron, sulfides, and manganese reach concentration levels toxic to plants.

Overflow bottomlands often flood deeply enough to submerge tree seedlings. Both soil air and the atmosphere itself are displaced by water. Experimentation has shown that the tree species typically found on such sites are much more tolerant of flooding than are characteristic upland species. As most species can survive dormant-season inundation, season of flooding is important. Flood waters themselves may carry appreciable quantities of oxygen. Measurements of the oxygen content of moving soil water have shown some amazingly high values, vastly greater than for those of stagnant soil water. Water movement may be important in explaining why some sites that appear to be equally wet are very different in productivity.

Poor soil drainage is generally considered to be an adverse site factor, but it must be stressed that its effect varies greatly among various wetland types. The bad physiological effects of too much water are striking when sensitive and demanding trees are involved, such as yellow-poplar. But other species, such as water tupelo, seem to make a mockery of what are normally considered good growing conditions.

Since the environments of wetland forest types are different, their species compositions differ. Site characteristics dictate which species can survive. In the wettest types we find only trees that are tolerant of poor aeration, high carbon dioxide levels, and soft soil for root anchorage. Baldcypress and water tupelo are both good examples; their roots are able to grow and even flourish in soils that are saturated for long periods.

Species site requirements vary greatly. *It is dangerous to think in terms of one ideal set of site conditions.* The tolerance demonstrated by a species to certain site conditions, arbitrarily pronounced detrimental, may actually be an indication of preference. Nevertheless, there is no lack of wetland sites where even the most accommodating of wetland species do very poorly. **The problem's solution is a knowledge of species site requirements and what can be done on a particular area to approach these conditions.** When excessive soil moisture is the limiting site factor, it should be controlled.

Research in the site effects of drainage having only recently begun; we cannot say with assurance which types will benefit most. There is little quantitative data as to the degree of site improvement and increase in wood production attributable to drainage. Certainly some wetland types will benefit more than others, and in some types drainage may actually be harmful. However, favorable effects from drainage are obvious on some wetlands, notably pocosins, bays, and wet flats.

On the Appalachicola National Forest in western Florida there are thousands of acres of wet flats and savannahs. With the help of the Soil Conservation Service, this national forest and the Southeastern Forest Experiment Station have installed a cooperative drainage study on a representative example of these sites.

Near Summerville, S. C., the West Virginia Pulp and Paper Company owns an extensive acreage of pine-hardwood wet flats interlaced with fingers of creek swamp. In a mutual effort with the Southeastern Station, 52 plots have been located on a broad range of soils and drainage conditions, mostly within areas affected by drainage ditches. Five species were planted: loblolly pine, baldcypress, water tupelo, swamp tupelo, and sweetgum. In addition, hydrologic studies are being carried out on these plots.

Most of our silvicultural work with bottomland hardwoods has been concentrated on the Santee Experimental Forest, near Charleston, S. C. Research has been oriented along two lines — the management of existing hardwood stands which have reasonably good stocking and species composition, and the rejuvenation of rundown stands through planting and direct seeding.

Along the first line of inquiry, two stands were given a selection cutting aimed toward uneven-aged management. Several serious disadvantages of this system became evident—logging damage was considerable, water sprouts severely degraded the residual high quality growing stock, and reproduction did not develop in the openings. Based on lessons from this case history, even-aged hardwood management is being tested through a stand cut to seed trees. All early indications point toward success. Reproduction varies from excellent to adequate throughout the area, and seed tree losses have been minor, even though they have weathered two hurricanes and a severe ice storm. To find means of rehabilitating poor hardwood stands on good sites, a broad variety of the best native species have been planted on creek bottomland and terrace locations. Their performance has been evaluated, and planting recommendations will soon be published.

The research accomplished and currently under way suggests new opportunities and avenues of attack. We want to learn more about the site requirements of individual species, determine what the growing conditions are on the numerous wetland types, and how and to what degree drainage or other measures can improve the site. There is almost certainly a great deal of genetic diversity in some wetland species, and to avoid mediocre planting success or outright failure this variation needs clarification. Such studies are also basic to genetic tree improvement programs. Our many wetland forest types are a similar problem. Apparent contradictions in some research results would be understood if the forest types involved were better known and described.

Eventually, we would like to be able to analyze a wetland forest management opportunity systematically. We would determine the forest type—where the land fits in a detailed forest classification scheme. In establishing this we would know the species present and promising species to manage. The classification would be based on a knowledge of species site requirements, and what could be done on that forest type to meet these needs.

Judging by the meager extent of our present wetland knowledge, one might expect that the foregoing utopian situation is reserved for the distant future. Happily, this will not be the case; we have every reason to believe that the burgeoning research and management efforts in wetlands will parallel the sensational advances already made in other fields of southern forestry.

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