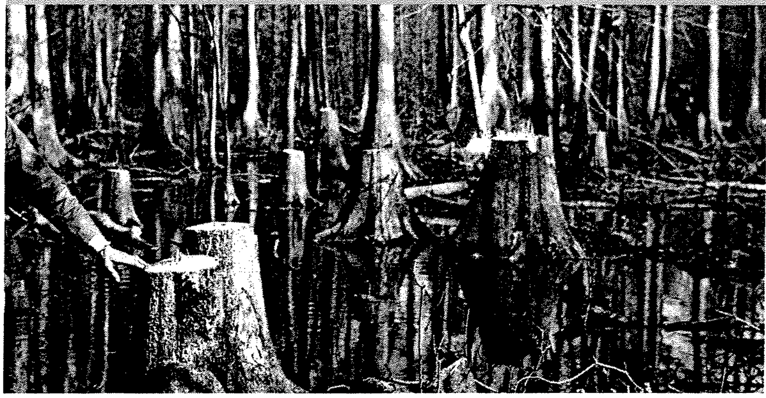

Watershed Management

THE WETLANDS–
WATERSHED MANAGEMENT3 NEW FRONTIER

Mention watershed research and it immediately suggests experiments on mountain catchments as featured at the Station's Coweeta Hydrologic Laboratory and reported for many years in our annual reports. Yet our new wetlands research at Charleston, South Carolina, is showing that opportunities and need for better soil and water management are just as great in the flat, water-logged coastal plain forests as in well drained upland elsewhere in the Southeast. Indeed, water management of sorts is now a practical reality for large forest acreages in the low country, and the tempo of activities and interest in this work is increasing rapidly.

The wetland forests — about 20 million acres in all — stretch more than a thousand miles along the lower coastal plain from the James River in Virginia to southern Florida. The vegetation of these forests, the soils, the wildlife, and even their uses reflect the hydrology of this vast watery domain. The wetlands are the head-waters for countless streams and lakes, as well as the recharge areas for huge groundwater reserves which provide a fresh water buffer against intrusion of salt water into coastal plain water supplies. Moreover, they serve as water storage

*At **left of** ditch, controlled drainage in this large bay improved **forest productivity** and accessibility.*

sites for impoundments serving irrigation, fish and waterfowl management, hydropower production, and sundry other human activities.

Inherent wetness sets these areas apart from other forest lands and makes their management difficult. Some, though drowned much of the year, dry out surprisingly during certain seasons. Getting rid of the water is not necessarily a solution; for although some tree species respond to this change, others-both pines and hardwoods—produce top growth on some of the wettest situations. In any event, changing water relations through drainage, impoundment, or other means will surely modify the whole wetland environment; e.g., productivity of the soil for timber and other wood products; the groundwater levels including the timing and amount of streamflow and the hydrology of surrounding areas; and, the forest habitat potential for fish, waterfowl, and other wildlife.

More than a million acres of wetland forest has already been altered by drainage since 1950, and the end is nowhere in sight. Much of this work has been done by wood-using industries and government agencies; and most drainage features have been a byproduct of dredging operations to get spoil for building roads into wetland areas. Although the immediate aim is usually to facilitate logging and open up land for management, the opportunity to upgrade soil productivity is also a strong consideration.

A typical forest industry operation may involve construction of about 30 miles of main ditches and laterals on some 10,000 acres each year. Most of the ditches are dug along the lower, wettest areas to reduce construction costs, which depend upon the amount of clearing, size and spacing of ditches, and number of water control structures. Ditch design is usually based on farm drainage experience and hydrologic calculations which provide for comparatively slow rates of water removal because the trees can tolerate some flooding. However, where extra spoil for access roads is needed, the excavation often produces ditches much larger than they need be for water removal. Costs of the road-ditch systems may be as low as 6 or 7 dollars an acre, or they may run much higher, but they usually are well within the amounts owners estimate they can afford to spend on this type of improvement.

Accordingly, some forms of water management, however crude, are assured in wetland forests, if for no other reason than that ditching and road building open up boggy areas once accessible only by foot, boat, or swamp vehicle. Unfortunately, the pattern and effectiveness of drainage is geared to road access needs and rule-of-thumb procedures, with such critical questions remaining as: What are the peculiar water relations of wetland forests and how can they be modified? What unique properties and physical characteristics of wetland soils affect water movement and in turn are affected by it? What are the varying soil and water requirements of forest trees? And what are the management alternatives, particularly those which may improve wetland soils, yet conserve local and regional water supplies? Some answers to the first three questions must be obtained before much can be done about the fourth; hence they are priority phases for research attack in the Charleston, South Carolina, project.

Bays, Pocosins, Swamps

As one might suspect, the wetlands are a vast complex of unlike wet situations. Some are highly productive timber sites; many support only low-growing heaths and degenerate forests. They include such oddities as well-elevated swamps having deep sandy soils which drain scarcely at all, and water-logged flatwoods where trees grow 120 feet tall in 50 years. Furthermore, the wetlands often are not separate types but are intermixed and merge gradually with the changes in soils, landform, and the level, constancy and source of water supply.

The best way to appreciate this diversity is to spend some time walking through wetlands. In a typical traverse, one might first find himself crossing a wet pine flat imbedded with small hardwood and cypress ponds, before entering a large water-filled depression — an upland bay or pocosin — that slowly drains along sinuous pathways into a bottomland creek swamp. Farther downstream, the creek swamps merge and may finally lose identity as a great river swamp near the Atlantic.

Along the coast, where the river empties into an estuary, one may again cross a series of bays—this time, of the coastal variety. Although the peaty soils and vegetation of coastal bays and upland bays are quite similar in many respects, they often differ considerably in water relations. Low gradient of drainage outlets and tidal effects usually limit the drainage of coastal bays much more than the upland ones, which normally are at elevations of 25 feet or more above sea level. The peaty areas, mostly in North Carolina and Virginia, and totaling about 3 million acres, are relatively unproductive and pose special problems.

The water cycle of swamp areas bordering the streams also varies greatly from one situation to the next. Creek swamps ordinarily lie along

Most bays are poor timber producers *without soil and water* management.

the "blackwater" rivers and streams that rise in bays and wet flats. Here the moisture cycle reflects the typical coastal plain summer-wet, winter-dry climate; and high water levels are maintained in the summer which favor surface accumulation of organic plant residues. In contrast, the large river swamps, most common along the lower reaches of "redwater" streams, flood deepest and longest in response to headwater Piedmont and mountain patterns of precipitation, i.e., dry summer and wet winter. However, the frequent summer thunderstorms and an occasional tropical blow on its northward trek sometimes supply enough additional moisture in summer months to maintain high water levels throughout the year.

Thus, needs and opportunities for water management in bays, swamps and other wetland types depend upon their peculiar hydrology. These processes and relationships must be studied and understood for a regional range of wetland situations before there can be any sound undergirding of programs and plans for drainage systems, impoundments, and other water control developments.

Pocosins with peaty soils cover vast expanses of the lower coastal plain.

Soil Is a Key Factor

Wetlands soils hold, transmit, and yield water, and after all are the basic element in forest productivity. Some of the soils are covered with water only during wet seasons, while others remain flooded all year, with all degrees between these extremes. The common denominator, however, is abundant water for prolonged periods, due to presence of an impermeable soil layer, flat topography, and a lack of stream dissection. High groundwater levels and frequent stream overflow are common. Beyond this, the wetland soils vary widely in their properties, reflecting the parent materials from which they have evolved.

Parent materials may be recent alluvial deposits or marine sediments laid down as beds of sand, silt and clay, as well as phosphatic and calcic materials and accumulated plant remains. Some of these materials have been layered but others have been mixed considerably, producing soils with a broad range of profile characteristics and physical properties. More than 80 soil series are recognized in wetland forests, and this list is sure to be extended when soil men get better acquainted with coastal plain bays and pocosins, where soils are now lumped into broad, ill-defined categories such as peats or swamp soils.

Within this broad complex, some of the soils seem highly productive for most forest species, while others are greatly limited in this respect. A farmer selects his best land for his most intensive cropping procedures--drainage, fertilization, or irrigation-because research has shown that on those soils he can expect highest returns. But for the forester trying to manage wetlands, selection is mostly a matter of guesswork, since he lacks knowledge of relationships, the factors affecting wetland productivity, and the probable responses to treatment.

For the time being, and strictly as an interim guide, we think priority research should center on about 6 million acres of the wetlands — 2,700,000 acres in pond pine bays and pocosins plus some 3 million of other wet pine lands. In part, this is to help narrow the field for research attack; but it also reflects the view that commercial pine types, to which most wetlands are being converted following drainage, are most likely to show favorable response from altered water regimes.

Trees Tell a Story

Undoubtedly, the best single index of how much wetlands are improved by water and soil management is the reaction of the tree itself. The dominant trees can tell us by changes in rates of growth whether altered water levels from controlled drainage of wet areas are such as to permit good root development; whether oxygen diffusion through the soil appears adequate; how closely we should space ditches to achieve various levels of site improvement; the optimum quantities of water that should be left in the soil seasonally for best timber growth; and many other important clues to better management.

Not all trees tell the same story, however. The combination which makes for a favorable site for one species may not be desirable for others. This has been demonstrated dramatically in our early studies, where first-year survival and growth of planted water tupelo was best under prolonged flooding, whereas loblolly pine on these same plots did best when water levels were at their lowest. Older, more mature trees show these same habitat preferences, which leads one to conclude that in speaking of wetland improvement much depends on which species and which site.

In most cases the commercially valuable pines are the preferred trees for the wetlands, and are planted on many drained areas. Hence, loblolly pine in the more northern sections and slash pine farther south will be used as plant gages or "phytometers" in evaluating degrees of site improvement. Large-scale planting of these pines introduces special soil-water problems, such as their varying tolerances to flooding, and their changing water use demands as a hydrologic factor of importance in drainage design and efficiency. These and related problems also are under study by Station teams of hydrologists and foresters.

Water As a Resource

Although wetland improvement is essentially a matter of water control, water conservation is just as much a central aim and need as disposing of the excess water. Future research doubtless will show that water tables must be maintained at adequate levels to get optimum timber growth and sustain wildlife habitat. But beyond this there are likely to be even more important regional water requirements.

Growth of slash *pine trees was speeded by controlled drainage.*

The lower coastal plain has enormous total groundwater supplies — a resource of incalculable value giving this territory a productive potential second to none. Water supplies for towns, farms, and industries more than satisfy present demand — but how about tomorrow and an expanding economy? Can we afford to lower water tables over vast areas of wetland forest without regard to the effects on water supplies of the territories adjacent? Can we be sure that the channels opened to the sea to carry away water during wet years and seasons will not carry salt water inland during dry ones to infiltrate aquifers now storing fresh, potable water supplies? Questions such as these and many others about the water relations of wetland forests are basic to wetland improvement; and they will take on added force as populations and water requirements pyramid in the years ahead. Indeed, some years hence the number one function of some wetland forests may be to provide sources of fresh water rather than grow pine trees and waterfowl.

Much Needs to Be Done

One of the biggest brakes slowing wetland improvement is lack of knowledge. There is plenty of operational experience and engineering know-how on designing ditch systems and draining wetlands, but virtually nothing on how this modifies soils and hydrology for timber production and other purposes. Systematic observations on cause-and-effect relationships are few and far between. The research job largely lies ahead.

The new work at Charleston is proceeding under several subproject fields ***relations,*** i.e., studies of hydrologic processes, the seasonal moisture regimes of wetlands, and soil property changes induced by water control measures; (2) Plant-water ***relations,*** i.e., studies of the responses of tree species to varying moisture regimes and at different stages of growth, and the adaptation of timber stands to environments created by drainage; and ***(3) Wetland management,*** involving the development and testing of techniques and study of the economics of controlled drainage and related practices.

Some of our current research at Charleston is exploratory in character, designed to help us in classifying wetland situations and in studying their little-understood hydrology. We recognize that interim guides to better management are needed, and that suitable techniques must be developed for estimating how much water is really surplus to the water economy of coastal plain drainages. Knowing this, it would be a relatively simple matter for engineers to design adequate drainage systems to remove the water. Approaches include study of the water balance of selected watershed units; and evaluations of drainage-soil-tree growth relations at selected index locations. These observations, combined with long-term weather records may give us important clues to the response of specific wetland sites. In any event, some early answers, however empirical, will be sought to guide new programs and help wetland managers avoid costly enterprises which could be highly damaging to the Southeast's water resources, timber sites, and game habitat.

Measurements of oxygen diffusion rates and tree growth indicate whether controlled drainage has reduced water levels enough for best loblolly pine diameter growth in wetland forest bay in the South Carolina coastal plain.