

# Organic Soils

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## Introduction

Eastern North Carolina has as many as 1.5 million acres of peat and muck soils. There are many more acres of land with enough organic matter in the topsoil to influence the use of the soils. These soils occur almost exclusively in the tidewater and lower coastal plain regions. The flat topography, impermeable subsurface layers (aquatards), large distances between streams, and high rainfall combine to create conditions under which organic matter can accumulate.

Organic soils (histosols) do not exist at the latitude of North Carolina without poor drainage. They are, by definition, wetlands in their natural state and are known as swamps, pocosins, bays, marshes, and bogs. Some even go by the old English designation of “desert.”

It is estimated that there were over 2.2 million acres of pocosins in the state in 1962. Many of these soils have been modified for agricultural, forestry, or other uses. There is a long history of attempts to “reclaim” such land, but activity has declined substantially in recent years due to wetland regulations.

## History

The first European settlers entered northeastern North Carolina by land from tidewater Virginia. They viewed the wetlands as wastelands and a hindrance to land development. At the time, all agriculture was slash and burn, with its constant demand for fresh land. The Europeans did not have the equipment and technology to convert the swamps to agricultural uses or to effectively utilize the forest resources of the wetlands.

By the early 1700s, the Great Dismal Swamp of North Carolina and Virginia was being utilized for timber, mainly cypress and juniper. Much of the timber was converted to shingles where the trees were felled. Shingles were then carried out of the swamp by hand, mule cart, or barge.

Also by the early 1700s, there was a shortage of agricultural land in the region. Even though there was interest in clearing swamp land, little was accomplished. In 1763, just

before the American Revolution, George Washington and his associates acquired 40,000 acres in the Dismal but were never successful in developing swamp land for agricultural use. However, they did dig a canal at Lake Drummond to facilitate logging, and this canal (called the Washington Ditch) is generally considered to be the oldest canal still in use in the United States.

Less formidable, more easily drained wetlands were being developed even earlier around Lake Mattamuskeet. Soon after 1700, the English government allowed settlers into the south Albemarle and Pamlico regions. The Hyde County area was settled during this time and named in 1711. Hyde was designated a county in 1738 and is the oldest surviving county in North Carolina.

By 1711, records show that all desirable land along navigable streams had been claimed, and there was pressure to find new land. The settlers naturally utilized the well-drained land first but, undoubtedly, began to make use of more poorly drained very early.

The Revolutionary War changed land ownership and use patterns considerably. The English government had controlled land ownership through land grants and other means. After the Revolution, all unclaimed lands became state property, and the state was interested in developing as much of it as possible.

Essentially the only industry and the only outlet for investment in America was land. Citizens of the new nation of the United States were not allowed to invest in English-controlled countries or territories. Land was wealth, and land investment and speculation were very popular.

Veterans of the Revolutionary War were given land by the newly formed government. The western lands of Tennessee, Kentucky and Ohio were attractive but isolated from markets and subject to hostile Indian attack. Some investors decided to turn their attention to the only remaining undeveloped land in the east—the swamp lands. Rice was being cultivated in the coastal zone from Virginia south and was an attractive crop. However, swamps were believed to produce malaria, and swamp drainage was believed to improve the public health.

Several ambitious projects were started in the larger swamp lands at about the same time immediately after the Revolutionary War. One was the digging of the Dismal Swamp Canal. The other was the Collins Plantation project in what was later to become Washington County.

The Dismal Swamp Canal was intended to open water transportation between the port at Norfolk and the inland waters of northeastern North Carolina. North Carolina had a treacherous coast with poor and shallow inlets to the ocean. Nor really good ports existed.

Digging of the canal began at each end in 1793. The canal was essentially completed in 1805, but there were no locks. Locks were added by 1812, providing 19 feet of lift for

passage through the middle of the swamp. The Great Dismal, like many coastal swamps in the Tidewater area, is an elevated pocosin-type swamp that is higher in the center than on the edges.

The canal was a limited success for water transport, but it had the unexpected effect of draining swamp land to the east of the canal. The spoil bank and the canal itself intercepted the eastward flow of water and diverted it, making the land relatively easily drained. This land was very rapidly utilized for agriculture. With additional drainage over the years, it is estimated that only one third or less of the original swamp remains today.

The other major development in organic soils was at Lake Phelps, at times called Lake Scuppernong. The lake was not known to exist by Europeans until 1755, even though Indians had utilized it for over 4,000 years. In 1784, a group of businessmen from Edenton, led by Josiah Collins, received permission to drain the lake from the North Carolina General Assembly. Lake drainage was a common practice for developing agricultural lands in other parts of the world, including the Netherlands and England.

The Collins group acquired rights to nearly 170,000 acres of land lying from the Alligator River west to the area around Lake Phelps. The lake was not drained, however, because a survey revealed that the lake was higher than the Scuppernong River and could supply water power, irrigation, and water transport. Slaves were procured from Africa, a canal was dug from the lake to the Scuppernong River, and land was cleared north of the lake for farming. So far as is known, this project was the first in North Carolina to use deep organic soils on a large scale.

Records indicate that the cleared land was forested in cypress and had over three feet of organic surface with numerous buried cypress logs. Land clearing was very laborious. Trees were girdled and left to die and then to fall on their own. They were then cut into lumber on the plantation. Lumber sales were a significant part of the plantation's income.

Over time, Collins became the sole owner of this plantation, called Somerset Place. Rice was the first crop grown, but problems with malaria led to a shift to corn and wheat. Other land developers soon followed, notably the Pettigrew family on an adjacent plantation called Bonarvia.

The apparent success of these developments attracted widespread attention from the agriculturists of the time. One of the best known and most active was Edmund Ruffin of Virginia. Ruffin farmed near Richmond but had some experience with organic soils along the James River. He was very interested in sustainable production.

Edmund Ruffin was the first person to argue that the black soils of the South were peat lands similar to those of Europe. At the time, European scientists rejected the notion that organic soils could exist as far south as Virginia and North Carolina. Their experience was mainly with peat bogs, which owed their existence primarily to cool climate. Ruffin republished European articles on peat soils in his agricultural journal, the *Farmer's Register*.

Ruffin was an astute observer and saw that black soils subsided when drained. When he visited Somerset Place in 1839, he found an estimated 5,000 acres of land being farmed by five or six proprietors. When Ruffin revisited the area in 1857, he found evidence that at least three feet of organic surface had been lost since the field ditches were dug. Ruffin published his findings in his book of 1861 and argued at length for the reality of subsidence.

Ruffin also described land abandonment in Hyde County due to loss of land elevation near the Pamlico Sound. Land development in wetland soils had been ongoing for many years in Hyde County. By 1839, Ruffin estimated that there were 32,000 acres of land in cultivation around the lake. In 1861, Ruffin described this land as “. . . the most extensive and important of all the drained and cultivated swamp lands on the Atlantic coast, and also the oldest of such improvements.” He included soil profile descriptions and soil chemical analyses in his book.

During the time period preceding the Civil War, the state of North Carolina tried vigorously, but unsuccessfully, to develop other swamp lands. The Board of Internal Improvement promoted swamp drainage from 1819 until 1826. In 1825, the state Literary Fund was established to support public education. All remaining state-owned swamp lands were turned over to the Board to be used to raise money for public education.

The state began surveying the swamp lands in 1827. Activity greatly increased in 1836 after the state received a windfall payment as their share of the monies realized from the sale of western lands. The state received over \$1,400,000, paid off the state debt of \$400,000, set aside \$100,000 for current expenses, and richly endowed the Literary Fund. At the time, these were huge amounts of money.

The Literary Board set aside \$200,000 for swamp land drainage. Between 1838 and 1842, it had canals dug at Pungo Lake, Alligator Lake, and Lake Mattamuskeet. Over the next 10 years, the Board tried to sell land but sold very little and at very low prices.

Later, in 1855, a canal was dug into Open Ground Swamp in an attempt to open that land to development. Ruffin visited Open Ground in 1856 and proclaimed it totally worthless for agriculture. The Civil War ended this era of land development and bankrupted both the state and the plantation economies of the larger farming operations.

### **Rich and Not-So-Rich Soils**

The problem of land development during the first half of the 1800s was that all black soils are not created equal. In fact, this problem was still manifested even into the 1970s and 80s. Compounding the problem was the lack of understanding of soil fertility and chemistry.

Some soils were very productive, but others were not, and the reasons why were not clear. In the early 1800s, Ruffin and others wrote at length about the richness of the

swamp soils and their continuing fertility. This was a time when agriculture was still based on slash and burn, and commercial fertilizers and limes were not understood, nor were they available.

Soils around Lake Mattamuskeet were described as productive for as long as 70 years, which was unheard of on upland soils of the time. The main reason for the continuing productivity was most likely the release of nutrients from the decay of the organic soil itself, especially phosphorus.

The main cropping pattern was continuous corn intercropped with peas. Hogs were fattened on the peas and waste corn. The corn received nitrogen from the peas and phosphorus from decay of organic matter. Many nutrients, notably potassium, were recycled in this manner. In addition, hog manure provided some nutrients. This system was apparently sustainable for the relatively low-yielding corn of the time.

Another very important factor contributing to the fertility of these soils was the higher-than-expected base saturation of some of the underlying mineral soils of Hyde County. These parent materials are quite young and less highly weathered than more upland soils. This circumstance could have contributed to the long-term sustainability in the absence of lime use.

The cropping system at Somerset Place was different, with a corn-wheat-fallow rotation. In addition, Ruffin had recommended lime use, and some lime was being applied at Somerset Place. Ruffin is credited with realizing the need for lime on the acid soils of the south, and he published a book on the subject.

The agricultural successes in some places and failure in others prompted the State of North Carolina to hire Edmund Ruffin as a consultant in the 1850s and to commission a book, which he titled *Sketches of Lower North Carolina and Similar Adjacent Lands*. This book describes agriculture in several areas of the state, including Edgecombe County, the area north of Albemarle Sound, Lake Phelps, and Lake Mattamuskeet. The book makes recommendations for agricultural improvement in each area. The book also contains sections on forestry and on the barrier islands.

Ruffin's book was published in 1861 by the Institute for the Deaf and Dumb in Raleigh and was immediately forgotten due to the trauma of the Civil War. Ruffin himself was never able to accept defeat in the war and committed suicide at its conclusion. This aspect of his life has tended to overshadow his monumental contributions to agriculture of the time.

Ruffin's book includes some of the first, if not the first, soil profile descriptions of wetland soils in North Carolina as well as soil analyses. His greatest contribution was his unusually clear interpretation of what he observed in the field. However, he was a product of his time, and the introductory chapter of his book attempts to explain southeastern geology in light of the great flood of the Bible.

## **After the Civil War**

If the war had not occurred, the science of soils would likely have advanced more quickly. Soil processes were still a mystery and would remain so for generations to come. Trial and error had shown that all swamp lands were not equally productive, but the reasons were not understood.

In 1867, W. C. Kerr, state geologist wrote that “The inevitable conclusion . . . is that the swamp lands are simply vast beds of peat, the only portions of them having any agricultural value consisting of a few belts and ridges.” Distinction was made between “hard swamp” (shallow organic) and “deep swamp” (deep organic), and there was general agreement that so-called “juniper lands” were worthless.

There were some successes. General Blount of Beaufort County, who owned 50,000 acres, was described in 1860 as being a “. . . successful pioneer in subjugating the swamps.” As late as 1896, though, the State Board of Agriculture wrote, “The character of Hyde County soil has never been understood. The cause of its fertility has never been explained . . .” The board also wrote, “Lands in Hyde County, cultivated for a period of one hundred years continuously in corn, without the application of manure, show no apparent loss of fertility.”

The main activity in swamp lands after the Civil War was logging. Northern entrepreneurs, many of whom came south with the Union Army, began to log the swamps. At the time, most of the state’s forested swamp land was still in virgin growth but heavily modified by fire.

The Great Dismal Swamp was the most highly modified swamp land. Drainage by the Dismal Swamp Canal and devastating fires had repeatedly denuded the swamp and burned off a considerable amount of the organic surface. The Dismal as it is today is not the same swamp as existed in the late 1700s.

Fires were common throughout the east after the arrival of the Europeans. Indians had used fire to clear land and open up the forest for game, and settlers continued the practice to control pests and to improve grazing. Fire had devastated the long leaf pine lands used for naval store production, and fires continued to modify the vegetation of the great swamps and to remove organic surface. The records of the Pettigrew family indicate that great swamp fires were a common occurrence. Early records indicate that the drainage projects of the 1830s, 40s, and 50s resulted in more rapid loss of organic surface.

The forests of the north were, for the moment, depleted and lumber was needed for everything from building construction to roof shingles, tubs, pails, barrels, water tanks, and so on. By the end of the 19th century, the majority of the state’s swamp lands had been logged, and timber companies were moving on or going out of the logging business. There was no reforestation, and there was a continuing demand for agricultural land.

Few fertilizers and little lime were used in the state, and the black soils still held out the promise of productivity. Cut-over swamp land began to be promoted for development. European settlers were wooed with promised of land. Many came to places such as Terra Cecia and New Hanover and Pender counties.

## **New Era**

Large amounts of former timber company land had been acquired by the railroads in order to obtain their railroad rights-of-way. In the western United States, railroad companies had been given land as an incentive to build railroads, and there was a history of land promotion and sales. In North Carolina, the Norfolk and Southern acquired the lands of the Roper Lumber Company and began to promote land sales actively.

The Norfolk and Southern was aware that many questions were unanswered concerning successful agriculture on these lands and, in 1912, donated land for the establishment of the Blackland Test Farm at Wenona in Washington County. This occurrence followed the passage of the state Drainage Act in 1909. For the first time, landowners could cooperatively drain lands in a logical manner on an area-wide basis. By 1911, some 53 drainage districts had been established or were being established covering over 700,000 acres of land.

One of the first drainage projects was at Terra Cecia in Beaufort County. The Wilkinson brothers had logged the land and then developed it for agriculture. By 1928, it was estimated that over 500,000 acres of land had been drained in the coastal plain by drainage districts.

The Blackland Test Farm may have been the first research station in the United States devoted to organic soils research. Research was conducted with cattle, horses, and various crops. Attempts were made to drain the land with tile drains. Fire was a constant problem for the entire time the farm existed. Unfortunately, crop yields were consistently low, and little progress was made in that area.

The main agricultural problems appeared to be in the areas of insect control (billbugs on corn), liming, plant nutrition, and root zone development. There were no effective chemical controls for billbugs, which could totally wipe out a corn crop. Liming was not well understood; rates were usually too low; and the quality of the lime was poor. Because of subsidence, root zones had to be deepened over time. In addition, the organic soils were so acid, woody, and wet below the tilled top few inches that roots did not grow downward, and crops were often injured by drought. However, one of the greatest limiting factors, and a point of embarrassment for soil scientists, was the failure to recognize copper as an essential nutrient.

The need for copper on organic soils was discovered in Florida in the mid 1920s through “shotgun” nutrient experiments in the Everglades. The researchers there knew

that organic soils had problems, so experiments were designed in which essentially every chemical available was applied to the land. The response to copper stood out, and by 1927, a number of growers in the Everglades were applying copper even though the essentiality of copper was not established scientifically until 1931.

For whatever reason, tests with copper in North Carolina were not impressive, probably because yields were low due to other problems. In 1936, Willis and Piland were recommending against the general use of copper. There was a theory of “toxic iron” in vogue among some soils researchers, and Willis and Piland concluded that any beneficial effect of copper was simply a catalytic effect in reducing soluble iron in the soil. As a result, successful use of organic soils was delayed for many years.

Because of the many problems, the state gave up on organic soils in the early 1940s and moved the operations of the Blackland Test Farm to the present location of the Tidewater Research Station in 1943. There were no organic soils at that location, and the name changed to reflect the change in emphasis of the station. Over the years, there were some people who noticed better crop growth under copper transmission lines, but the issue of copper deficiency was not addressed intently until the 1960s. The work of Roger Hanes, Robert Patterson, Eugene Younts, and Carl Schauble finally established copper as an essential part of organic soil agriculture.

The use of copper was a major step forward, but people were realizing that organic soils differed from mineral soils in many other ways. There were issues of drainage, other nutrients, insect control, weed control, subsidence, and liming. In general, the deeper organic soils contained large amounts of undecayed wood that made clearing and development very difficult.

The chemistry of organic soils differs from that of the mineral soils in the state. For example, organic soils are low in aluminum and can support crop growth at much lower pH values than mineral soils can. Also, the same aluminum factor changes soil test phosphorus interpretation. These are only two of the differences now recognized.

The realization of the unique needs of organic soils, along with a boom in land development in the east, led the legislature to establish a position in organic soils research and extension and to place the position at the Tidewater Research Station in the 1960s. The first blackland soil specialist was J. R. Woodruff. After he left to accept a position at Clemson University, Steve Barnes was hired in 1964. When Steve left to work with First Colony Farms in 1974, I — J. Paul Lilly — was transferred to Plymouth from Castle Hayne to fill the position. By the time I retired in 1995, the emphasis had changed considerably from land development and crop production to environmental and sustainable concerns. Carl Crozier is now located at the Vernon James Research and Extension Center with responsibilities in organic soils.

Since the 1960s, new extraction techniques and soil test interpretations have proven that organic soils cannot be treated as mineral soils. In general, recommendations

for lime and nutrients are more reliable than in previous years. There are still areas where more precision is needed, and research continues.

## **First Colony Farms**

By far the largest and most ambitious development of organic soils was by First Colony Farms, beginning in 1973–74. Malcolm McLean acquired some 376,000 acres of mostly swamp land in Washington, Tyrrell, Hyde, and Dare counties with plans for developing it into agricultural lands, pastures, forest lands, and wildlife areas. Much land was developed, but large-scale agriculture proved to be both expensive and difficult. The farm was converted to a tenant system within a few years.

Plans to develop some lands were frustrated by evolving wetland regulations. For example, ambitious plans for Dare and Tyrrell counties were eventually abandoned after extensive work on an environmental impact statement. In another case, attempts to strip some of the undesirable surface organic soil and use it for fuel encountered the same opposition.

Ultimately, First Colony Farms sold and traded most of the land. One tract in Dare County was acquired for bombing ranges. Another large tract in Dare and Tyrrell counties was acquired by Prudential Insurance and eventually formed the basis for the Alligator River National Wildlife Refuge. Some land was sold, and a remnant of about 100,000 acres formed the basis for Pocosin Lakes National Wildlife Refuge.

## **Peat Mining**

In the late 1970s, First Colony Farms conducted experimental peat mining south of Lake Phelps in the vicinity of Allen Road in Washington County. The energy crisis of the 1970s, as well as tightening environmental regulations on sulfur emissions, had resulted in renewed interest in using organic soils to fuel power plants. The state commissioned Dr. Roy Ingram to conduct a survey of minable peat. His report was issued in 1987.

First Colony Farms abandoned their peat mining attempts, but other projects were proposed in Hyde and Pamlico counties and perhaps in other places. At present, the only peat mining in progress is to obtain peat for use in soil mixes. The “peat” of North Carolina is less desirable for horticultural purposes than peat moss from the north, but it is nearby and abundant.

One reason for the interest in mining peat is that fact that organic soils of North Carolina are, for the most part, underlain by mineral soils that are often better for agricultural production than the overlying organic. Woody colloidal muck soils are very difficult to develop and have long-term limitations for crop production. In addition, no land in North Carolina has been abandoned due solely to loss of organic surface in contrast

to south Florida where the organics are underlain by rock and abandonment is a real concern. In the past, land developers even encouraged the removal of the overlying organic soil by fire in order to uncover the more easily managed mineral soil.

## **Classification**

Until the 1960s, soil surveys generally gave very little information about organic soil areas. They were usually designated as “swamp” or “peat” and that was thought to be sufficient. However, the great increase in land development starting in the 1960s led to a need for more detailed information. Work by J. W. Dolman, S. W. Buol, and others established basic characteristics of organic soils.

The researchers of the time recognized that one important characteristic of many organic soils of North Carolina was the presence of colloidal muck. Colloidal muck soils are difficult to drain and develop because they are sticky, plastic, impervious to water movement, and very acid. They must undergo a “ripening” process before they are suitable for agriculture. When drained they undergo irreversible drying and may develop poor water-holding characteristics. Deep colloidal muck soils are very difficult to farm successfully.

By the 1970s, a system of organic soil mapping based on organic thickness, nature of the organic material, and characteristics of the underlying mineral soil was evolving. Washington County was mapped in the late 1970s and was the first county mapped with this degree of detail. Even so, soil maps are still less precise than on most mineral soils. There are many inclusions, and the variability of the underlying mineral soils makes mapping more difficult. Also, soil surveys of organic soils are confounded by the fact that the surface thickness is subject to change. Long-term subsidence or more rapid loss by fire can change the soil series name when depth of the organic layer is used as a mapping criterion.

## **Present and Future**

Evolving wetland regulations have essentially ended clearing of organic soils for agriculture. In addition, state and federal governments have acquired large areas of these soils for wildlife refuges, bombing ranges, and other purposes. Other areas are managed for forestry. Many developed areas of organic soils are in environmentally sensitive areas and are under fire for environmental reasons.

Agriculture will likely continue in areas already developed but will not expand. The cleared organic soils will inevitably subside and become lower in organic matter. Over the years, a very large portion of the original organic surface of the eastern swamp soils has been lost due to fires and drainage. The deep organic soil of the Collins Plantation north of Lake Phelps no longer exists. I would estimate that as much as one half of all the original

organic mass of the state has been lost. Farmed — and some forested — areas will continue to lose organic surface because of drainage. Some areas, most notably Pocosin Lakes National Wildlife Refuge, are being managed in an attempt to stop or reverse the loss.

The organic soils of North Carolina have a long and colorful history. In comparison with most mineral soils, they are still not well known. They have stimulated many dreams and have frustrated many potential users. In many ways, they have been North Carolina's frontier for the last two centuries, but they have defied easy conquest. Even after a century of soils study, they remain in many ways a mystery.

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