

## Wetland Soils

This is the third and final article in a series on what makes a wetland a wetland. The previous two, on wetland hydrology and wetland plants, appeared in the July '93 and Sept '93 newsletters, respectively.

Perhaps one of the reasons I saved this topic for last is that it is my weakest area of understanding, although I hope to study this fascinating subject some time.

Soils are very complicated substances, and are formed through a combination of geological, biological, and chemical processes. It takes a great deal of time for soil to form (a rule of thumb is about 500 years for every inch of topsoil), and our current rate of soil loss will eventually lead to a very critical situation, a crisis as real and as threatening as any other environmental problem we currently face. Thus the function of wetlands in helping to control soil loss is crucial not only because it protects river habitats from turbidity (sunlight cannot penetrate cloudy water, so plants die or are stunted, and predators' ability to hunt is reduced) and sedimentation (farm runoff smothers plants, covers sand and gravel bars and other areas which provide critical spawning habitat for fish and other species; soil fills in pools, and interferes with the life processes of insects and other invertebrates which are important in the ecology of streams), but also because wetlands help conserve soil resources.

Most soils have two components - minerals, derived from the erosion of rock, and organic materials, which come from the remains of plants and animals. Through the biological and chemical interactions between these two components, nutrients which are normally locked up in the minerals are released as nutrients and cycle through the biological and chemical systems at work within and above the soil layer. So we get different soil layers, or *horizons*, which differ in their physical and nutritive qualities, depending on what sorts of interactions are taking place in them. There is sometimes a waterlogged layer called *glei* or *gley* in some wetland soils; it is near the surface in permanently saturated soils, and somewhat lower in periodically wet soils.

Many wetland soils in our area are clays or silty loams. The origin of these materials is ultimately from the micas and feldspars included in the granites, gniesses, and schists of the ancient Appalachian Mountains that were eroded away and whose sediment filled in the ancient shallow sea that covered Ohio from about 550 to around 300 million years ago (for most of the Paleozoic Era). These sediments were piled thousands of feet thick and were compressed into the shales, siltstones, and sandstones that are now exposed in northeastern Ohio (there were also limestones formed early in this process which lie now in deeper layers and which, because of the eventual buckling of these layers and their subsequent erosion, now lie exposed in various places in western Ohio, including the islands of Lake Erie's western basin). As these sedimentary rocks have eroded they have formed the basic mineral materials for our soils. But more to the point in northern Ohio, the advent of the glaciers about two million years ago caused the weathering and movement of great quantities not only of these sedimentary rocks but also of granitic continental bedrock material from the Canadian sheild to the north, all of which was deposited over glaciated Ohio as a material called glacial till, or morain, and which forms the basis for soils in these areas. Because these materials were often carried by water out of the glaciers or along stream systems as the glaciers were melting, they were sorted by particle size by this moving water which, as it slowed down, deposited larger particles first (forming sandy soils) and then smaller particles (forming silty and clay soils). Furthermore, in areas like northern Lorain County which were covered by Lake Erie as it was being formed, a great deal of sorting took place along zones which were roughly parallel to the various shorelines. This sorting gave rise to the extensive areas of silty and clay loams which now comprise the wetland soils of these areas, and explains why 90% of northern Lorain County (that is, the part that was once lake-covered) was originally wetlands - and still would be if left to its own devices. Only the old sandy beach ridges left behind by the successive shores provide substantial stretches of well-drained, non-wetland (non-hydric) soils.

These silty and clay soils, with their small particle sizes and often disc-like structure, do not lend themselves to good drainage - especially vertical movement, or percolation, of water through them. Thus when water does reach them, through groundwater movement or from precipitation, it tends to stay there for extended periods. And it is the presence of water and the attendant absence of air which creates the conditions known as hydric soils, which tend to be dark in color, black or gray rather than reddish, and which tend to have unpleasant

odors, often sulfurous. These conditions are set by chemical interactions, and the secret to understanding them is something called *redox potential*. And my understanding of this situation is rudimentary at best; but hold on - here we go....

Let's think of the state of affairs down in this mucky mud as a party. Now, many of the nutrients involved in biological processes are metals - that is to say, they are *ionic*. These ionic party animals are willing to dance and mingle with their buddies in the mud (biochemicals and their pals), but they are kind of demanding party particles. You see, they have these sort of excess electrons in their outer orbits which they don't really like, and as long as they're stuck with them these ionic dudes are real stick-in-the-muds (so to speak). However, whenever they can find someone to babysit these miserable electrons they're willing to really mix it up, and all kinds of groovy chemical interchanges can take place which really help biological processes in plants and animals. Normally, there are babysitters available in the form of oxygen atoms, which simply *adore* electrons and are happy to take care of them as long as their arms aren't full (their outer orbits). When oxygen is present, then, there is high redox potential, and a fairly fluid situation as far as chemical reactions are concerned.

But these oxygen atoms are present as part of the air spaces between the soil particles, and when the soil is soaked with water, the oxygen says, "Gee, I'd love to stay, but I'm being chased out of here by this water, and I can't take your electrons with me, dear Fe, Mg, Na, K, P, et al; sorry, but you'll have to take them back." And the ionic elements are stuck with these electrons, and pout and glower in the corner, and redox potential goes down, and the chemical party quickly downshifts several gears. And times are hard for any plants trying to eke out a living in this mess, because there aren't many ionic nutrients available. And the ionic substances change oxidation states and form the compounds that give these soils their characteristic colors and odors; for instance, the iron doesn't form the iron oxide -  $\text{Fe}(\text{OH})_3$  - that makes most soils reddish, but instead forms  $\text{Fe}(\text{OH})_2$  instead, which imparts a gray-green color that is common to many wetland soils. This process is what is called *gleying* (see above).

Such conditions preclude the survival of many or most species of plants which are adapted to drier soils, and have led to the evolution of some of the adaptation of wetland plants discussed in the earlier issue of the newsletter.

There are some hydric soils which are almost entirely organic, called peats. These soils are involved in bog formation and ecology, and will be dealt with to a certain extent in an upcoming article on bogs.

I hope I have not murdered the topic of wetland soils beyond resurrection. There is much of the chemistry of hydric soils which I have not touched on - for example, the transformations of nitrogen, sulfur, carbon, et al. I refer the reader interested in these and other aspects to *Wetlands*, by William Mitsch and James Gosselink (Van Nostrand Reinhold, New York, 1986).