Soils Station Learning Objectives

I. SOIL CONCEPTS

A. Definition of soil -- There can be many uses of the word "soil", depending upon the context. For example, soil can be thought of as an engineering material for road construction, as dirt on clothing, as a mixture of ingredients for growing potted plants, or what the farmers plow every spring. For the purposes of the Envirothon, "soil" is defined as "the collection of natural bodies on the earth's surface, in places modified or even made by man of earthy materials, containing living matter and supporting or capable of supporting plants out-of-doors." Soil is thus considered both a product of nature and a critical part of natural systems. This definition also allows soils to be collectively grouped into a classification system, as used in making soil surveys.

B. Soil development -- a process that occurs over time (a very, very, very long time).

1. Soils "begin" as parent material, then the process of weathering occurs.

2. Weathering eventually causes a differentiation into distinct horizons.

3. A soil and its profile show the effects of five soil-forming factors:

   Parent Material (geological or organic precursors to the soil)
   Climate (primarily precipitation and temperature)
   Living Organisms (especially native vegetation, microbes, soil animals, and human beings)
   Topography (slope, aspect, and landscape position)
   Time (the period of time since the parent materials became exposed to soil formation)

II. SOIL CHARACTERISTICS

A. Composition -- About a 50%-50% mix of solids and open space; voids may hold water or air.

B. Texture -- refers to soil particle size, sand = 2 to 0.05 mm; silt = 0.05 to 0.002 mm; clay = <0.002 mm. Soil texture influences water storage & movement, fertility, and workability or "tilth". "*Loam*" is a name for one of various mixtures of these three particle sizes.

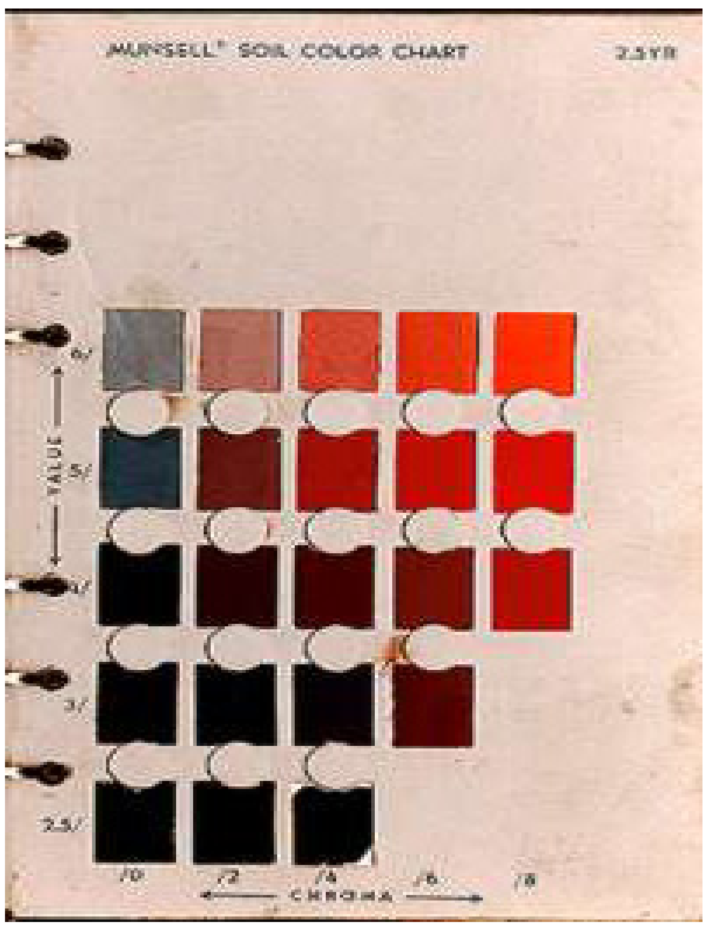
C. Structure -- the arrangement of soil particles into aggregates, which may have various shapes, sizes and degrees of development or expression. Soil structure influences aeration, water movement, erosion resistance, and root penetration. Common types of soil structure are as follows: Blocky (the soil breaks in to small angular or sub-rounded aggregates), Prismatic (the soil breaks in vertical columns or prisms), Platy (the soil breaks into flat, sheetlike “plates”), and Granular (the soil is loose and single grained, most often seen in sands and surface horizons).

D. Slope -- the inclination of the ground surface. Slope influences runoff of rainfall, soil erosion, stability, and machinery operation (a good way to measure slope is the number of feet of rise in 100 feet of run).

E. **Color** -- Soil color often indicates soil moisture status and is used for determining hydric soils. Often described using general terms, such as dark brown, yellowish brown, etc., soil colors are also described more technically by using Munsell soil color charts, which separate color into components of hue (relation to red, yellow and blue), value (lightness or darkness) and chroma (paleness or strength).

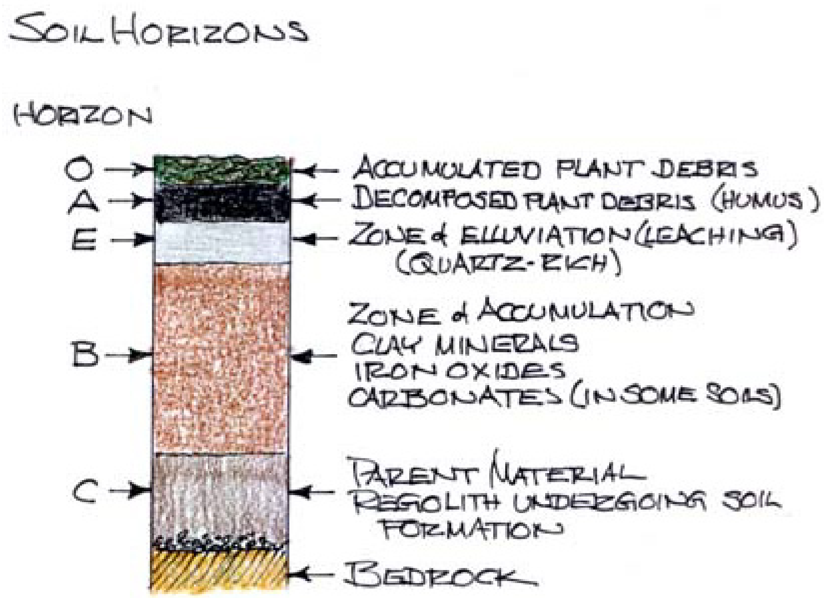
In this example of a Munsell Soil Color Chart the 2.5YR hue page is shown. The Value is read on the left margin from top to bottom and the Chroma is read at the bottom from left to right.

Practice: Pick out which color chip is the following color:
2.5YR 5/8



F. Chemistry -- A complex subject within soil science; the most important subjects are:
pH -- The acidity or alkalinity of soils, which affects plant growth and soil fertility.

G. The soil profile -- A vertical cut that exposes soil layering or horizons. Horizons are formed by combined biological, chemical and physical alterations. A, B, and C symbols are used to describe the topsoil, subsoil and substratum, respectively.



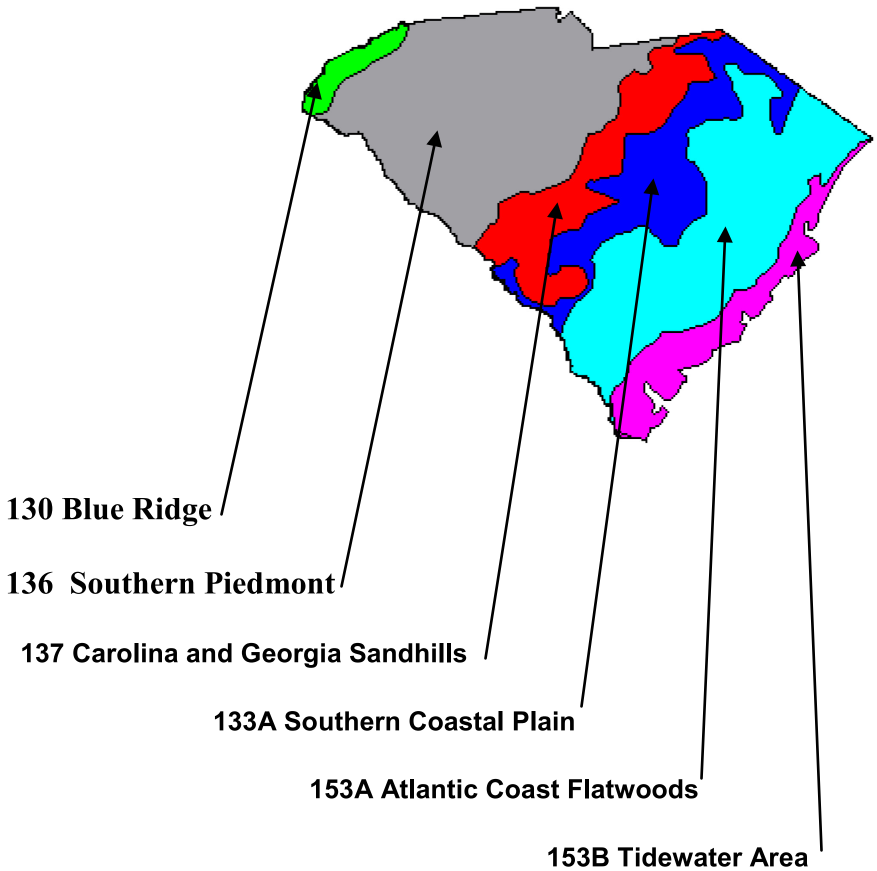
H. Permeability -- The ability of a soil to transmit water or air. Faster or greater permeability often occurs in sandy or gravelly soils due to large pore spaces. Slower permeability typically occurs in finer textured clay soils, or compacted soils with little structure.

I. Drainage -- The rate in which water is removed from a soil. Drainage influences most uses of soils, whether for agriculture, silviculture or urban. Classes of soil drainage are those found in soil survey reports, such as well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. Soil color patterns (such as mottle patterns or redoximorphic features) often indicate soil drainage class. Most productive agricultural soils in NY are well drained or moderately well drained. By contrast, hydric soils are poorly or very poorly drained. A soil's natural drainage rate can be significantly increased by subsurface "tile" drainage.

III. SOIL SURVEY MAPS

A. Soil Series -- A level of Soil Taxonomy, the soil classification system used in making soil surveys. One example is the "Pelion Series" that you can find at the Sandhills Research Station.

Major Land Resource Areas (MLRA's) in South Carolina.



IV. SOIL SURVEY INTERPRETATIONS

Become familiar with the interpretive tables within a relatively modern soil survey (since about 1970). These commonly include soil suitability for uses such as:

A. Agriculture – crops and pasture

B. Woodland Management and Productivity

C. Building Site Development

D. Construction Materials

E. Sanitary Facilities

F. Recreation

G. Wildlife

V. EROSION AND SEDIMENTATION

These are separate processes, but think of them as occurring together, since once soil is eroded it will eventually become sediment somewhere.
A. Erosion is the "wearing away" of land by the action of water, wind or ice. It is a natural, geologic process, but often is greatly accelerated by man's activities.

B. Sedimentation is simply the act of depositing sediment (soil particles).

VI. HYDRIC SOILS

A. Introduction

Most of the soils in the U.S. are aerobic. This is important to our food, fiber and forest production because plant roots respire (that is, they consume oxygen and carbohydrates while releasing CO_2) and there must be sufficient air -- especially oxygen -- in the soil to support root life. Air normally moves through interconnected pores by forces such as changes in atmospheric pressure, turbulent wind, the flushing action of rainwater, and by simple diffusion.

In addition to plant roots, most forms of soil microorganisms need oxygen to survive. This is true of the more well-known soil animals as well, such as ants, earthworms and moles. But soils can often become saturated with water due to rainfall and flooding. Air travels very slowly (some 10,000 times slower) when soil becomes saturated with water because there are no open passageways for air to travel. When oxygen levels become limited, intense competition arises between soil life forms for the remaining oxygen. When this anaerobic (no oxygen) environment continues for long periods during the growing season (March to November in SC), quite different biological and chemical reactions begin to dominate, compared with aerobic soils. In soils where saturation with water is prolonged and is repeated for many years, unique soil properties usually develop that can be recognized in the field. Soils with these unique properties are called Hydric Soils, and although they may occupy a relatively small portion of the landscape, they maintain important functions in the environment.

Why are hydric soils important?

The environmental conditions that create hydric soils (water remaining at or near the soil surface for extended time periods during the growing season) also favor the formation of many types of wetlands.

Wetlands play important roles in the environment, some of which we have only begun to understand and appreciate. Groundwater is recharged or restored by entering some wetlands; however, in some soils it is probably just as common that groundwater discharges (exits) to become surface water through wetlands. During periods of heavy rains or melting snow, flooding can present a real danger to people and property; but because wetlands occupy depressions in the landscape they can trap and thereby detain flood waters, thus reducing downstream damages. Wetlands are often difficult places for humans to physically move around in, so most people avoid them; this is one reason that they provide critical habitat for many rare and endangered species of flora and fauna. Because wetlands often occur in relatively low elevations, they commonly receive polluted waters from man's activities on higher, drier ground; wetlands can effectively filter these waters and retain excess nutrients. Wetlands are also valuable for recreation, including nature appreciation, hunting, fishing, canoeing, etc.

Due to historical and present development pressures, the number and extent of wetlands has been greatly diminished (by about 50%!) in the United States since the time when the first white settlers arrived. Within the last 10 to 20 years, political debates and new regulations have focused on methods to conserve and rehabilitate wetlands. Because they are formed in association with wetlands, hydric soils can be used to identify the presence and boundaries of wetlands. In fact, hydric soils were defined so that they help identify wetlands. Along with unique vegetation and hydrology, hydric soils are one of the three required indicators for wetland identification. As a result, hydric soils are a very important issue in land management and land planning across the United States due to their role in the identification of wetlands and their function in wetland ecology.

C. Defining hydric soils

Various government agencies are involved with wetland protection. The US Department of Agriculture - Natural Resources Conservation Service identifies and protects wetlands that have been used for agriculture. The US Army Corps of Engineers protects wetlands of practically any size. With the help of soil scientists, they have defined hydric soils, which they consider to be those soils which are developed under sufficiently wet conditions to support the growth and regeneration of hydrophytic vegetation:

A hydric soil is a soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part.

This definition can be broken up into three component parts:

1) The soil is saturated, flooded or ponded. Saturated conditions are often the result of a high water table. Flooded conditions are produced by overflowing streams, runoff from higher surrounding slopes or from high tides that inundate coastal wetlands. Ponded conditions are produced by higher water inflow than water outflow from a closed depression.

2) Wet conditions occur during the growing season. This is the period of time when the soil is above 5oC or approximately 40oF. Above this temperature, biological activity is significant and many plants are able to grow.

3) The soil is wet long enough to develop anaerobic conditions in the upper part. The vast majority of soil biological activity occurs at or near the soil surface. When the soil is biologically active, a few weeks of wet conditions is usually adequate to use up available oxygen; however, this can be affected by many factors (e.g. soil and water temperature, the oxygen content of the water, soil organic matter content, soil permeability, etc.). The important thing is that anaerobic conditions result often or long enough to support mostly hydrophytic (water-loving) plants. Further, much of the biological activity in soils is engaged in the decomposition of organic matter either deposited within or on the soil surface. When oxygen is not available to the soil flora and fauna, biological activity is greatly reduced. As a result, organic material builds up in the soil. Additionally as a result of the wet, anaerobic environment the soil takes on a characteristic reducing condition and undergoes chemical reactions that are different than non-hydric soils.

D. Hydric soil properties and indicators

The physical, chemical and biological properties which make hydric soils recognizable are the result of complex bio-geochemical processes occurring over many years.

Hydric soils usually have a water table, or the top of a zone of saturation, within one foot from the soil surface during the growing season. This shallow water table excludes oxygen and so creates a reducing environment, especially in the upper part of the soil profile. As a result, mostly hydrophytic plants proliferate -- such as rushes, cattails, and sedges.

Most soils, including hydric soils, are dominantly composed of minerals such as quartz, feldspars, clay minerals, etc. However, hydric soils commonly have a build-up of organic matter at the soil surface, for reasons described above, which can make the surface horizon dark colored. If the organic matter content (measured as organic carbon) is greater than 20 to 30% of the soil's weight (depending upon clay content) and this organic-rich layer is over 16 inches thick, then it is considered an organic soil. Most soil organic matter originates as plant tissue, so organic soils are called Histosols (the Greek word for tissue is histose). Many types of organic soils exist, but they can be classified by their thickness and degree of decomposition (see chapter 12 of text). Peat, such as common "peat moss", is mostly composed of recognizable plant fragments that are only partly decomposed. Muck contains highly decomposed organic matter and, when drained of excess water and carefully managed, these black and spongy soils comprise some of the most important vegetable-producing soils in the eastern US. Another property unique to hydric soils is their color or color patterns. Besides the dark shading from the presence of organic matter, iron compounds are the most important coloring agents in soils. Hydric soils tend to exhibit gray or blue-gray colors (known as gleying or gleyed colors) especially just beneath the topsoil or surface horizon (see lower portion of photograph). This results from the chemically reduced oxidation state of iron compounds, as opposed to the rusty red (oxidized) and brown colors of drier, non-hydric soils. Where shallow water tables fluctuate, gray, yellow and red colors can also occur as small splotches, threadlike or network patterns, created by accumulations or depletions of iron and manganese (orange colors in photograph). Because they result from processes of reduction and oxidation these color indicators of wetness are collectively termed redoximorphic features.