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CHAPTER 10

Interpreting Hydric Soils

Your first experience with hydric soils probably came upon walking into a marsh or a swamp, when you either felt the spongy or soggy ground underfoot or, in more extreme cases, sank knee-deep or even waist-deep into the muck. It did not take long to realize that these soils were wet. In these situations, you probably would not have to examine the soils to determine that the area was wetland, because good wetland-indicator plants or other signs of wetland hydrology would likely be present. Given the variety of wetlands that exist along the natural soil-wetness gradient, identification of hydric soils becomes more important in drier wetlands (e.g., those saturated for only the early part of the growing season) and for determining wetland boundaries in areas of gentle topographic relief.

Lists of Hydric Soils

The USDA Natural Resources Conservation Service (NRCS) has published national lists of hydric soils and state and county lists of soil-mapping units that contain hydric soils. These lists are helpful for interpreting published county-soil-survey reports, which include maps that show soil-mapping units (see Chapter 12 on uses of these data). As new soils are described, the national list is updated; contact your local NRCS office to learn how to access this information from the Internet.

Describing Soils

In describing soils, soil scientists identify and characterize different layers or horizons (Figure 10.1). Hydric organic soils are typified by one layer, the O-horizon. This horizon is dominated by the decomposed remains of plants that take the form of peat, muck, or a combination of the two. Below the O-horizon is unrelated parent material (the C-horizon) or bedrock (the R-horizon).

Mineral soils usually have more complicated patterns. When examining these soils, different layers or horizons are usually observed. Each layer has a characteristic color, the dominant or matrix color. Some soils, especially hydric soils and soils adjacent to wetlands, often have other additional colors (one or more non-dominant colors, called "mottles"). Describing the soil involves characterizing the soil colors of the matrix and mottles. For hydric soils, the upper 20 inches of soil are usually examined (see below).

The wetter mineral soils often have an organic layer of variable thickness on top of sand, loam, silt, or clay. As in organic soils, this organic layer is called the O-horizon. It is subdivided into three layers based on degree of plant decompositon—Oa (for mucky material, or sapric), Oi (for peaty material, or fibric), and Oe (for peaty muck or mucky peat material, or hemic)—following the same rules used to separate the three types of wet organic soils (see Organic Soils below). Beneath the O-horizon is the uppermost mineral layer: the A-horizon, which is commonly called topsoil. This layer is usually darker than the underlying mineral layer due to enrichment by organic matter. The subsoil may be represented by a B-horizon (with evidence of soil weathering), or an E-horizon (a layer of eluviation where organic matter, aluminum, clay, or other materials are leached out) with a B-horizon beneath it. In evergreen forests, the E-horizon may be subtended by a reddish brown or dark brown layer of variable thickness called the spodic horizon (designated as a Bh-horizon when the layer has a lot of organic matter, or a Bs-horizon when iron and aluminum oxides dominate). Such soils are called spodosols (see discussion later in this chapter). The C-horizon or parent material typically underlies

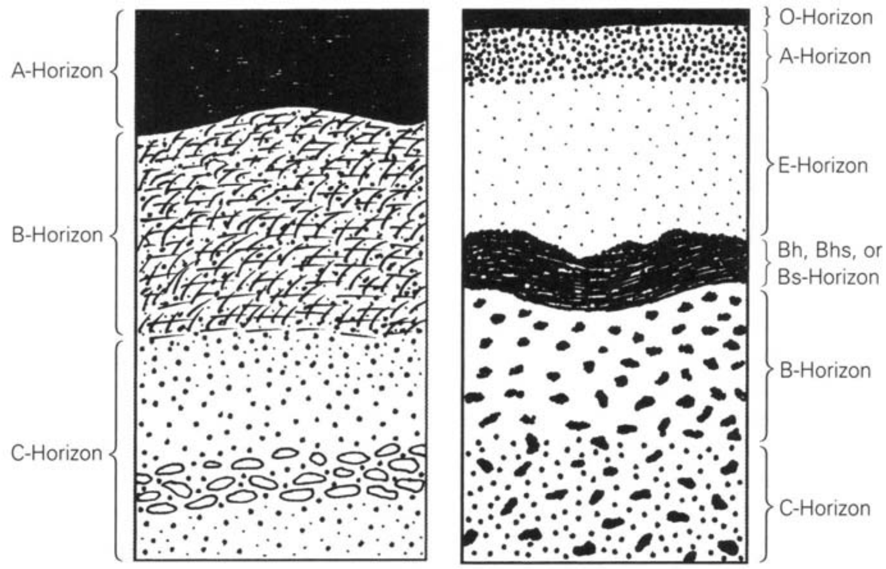

Figure 10.1. Two examples of mineral soil profiles with diagnostic layers, or horizons: nonsandy mineral (left), and mineral spodosol (right). The O-horizon is dominated by organic matter; in organic soils this horizon is typically 16 inches or more thick. The A-horizon is the surface mineral layer, where organic matter mixes with mineral material. The B-horizon is the mineral subsoil, where soil-forming processes are at work. The E-horizon is the eluvial layer, where materials such as iron, aluminum, and organic matter have been leached by organic acids from overlying vegetation. The Bh-, Bs-, or Bhs-horizon is the spodic horizon where these leached materials accumulate. The C-horizon is the parent material layer below the depth at which soil-forming processes occur.

the B-horizon. Floodplains often have buried A-horizons due to periodic sedimentation from floods, producing a rather interesting combination of soil layers.

Munsell Soil-Color Book

As shown in Figure 10.2, soil colors can tell us a great deal about the wetness regime, especially in mineral soils. Scientists and others examining the soil determine the approximate soil color of different horizons by consulting a Munsell color chart. The so-called Munsell soil-color book (Macbeth Division 1994) contains charts with paint chips of soil colors (Plate 23). Soil colors are identified on the charts by three characteristics: 1) hue, one of the main spectral colors—red, yellow, green, blue, or purple—or various mixtures of them; 2) value, lightness or darkness of the hue; and 3) chroma, purity or saturation of the color.

In the Munsell soil-color book, each hue has its own page, which is subdivided into units for value (on the vertical axis) and chroma (horizontal axis). Although theoretically each soil color represents a unique combination of hue, value, and chroma, the number of combinations common in the soil environment usually is limited. Because of this situation and the fact that accurate reproduction of each soil color is expensive, the book contains a limited number of combinations. The typical Munsell book has about a dozen pages of different hues (e.g., 10YR, 2.5Y, 5Y, 7.5R), which are mostly combinations of yellows (Y) and reds (R), plus gley charts. A new soil-color book (Color Communications, Inc. 1997) has sixty-two pages of hue-chroma combinations.

Low-chroma colors (2 or less) include black, various shades of gray, and darker shades of brown. These colors are associated with hydric soils and organic-enriched nonhydric soils (usually the A-horizon of the latter soils). The gley charts represent colors associated only with hydric soils (mainly grayish, bluish, and greenish colors), while the other hue charts show both hydric and nonhydric colors.

Using the Munsell Charts

Different colors found in soils are classified by comparing a soil sample with the color chips on the Munsell charts. First try to find a hue page with the correct soil color. In most of the Northeast, begin with the 10YR page. If the soil is yellower or more olive colored, try the 2.5Y or

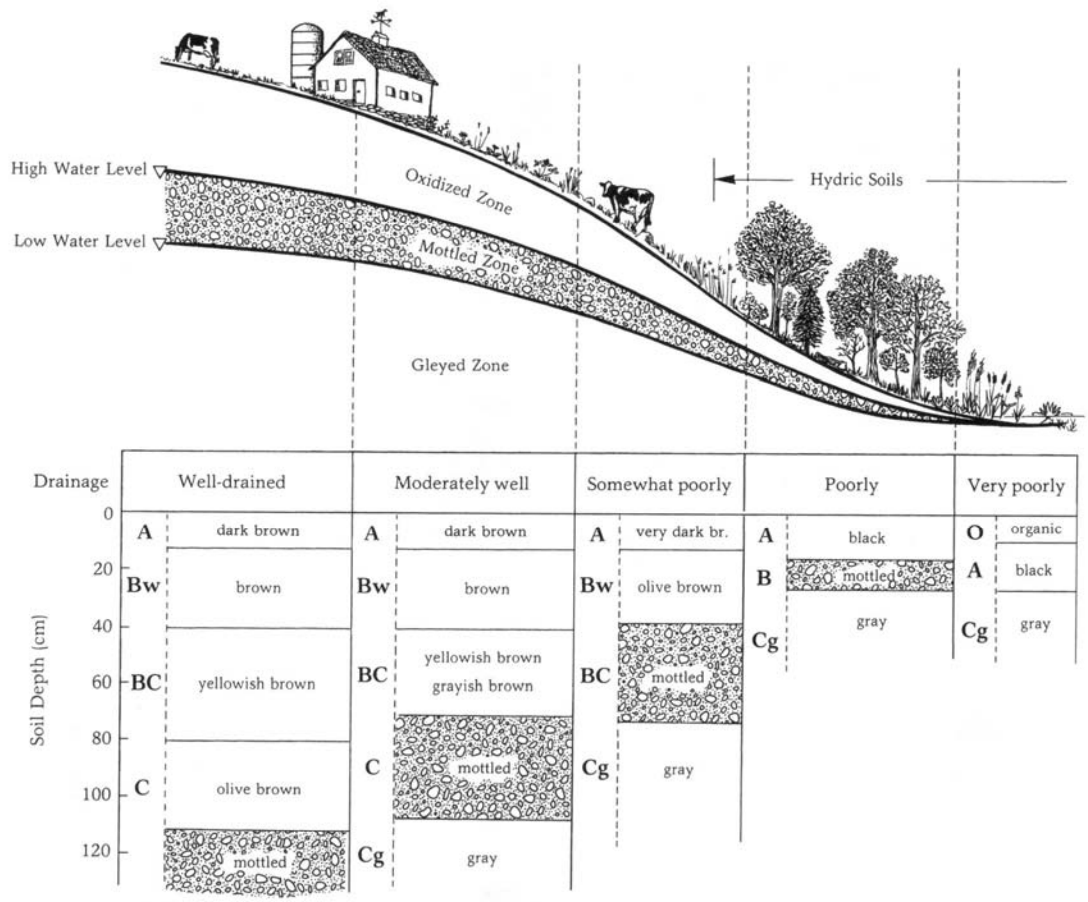

Figure 10.2. Soil colors typically change with slope. Although hydric soils may include a few somewhat poorly drained soils, most are poorly or very poorly drained. The color pattern shown here for somewhat poorly drained soil is that of a nonhydric soil, as there is no evidence of prolonged waterlogging within 6 inches (15 cm) of the surface. (Source: Tiner and Veneman 1995)

5Y pages. For redder colors, check 7.5YR, 5YR, and 2.5YR. If the soil is black, gray, blue, or green, consult the gley pages. Place the soil sample behind the hue page, look through the holes, and move the sample from hole to hole until you match the dominant soil color to a color chip. The matched color is the matrix color of the soil. The other colors are nondominant mottles. Both matrix and mottle colors are important for recognizing hydric soils.

Be sure you have adequate light to view the soil sample, and do not attempt to read the color charts with sunglasses on. Cloudy days or late fall and winter afternoons may pose problems. In some cases, you must simply return the next day or bring home a sample to evaluate under more favorable conditions.

When recording data for a wetland determination, specialists employ the Munsell notation, an alpha-numeric code for hue, value, and chroma: for example, 5Y 2/1 (hue is 5 yellow, value is 2, and chroma is 1). Low-chroma colors associated with hydric soils are represented by the left two columns of the hue pages and by the entire gley pages. The rest of the columns are essentially nonhydric-soil colors. The appropriate Munsell color name can be read from the page facing the color chart. (Note: For hydric-soil determinations, be sure to use a 1990 or later edition of the Munsell soil-color book.)

How to Recognize Hydric Soils

Extracting a Soil Sample

To examine the soil, dig a hole about 2 feet deep by 1½ feet wide. If there are more than 8 inches of organic material on the surface (excluding leaf litter), the soil is hydric. If the soil does not

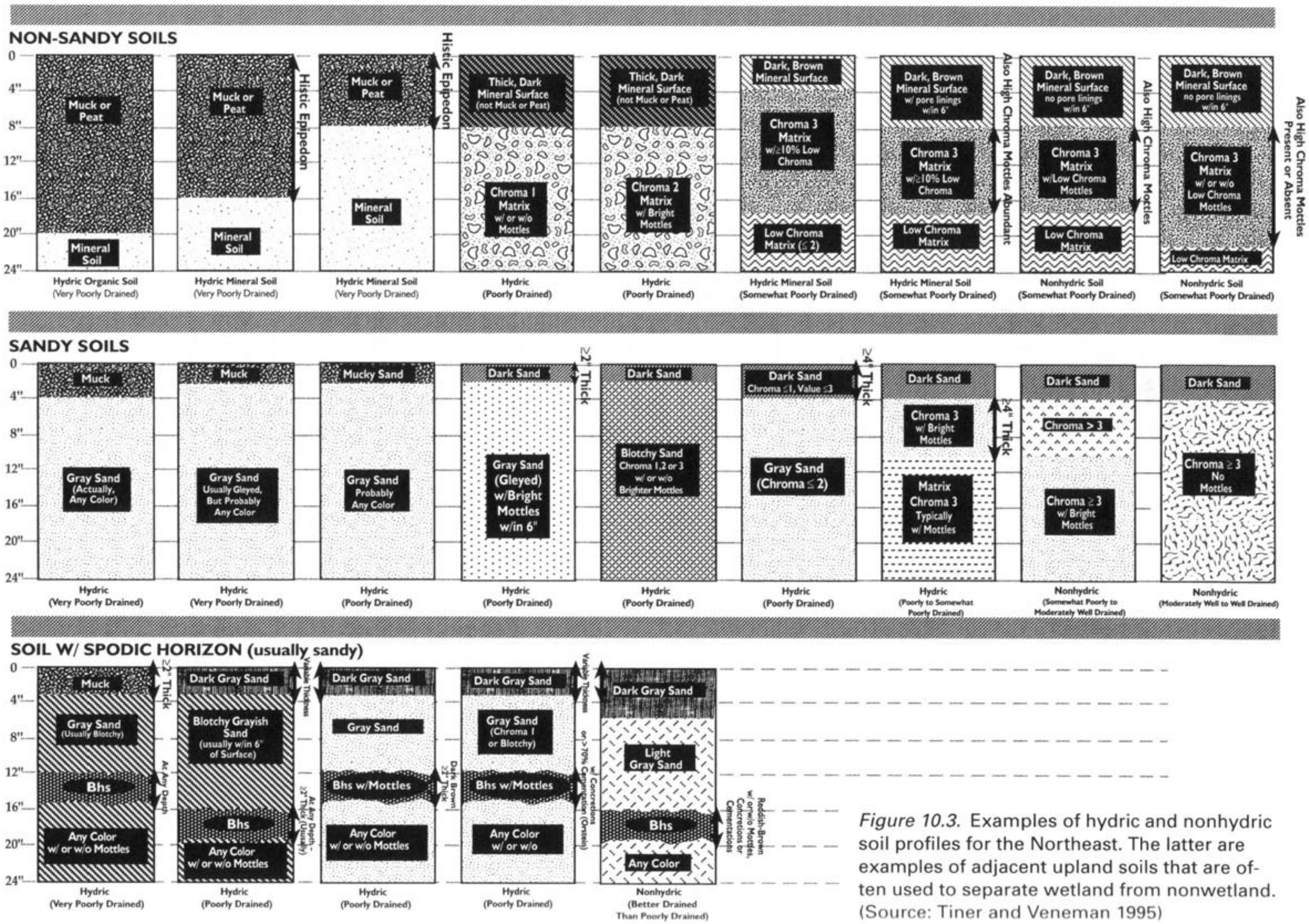

Figure 10.3. Examples of hydric and nonhydric soil profiles for the Northeast. The latter are examples of adjacent upland soils that are often used to separate wetland from nonwetland. (Source: Tiner and Veneman 1995)

have this amount of organic matter, look at the subsoil horizon (often the B-horizon) immediately below the surface layer (A-horizon). The colors below 6 inches must be examined, because many cultivated soils (past and present) have been disturbed above this point by plowing and have been enriched with organic matter, thereby affecting the original soil color. This disturbed zone is called the plow layer. If the subsoil layer is predominantly gray (and you're not looking at a spodosol), the soil has a good chance of being hydric. This layer is easily recognized by an abrupt boundary (straight line) between the A-horizon and B-horizon (see Plate 27).

Typical Hydric-Soil Properties

The following properties usually indicate a hydric soil in the Northeast: 1) a peaty or mucky surface layer 8 inches or thicker, and 2) dominant colors in the mineral-soil matrix with chroma of 2 or less if there are mottles (usually orangish, yellowish, or reddish brown) or 3) dominant colors in the mineral-soil matrix with chroma of 1 or less, if there are no mottles present. Sandy soils have slightly different requirements (see Problematic Hydric Soils below). Figure 10.3 shows typical hydric and adjacent nonhydric soils found in the Northeast. Hydric-soil indicators are still in the development phase. Some indicators developed by New England soil scientists are being used for wetland determination in New England but are not applied elsewhere in the Northeast. The indicators presented in the following discussion include both nationally and regionally recognized ones and are duly noted as such.

Organic Soils

Organic soils typically form in 1) waterlogged depressions (e.g., glacially formed kettle holes, river oxbows, and lake margins) where peat or muck deposits range today from about 1.5 feet to 50 feet or more deep; 2) cold, wet climates like northern New England; and 3) low-lying areas along coastal waters where tidal flooding is frequent and saturation is nearly continuous. In the humid subarctic, the cold climate lowers evaporation and plant transpiration, allowing the development of organic soils on broad lowlands such as the Hudson Bay lowlands (once the Tyrrell Sea) in Canada and former Lake Agassiz from Minnesota north. In these regions, organic soils may cover many miles of the landscape, even rolling terrain with blanket bogs.

Peats and mucks are not the same, although nonscientists commonly use the terms interchangeably. Muck (saprists) consists of organic matter that breaks down into a greasy mass upon rubbing, of which less than one-third of the material can be identified. In peats (fibrists), more than two-thirds of the organic material is identifiable (leaves, stems, roots). There are intergrades between the two—mucky peats and peaty mucks (hemists)—depending on the amount of identifiable material. A fourth group of organic soils (folists) is nonhydric, forming in high mountains in the tropics and in boreal and arctic regions. In the Northeast, folists are limited to mountainous areas in northern New England, where they are generally thin organic soils on bedrock in landscape positions that are obviously not associated with wetlands.

Organic soils can easily be recognized by their characteristic black muck or black to orange-brown peat, which is usually thicker than 16 inches (Plates 24 and 25). Shallow organic soils of variable thickness exist over bedrock. If the organic layer is less than 16 inches thick and overlies mineral material, the soil is classified as mineral. Perhaps the easiest way to identify the presence of organic soil, besides sinking in the muck, is to take a shovel or auger and try to push it into the soil. If the shovel is easily pushed 16 inches or deeper, the soil is organic (Figure 10.4). If the depth of penetration is less, the soil may still be an organic soil if you hit bedrock, but it is more likely that the soil is mineral with a shallow organic layer on top.

While it is not really necessary to separate peats from mucks for wetland identification since both are obviously hydric soils, you might be interested in trying this simple test. When rubbed between your fingers, mucks have almost all of the plant remains decomposed beyond recognition and feel somewhat greasy. Peats are slightly decomposed, and when rubbed between the fingers, most of the plant materials can be recognized as parts of grasses, sedges, and mosses, or types of wood.

Mineral Soils

The wettest mineral soils often have a layer of organic material (frequently muck) on the surface. When this layer is 8–16 inches thick, it is

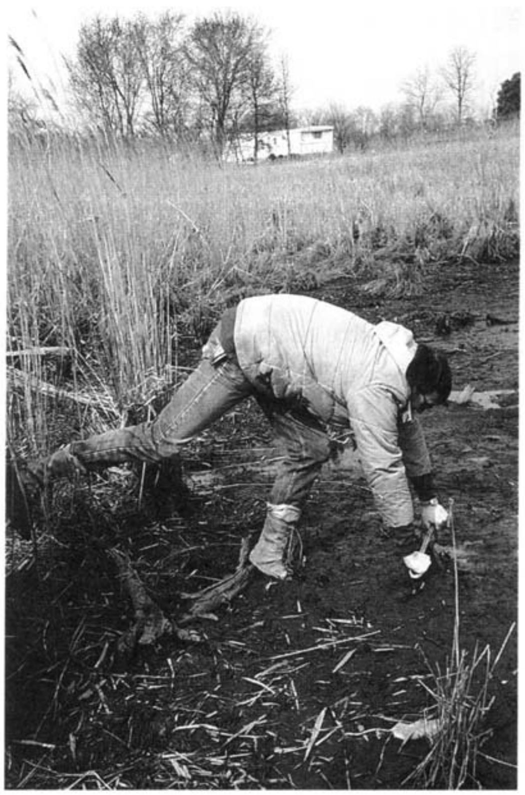

Figure 10.4. Professor Peter Veneman demonstrating the simplest technique to detect an organic soil: pushing an auger into the soil. In this case, the entire auger, more than 4 feet long, has been pushed into the soil with little difficulty.

called a histic epipedon (Plate 26). This is an automatic indicator of hydric soil and wetland (unless the area is effectively drained). Some of these soils produce a strong odor of rotten eggs (hydrogen-sulfide gas), which is another excellent hydric-soil indicator; some mucky organic soils also do this.

For other mineral soils, it is important to recognize different textures, mainly to separate sandy from nonsandy soils. Sandy soils are more permeable and have different hydric properties from those of nonsandy soils. These soils can be distinguished by applying a simple test. Take a small sample of soil, moisten it, and make a ball about one inch in diameter. Gently press the ball between your thumb and index finger. If the ball crumbles, the soil is a sand. If not, it is nonsandy. That's all you need to know for routine hydric-soil assessments, but if you'd like to separate clayey from loamy soils, do the additional steps shown in Figure 10.5.

Gleying and low-chroma mottling (redox depletions) are typical hydric mineral-soil properties. The abundance, size, and color of the mottles usually reflect the duration of the saturation period and indicate whether or not the soil is hydric. In general, the more gray present and the closer the gray layer is to the surface, the wetter the soil and the more likely the soil is hydric (with spodosols a major exception; see below; Plates 27–30). Soils with only gray mottles near the surface may not be wet enough to be considered hydric. Mineral soils lacking gray mottles are usually nonhydric, except for certain sandy soils (Plate 31). Nonhydric mineral soils that are never saturated are usually bright-colored near the surface and are not gray-mottled (Plate 37).

Hydric mineral soils are usually identified by a gray subsoil (redox depletions or depleted matrix) with bright-colored mottles (redox concentrations) within 12 inches of the surface. Depleted matrices are represented by chroma of 2 or less with mottles, or chroma of 1 or less without mottles. Many hydric soils are characterized by a thick, dark surface layer (black or dark brown), a predominantly gray subsurface layer (the low-chroma matrix) with yellow, orange, brown, or reddish mottles, and sometimes iron-oxide concretions near the surface (Plates 26–28, 30). Some hydric mineral soils have reddish brown to orange mottles lining the root channels (oxidized rhizospheres or pore linings; Plate 1e). Black concretions of manganese oxide may also be present near the surface. The gray matrix color of the subsoil (usually within 12 inches of the surface) and thick, dark surface layer are the best indicators of current wetness, since the iron-oxide mottles and concretions are very insoluble, and once formed will often remain indefinitely in the soil as relic mottles.

The wettest mineral soils are typically neutral gray in color (gleyed soil; Plate 27), although occasionally the color may be greenish gray or bluish gray (Plate 28). Sometimes the color may fade when the soil is exposed to air; this usually means that reduced iron is present. Gleyed colors are found on the gley pages of the Munsell soil-color book. A gley matrix within 6 inches of the soil surface is a hydric-soil indicator. These soils are saturated for significant periods to be considered hydric. Soils with a depleted matrix (chroma 2 or less) at least 6 inches thick starting within 10 inches of the surface are also hydric (Plate 29). Soils with thick black or dark gray surface horizons (chroma 0—neutral or

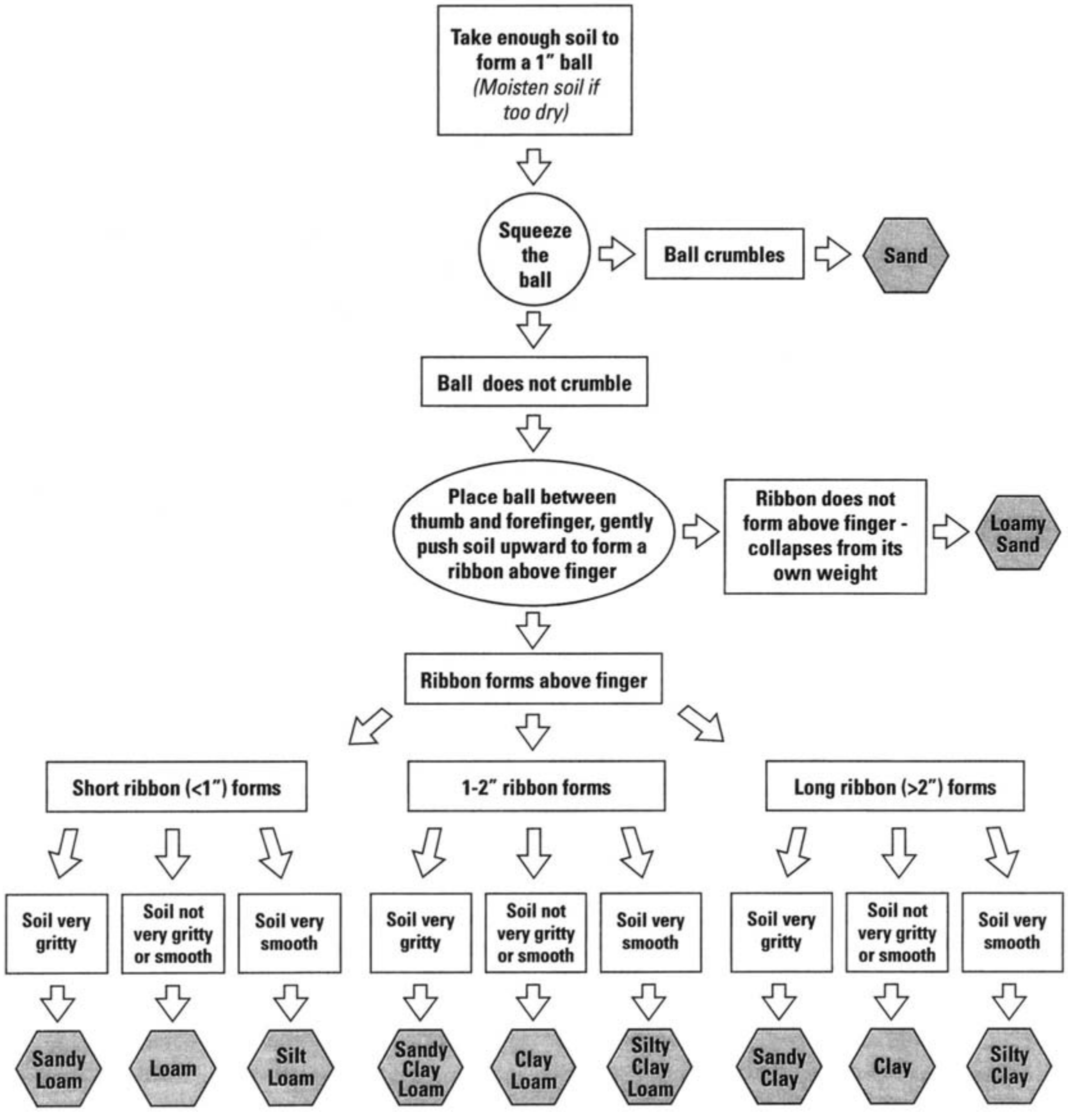

Figure 10.5. Easy steps for texturing soil. (Source: Adapted from Thien 1979)

chroma 1) and depleted matrix subsoils are also hydric (Plate 30). Most nonsandy soils in the Northeast with gray colors dominating the subsoil immediately below the topsoil are generally recognized as hydric. (Note: Beware of gray-colored E-horizons; see spodosols discussion under Problematic Hydric Soils.)

Other hydric-soil indicators for nonsandy soils include 1) hydrogen-sulfide odor detected within 12 inches of the soil surface, 2) stratified layers within 6 inches of the soil surface (one layer must be organic soil or mineral of chroma 1 or less), 3) the presence of 2 percent or more organic bodies of muck or mucky mineral texture (typically attached to the roots) within 6 inches of soil surface (body diameters 0.5 to 1.0 inch; Figure 10.6), 4) a mucky modified mineral surface layer 2 inches or thicker within 6 inches of the soil surface, 5) a muck layer 0.5 inch or thicker within 6 inches of the soil surface (a thickness of 0.75 inch is being tested for the rest of the Northeast), and 6) a loamy mucky mineral layer 4 inches or thicker beginning within 6 inches of the soil surface. Indicators 3, 4, and 5 above are currently permitted for use in the Northeast only on the Delmarva Peninsula, although they are probably also useful in the coastal plain of New Jersey. (Note: Mucky modified mineral is an organic-rich mineral layer that feels greasy, making it difficult for some to separate organic soil from mineral soil.) For a list of official indicators for regulatory

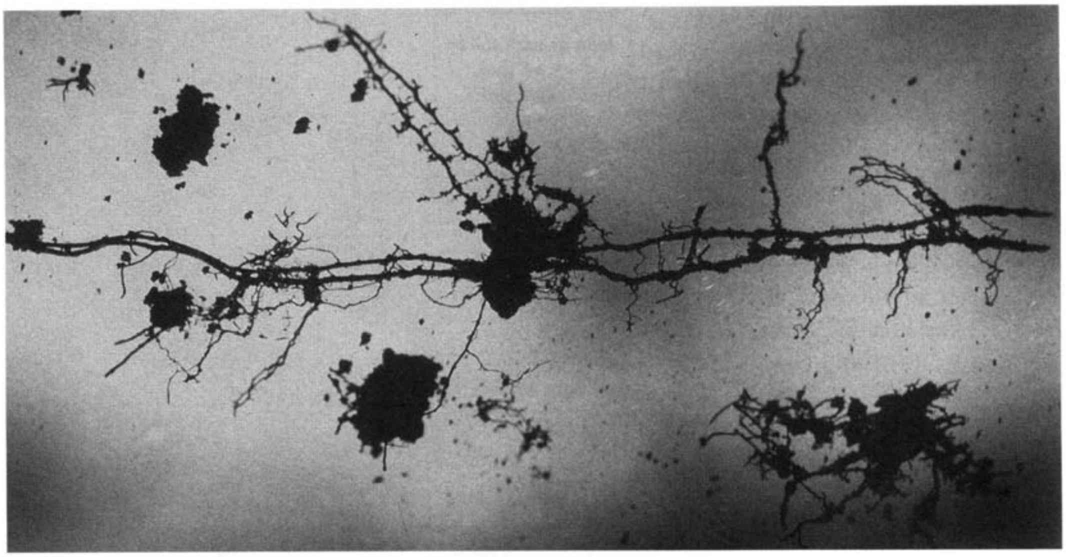

Figure 10.6. In the coastal plain, organic bodies—mucky to mucky-mineral soil masses attached to plant roots—develop in some soils where seasonal waterlogging kills a significant portion of the roots, which then form these ½ inch or larger masses.

purposes, consult your state soil scientist or wetland regulator.

Problematic Hydric Soils

Hydric-soil determinations are not always straightforward. There are exceptions to most rules. Certain reddish and other brighter-colored soils are hydric, and certain gray-colored soils are nonhydric. These soils may require considerable expertise for positive identification, unless the vegetation is obviously hydrophytic in the first case and nonhydrophytic in the latter. Consequently, in these and other problematic situations, evidence of wetland hydrology and the presence of wetland vegetation should be used to make a wetland determination rather than worrying about obscure or nonexistent soil properties. Consult a state or local office of the Natural Resources Conservation Service for more information on these soils. Listed below are examples for your general information.

Sandy Soils

Some sandy soils pose the greatest problem in identifying hydric properties, since all or many of the diagnostic characteristics listed above may not be present (Plates 32 and 33). Given their rapid permeability, evidence of prolonged saturation must be found within 6 inches of the surface. Like their nonsandy counterparts, some hydric sandy soils have thick, dark (often black) surface layers with high organic-matter content or a gleyed matrix within 6 inches of the soil surface (Figure 10.3). The former may be a histic epipedon or a sandy mucky mineral layer (at least 2 inches thick) beginning within 6 inches of the soil surface (Plate 32). These soils are readily identified as hydric. The presence of a thin layer of muck (2 inches or thicker) on top of a sandy soil is also evidence of prolonged wetness and a hydric sand. Even an inch of muck is probably enough, although this has not been recognized nationally. Other sandy hydric soils may show evidence of vertical streaking by organic matter below the surface layer. The black or dark gray streaks on a medium or light gray matrix are easily detected (see subsoil in Plate 32).

More difficult to recognize as hydric are blotchy sands (see subsoil in Plate 32). These soils have a blotchy subsoil (mixtures of chroma 1, 2, or 3 colors) due to variable organic coatings around some of the sandy grains. This condition is called either "polychromatic matrix" or "stripped matrix." The presence of organic materials in blotchy sands is determined by a simple test. When rubbed gently on the palm of your hand, organic-coated sand grains from the darker blotches leave a dark-colored, often blackish, stain on your skin. Rubbing the uncoated grains from light blotches leaves almost no stain. Sands with a matrix of chroma 3 with both low-chroma and high-chroma mottles (redoximorphic features: iron depletions and concentrations, respectively) within 6 inches of the soil surface are also hydric. Recently deposited sandy soils, such as sand bars along rivers, may not possess any typical hydric-soil properties, but they can be recognized as hydric soils by their landscape position, associated vegetation, and signs of flooding.

Floodplain Soils

Floodplains are depositional environments, where soils are constantly being buried by new materials brought in by floodwaters. Such soils often have little or no evidence of weathering. These alluvial soils typically have buried surface layers (A-horizons) at various depths. Not all floodplain soils are hydric, since many are only infrequently flooded. Of those that are hydric, some possess typical hydric-soil properties, while others do not. An additional hydric-soil indicator is used along the coastal plain from the Delmarva Peninsula south: loamy floodplain soils with a layer having 40 percent or more chroma 2, with 2 percent or more black (manganese) or reddish brown–orange (iron) mottles occurring as soft masses. Some floodplain soils are predominantly red-colored due to the deposition of soil derived from red parent materials (see below). In general, landscape position, vegetation, and evidence of flooding are useful for distinguishing hydric floodplain soils from nonhydric ones.

Red Parent-Material Soils

Soils derived from red parent materials (e.g., strongly weathered clays and exposed Triassic and Jurassic sandstones and shales) present particular problems for hydric-soil recognition. In the Northeast, examples are found in the Connecticut River valley, central Massachusetts, and central New Jersey. In these areas, glaciation exposed ancient formations that are now eroding. The red colors are attributed to the dominance of the iron mineral hematite. The colors are redder than 10YR and obscure the low-chroma colors that normally develop under anaerobic, reducing wetland conditions. Some of these hydric soils may have low-chroma colors within 1½ feet of the surface, but many do not. In most instances, the landscape position, resulting vegetation, and certain signs of hydrology are the best indicators for making a wetland determination. Wet-season field checking may be desirable. For a hydric-soil indicator, the federal government is testing the following: within 12 inches of the surface, a layer at least 4 inches thick with a matrix of 7.5YR or redder and a chroma of 3 or less with 2 percent or more redox depletions (chroma 2 or less) or redox concentrations.

Evergreen-Forest Soils

Spodosols are associated with evergreen forests, typically on sandy soils. They are common in northern temperate and boreal regions and along the coastal plain from New Jersey south. Evergreen forests of hemlock, spruces, and pines dominate these regions. Larch, oaks, and beech are also associated with spodosol formation.

Most spodosols (hydric and nonhydric) have a characteristic gray E-horizon (E for eluvial: a leached layer) overlying a diagnostic spodic horizon of accumulated organic matter, iron, and aluminum (see Plates 34–36). The gray layer is not necessarily due to wetness, but is formed by a process called "podzolization" that commonly occurs under pines on sandy soils and under hemlocks and spruces on any soil. Organic acids from the breakdown of leaves of these and other species move down through the soil with rainfall, cleaning the sand grains and depositing organic matter, iron, and aluminum in the next layer (the spodic horizon). This process occurs in both wetlands and uplands. In the Northeast, it takes place mainly in sandy soils. When formed under wet conditions, the spodic horizon is dark brown—the color of coffee grounds—and it is usually thick (greater than 2 inches; Plate 34), whereas in dry situations (nonwetlands), the spodic horizon is more reddish brown and quite thin (Plate 36).

Wet, sandy spodosols may be recognized by typical hydric sandy-soil properties (including a muck layer 2 inches or more thick; Plate 35) or by either: 1) a cemented spodic horizon within 12 inches of the soil surface (Plate 34), 2) high-chroma mottles in the upper part of the spodic horizon, or 3) mottling in the spodic horizon (see Figure 10.3; Plates 34 and 35). Loamy hydric spodosols may also be recognized by these three features.

Newly Formed Soils

New hydric soils may form with the help of beavers or humans. Whenever a nonhydric soil becomes flooded for more than one week during the growing season in most years, it is considered hydric by definition (hydric-soil criteria 3 and 4). Of course, the permanence of the beaver dam or human construction (e.g., road impoundments) must be considered before calling any flooded area a hydric soil or wetland. If a beaver dams a road culvert, blocking flow and flooding low-lying nonhydric soils, and someone removes the dam and attempts to keep the beaver out of the area, the situation is temporary, and the area should not be considered to have newly created hydric soil or wetland. If the situation has, however, lasted for some time and wetland vegetation (e.g., cattails and water lilies) is established and upland plants are dying or dead, then the area should be considered to have newly created hydric soil and to be wetland. Given the recent flooding in these cases, the soil properties will not be typical of hydric soils. It usually takes decades and perhaps a century or more for a soil to develop these properties. Again, vegetation and signs of hydrology are the best clues for identifying these wetlands.

Drained Hydric Soils

Where a network of drainage ditches or similar structures (tile drains and dikes, with pump houses) is observed, the effectiveness of the drainage needs to be determined to identify the presence or absence of wetland—drained hydric soils must be distinguished from undrained hydric soils. This is by no means a simple task. In general terms, if the soils are drained to the point where they are no longer capable of supporting the growth and regeneration of wetland vegetation, then they are effectively drained hydric soils and not considered wetland. This exercise is clearly beyond the skills of the average person, yet it is usually easy to recognize that an area has been subjected to drainage (exceptions: tile drains and groundwater withdrawals). The difficulty is determining the magnitude of the hydrologic alteration. To accurately identify the extent of drainage usually requires the services of a wetland scientist or soil-drainage engineer. The detailed soil-wetness studies that may be needed to evaluate such a condition are clearly beyond the scope of this book. One thing to remember, however, is that one shallow ditch is usually not sufficient to effectively drain a large wetland; a network of ditches is typically required to do this.

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