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Chapter Twenty

WETLAND BOUNDARY DELINEATION

RALPH W. TINER, JR.
Regional Wetland Coordinator
U.S. Fish and Wildlife Service
Northeast Region
Newton Corner, MA 02158

INTRODUCTION

Accurate identification of wetlands and their boundaries is an important step towards providing adequate protection to wetlands through existing regulations. Failure to properly identify the limits of wetland can lead to wetland destruction without administrative review by regulatory agencies. Just how many acres of wetlands have been lost to development due to misidentification is impossible to determine, yet I have witnessed too many instances where the limits of wetlands have been misidentified. I believe that a major cause of the problem has been the lack of a scientifically valid procedure for identifying wetlands and their boundaries. Until recently, there were no manuals or guidebooks to help people identify wetlands. In the past, wetlands were chiefly identified by a set of plants that were considered to be good indicators of wetlands. Unfortunately, the best wetland indicator plants are representative of the wetter wetlands and are often not found in the drier wetlands (e.g., temporarily flooded) or along the upper limits of the wetter ones. So, using vegetation alone is often inadequate for identifying many wetlands. Today, wetland scientists consider vegetation, soils, and hydrology in recognizing wetlands and delineating their boundaries. The purpose of this chapter is to review existing wetland delineation techniques and compare major differences.

OVERVIEW OF WETLAND IDENTIFICATION TECHNIQUES

Federal regulatory agencies and key federal conservation agencies utilize vegetation, soils, and hydrology to identify wetlands and their boundaries. State agencies with wetland protection laws may consider all three characteristics or

TABLE 1

Examples of Federal and State Wetland Definitions with Reference to Parameters Used for Wetland Identification.

Agency	Definition	Parameters Used	Comments
U.S. Army Corps of Engineers and U.S. Environmental Protection Agency	Wetlands are "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."	Vegetation, Soils, and Hydrology	Definition is federal regulatory definition in accordance with Section 404 of the Clean Water Act. Wetlands must be vegetated. The two agencies have developed different techniques for identifying wetlands.
U.S.D.A. Soil Conservation Service	Wetlands are "areas that have a predominance of hydric soils and that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions, except lands in Alaska identified as having potential for agricultural development and a predominance of permafrost soils."	Soils, Hydrology, and Vegetation	Definition for implementing "Swampbuster" provision of the Food Security Act. It excludes certain wetland areas in Alaska due to agricultural interests.
U.S. Fish and Wildlife Service	"Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate in nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year."	Vegetation, Soils, and Hydrology	Definition is used for mapping the nation's wetlands. It recognizes that wetlands may be vegetated or nonvegetated (e.g., tidal mud flats).

TABLE 1 (Continued)

Commonwealth of Pennsylvania	Same as federal Section 404 definition (see above).	Vegetation, Soils, and Hydrology	Definition for state regulations under Dam Safety and Encroachment Act.
State of Connecticut	Wetlands are "lands, including submerged land...which consists of any of the soil types designated as poorly drained, very poorly drained, alluvial and floodplain by the National Cooperative Soils Survey...."	Soils	Definition for freshwater (nontidal) wetlands for state regulations under Connecticut Inland Wetlands and Water Courses Act.
Commonwealth of Massachusetts	"Bordering Vegetated Wetlands are freshwater wetlands which border on creeks, rivers, streams, ponds and lakes. The types of freshwater wetlands are wet meadows, marshes, swamps, and bogs. They are areas where the topography is low and flat, and where the soils are annually saturated. The ground and surface water regime and the vegetational community which occur in each type of freshwater wetland are specified in the Act."	Vegetation, Soils, and Hydrology	Definition for freshwater wetlands in state regulations under Wetlands Protection Act. *Note:* Although the regulatory definition addresses three parameters, in application the state tends to rely heavily on vegetation and generally ignores soils.
State of New Jersey	Freshwater wetland "means an area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation...."	Vegetation, Soils, and Hydrology	Definition for freshwater wetlands for state regulations under Freshwater Wetlands Protection Act. *Note:* This is the first law that actually specifies a wetland identification and delineation technique (refers to EPA methodology).

rely on just a single characteristic, such as vegetation or soil to make a wetland determination (Table 1). The following discussion is an overview of common wetland identification techniques used prior to 1989. On January 10, 1989, four federal agencies (U.S. Army Corps of Engineers, Environmental Protection Agency, Fish and Wildlife Service, and Soil Conservation Service) adopted a new interagency manual for identifying and delineating jurisdictional wetlands. A brief overview of this manual is provided in the following discussion, since the published manual was not available when this chapter went to press.

U.S. Army Corps of Engineers

In 1987, the U.S. Army Corps of Egineers (Corps) published *Corps of Engineers Wetlands Delineation Manual.* This technical report prepared by the Corps Environmental Laboratory details a delineation "method approved for voluntary use in the field for a trial period of one year" by Corps personnel. It contains technical guidelines and methods using a three-parameter approach to identify and delineate wetlands in accordance with Section 404 of the Clean Water Act (see Table 1 for wetland definition).

This manual offers two basic approaches for wetland delineation: (1) *routine approach* for use in the majority of cases where minimal effort is required and (2) *comprehensive approach* which requires implementing quantitative procedures for making wetland determinations in more difficult or controversial cases.

In all cases, areas identified as "wetland" according to this manual must show "evidence of a minimum of one positive wetland indicator" for each of three parameters: (1) vegetation, (2) soil, and (3) hydrology. In other words, wetlands must have a predominance of hydrophytic vegetation and hydric soils, and show evidence of being inundated either permanently or periodically at mean water depths less than 6.6 feet or have soils saturated to the surface at some time during the growing season of the prevalent vegetation. It is obvious that this definition of wetlands relates solely to vegetated wetlands and does not include nonvegetated wetlands (such as tidal flats in coastal areas or ponds).

Vegetation. Hydrophytic vegetation is defined as "the sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present." For application in the field, the Corps considers only those plants listed on the U.S. Fish and Wildlife Service's national wetland plant list (Reed 1986) as obligate (OBL) hydrophytes, facultative wetland (FACW) plants, and facultative (FAC) plants as "typically adapted for life in anaerobic soil conditions." Facultative minus (FAC−) plants and facultative upland (FACU) plants which often occur in wetlands are "not considered to be typically adapted for life in anaerobic soil conditions." For purposes of delineation, these plants are

treated as upland plants. In order to be considered wetland, an area must first have more than 50 percent of the dominant species composed of OBL, FACW, or FAC species. In cases, where all species are FAC, or the number of species wetter than FAC equals the number drier than FAC, the wetland determination will be based on the soil and hydrology parameters. Other indicators of hydrophytic vegetation include: (a) morphological or physiological adaptations for growth in wetlands, (b) visual observations of plants growing in areas of prolonged inundation/soil saturation, and (c) documentation in the technical literature of plant species growing in wetlands. Indicator (b) above may be particularly important, in that, it may possibly be used to consider FAC– and FACU plants as hydrophytic vegetation, although the manual presents only obligate hydrophytes as examples of this situation and it was probably not intended for this use. For example, if eastern white pine (*Pinus strobus*)—a FACU plant or loblolly pine (*Pinus taeda*)—a FAC– plant in the Northeast, and other FAC– or FACU plants are the dominant vegetation *and observed* growing in an area of prolonged soil saturation, these plants may possibly be considered hydrophytic vegetation. However, if these direct observations are lacking, then these dominant plants are not considered hydrophytic vegetation, even when growing in undrained hydric soils. One might also reasonably argue that the observation of such plants in an undrained hydric soil is enough evidence to satisfy the requirement of direct observation of wetland hydrology, but this has not been clearly addressed in the manual and, therefore, leaves it up to individual interpretation.

Soils. Hydric soil is defined as "soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation." This definition was adopted from the U.S.D.A. Soil Conservation Service (1985) (see Table 2 for current technical definition). "Only when a hydric soil supports hydrophytic vegetation and the area has indicators of wetland hydrology, may the soil be referred to as a 'wetland' soil." The Corps manual states that "a hydric soil that has been drained or partially drained still allows the soil parameter to be met," so the final determination of an area as wetland or nonwetland will be based on "the presence of either hydrophytic vegetation or a hydrologic regime that occurs in wetlands." Wetland soil indicators in nonsandy soils include: (1) organic soils, (2) histic epipedons (an 8- to 16-inch surface layer high in organic matter), (3) sulfidic material (e.g., H_2S—an odor of rotten eggs), (4) an aquic or peraquic moisture regime (indicative of a reducing, anaerobic environment), (5) direct evidence of reducing soil conditions (testing for ferrous iron), (6) soil colors (gleying and low chromas with bright mottles), (7) soil listed on the national hydric soils list, and (8) the presence of iron and manganese concretions (evidence of oxidation-reduction process). In sandy soils, wetland soil indicators include: (1) high organic matter content in the surface horizon (layer), (2) streaking of subsurface horizons (layers) by organic matter, and (3) organic pans which

TABLE 2

Technical definition and criteria of hydric soil (U.S.D.A. Soil Conservation Service 1987).

DEFINITION OF HYDRIC SOIL

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.

CRITERIA FOR HYDRIC SOILS

1. All Histosols except Folists, or
2. Soils in Aquic suborders, Aquic subgroups, Albolls suborder, Salorthids great group, or Pell great groups of Vertisols that are:
   a. somewhat poorly drained and have water table less than 0.5 ft from the surface for a significant period (usually a week or more) during the growing season, or
   b. poorly drained or very poorly drained and have either:
      (1) water table at less than 1.0 ft from the surface for a significant period (usually a week or more) during the growing season if permeability is equal to or greater than 6.0 in/h in all layers within 20 in, or
      (2) water table at less than 1.5 ft from the surface for a significant period (usually a week or more) during the growing season if permeability is less than 6.0 in/h in any layer within 20 in, or
3. Soils that are ponded for long duration or very long duration during the growing season, or
4. Soils that are frequently flooded for long duration or very long duration during the growing season.

commonly develop below the surface to the depth of the water table.

Hydrology. "Wetland hydrology encompasses all hydrologic characteristics of areas that are periodically inundated or have soils saturated to the surface at some time during the growing season." The presence of water in these areas has an "overriding influence on characteristics of vegetation and soils due to anaerobic and reducing conditions." Indicators of wetland hydrology include: (1) recorded data on flooding and seasonal high water tables; for example, (2) visual observation of inundation, (3) visual observation of soil saturation (usually must be within 12 inches of the surface — the "major portion of the root zone"), (4) water marks, (5) drift lines, (6) sediment deposits, and (7) drainage patterns as evidence of surface water flow. (*Note:* This method does not consider the presence of an undrained hydric soil to be a valid indicator of wetland hydrology.) These indicators are largely indicators of surface water flooding or ponding and they do not include a valid indirect indicator of saturated soils, such as diagnostic hydric soil properties. This latter issue is of vital importance, since there are many wetlands that exist due to the presence of a seasonal high water table with no surface water flooding or ponding. The Corps has also narrowly defined the growing season for making hydrologic observations as the frost-free period from the last killing frost in the spring to the first killing frost in the fall. This concept of growing season is inconsistent with the one used for determining hydric soils and used by other federal agencies, and results in a much shorter time period than the actual growing season for native plants.

In many areas, the growing season has been shortened by two months. This has profound effects on the utility of this method for accurately identifying and delineating wetlands, especially since direct observations of flooding, ponding, or soil saturation during the early part of the actual growing season are not recognized as valid observations of wetland hydrology in the Corps method.

On-site Determinations. In the field, two approaches for determining wetland can be used depending on the complexity of wetlands and the controversial nature of the case (e.g., litigation likely): (1) *routine determination* for most cases, and (2) *comprehensive determination* for difficult or controversial cases. Both procedures involve establishing transects for making observations and recording vital data. The routine determination in the field requires: (a) observing vegetation within a 5-foot radius for herbs and saplings/shrubs and within a 30-foot radius for trees and woody vines, (b) examining soils immediately below the A-horizon (the surface horizon) or 10 inches whichever is shallower, and (c) looking for signs of wetland hydrology. The comprehensive determination requires rigorous documentation of an area's vegetation, soil, and hydrology. For vegetation analysis, detailed measurements are necessary, including: (a) basal area or diameter at breast height of trees within a 30-foot radius, (b) height of shrubs/saplings within a 10-foot radius (method uses height to determine dominance and does not consider density), (c) percent cover of herb species within a 3.28-foot x 3.28-foot quadrant, and (d) stem count of woody vines within a 10-foot radius plot. In determining whether hydrophytic vegetation is present, the Corps method requires recording "the three dominant species from each vegetation layer (five species if only one or two layers are present)." If more than 50 percent of these species are OBL, FACW, and/or FAC, the vegetation is considered hydrophytic. One may also use the presence of morphological or physiological adaptations to growth in anaerobic soils or other indicators of hydrophytic vegetation. If hydrophytic vegetation exists, then one must determine whether hydric soils and then wetland hydrology are present. The wetland-nonwetland boundary is determined by the point where one of the three wetland parameters is missing. Therefore, if there are hydric soils and signs of wetland hydrology present, but the vegetation is not hydrophytic (i.e., greater than 50% of the dominant species being OBL, FACW, and/or FAC), then the area may be considered nonwetland. The Corps manual, however, does include a section on problem areas where one or more wetland parameters may be periodically lacking. It is important to note that these situations are not viewed as atypical cases, since they are due to normal seasonal or annual variations in environmental conditions.

U.S. Environmental Protection Agency

The Environmental Protection Agency has recently published the revised interim final version of *Wetland Identification and Delineation Manual* (Sipple

1988). This manual, like the Corps manual, pertains to vegetated wetlands subject to federal jurisdiction in accordance with Section 404 of the Clean Water Act, so nonvegetated wetlands and aquatic bed wetlands are not included. Perhaps the most important difference in the two approaches is that the EPA method does not require that "all three parameters (vegetation, soils and hydrology) have to be evaluated or measured in every instance in order to determine the presence and boundaries of a wetland." For example, if obligate wetland plants are dominant, in the absence of significant hydrologic modification, it can be assumed that the soils are hydric and that wetland hydrology is present. Moreover, the EPA method also considers that *all* plant species listed on the U.S. Fish and Wildlife Service's wetland plant lists are indicative of hydrophytic vegetation in the presence of hydric soils and hydrologic indicators. They do not use an abbreviated wetland plant list, as in the Corps method. EPA recognizes that facultative species, i.e., facultative wetland (FACW), facultative (FAC), and facultative upland (FACU) plants, should be considered indicative of hydrophytic vegetation if they occur in hydric soils and have one or more hydrologic indicators present. Moreover, in the presence of undrained hydric soils, a field investigator can consider supportive hydrologic information (from soil surveys or national/state hydric soils lists) to determine whether the hydrology parameter is met. The supportive data will show if significant soil saturation is expected during the wetter part of the growing season; this is particularly useful when making field inspections during late spring, summer, and fall.

Vegetation. Wetlands must have 50 percent or more of the total percent areal cover by emergent (erect, rooted non-woody plants) and/or woody species. Aquatic bed vegetation growing in ponds or shallow portions of lakes and rivers are considered to be more characteristic of permanent water areas and not of wetlands as defined by the Corps-EPA regulatory wetland definition (Table 1).

The term "prevalence" in the regulatory wetland definition is considered equivalent to dominance. Dominant plants are determined by measuring percent areal cover and, for trees, by basal area. The most abundant plants within each stratum (tree, shrub, herbaceous understory, bryophytes, and woody vines) that make up 50 percent of the stratum's total vegetative cover are considered dominants. The presence of one or more dominant obligate (OBL) wetland species in an area is indicative of wetland, provided the area's hydrology has not been significantly modified. Moreover, the various facultative species (FACW, FAC, and FACU) are also indicative of hydrophytic vegetation in the presence of hydric soils and hydrologic indicators. This is a vital point that has not been adequately addressed in the Corps method. Other indicators of hydrophytic vegetation are plants with observed or recorded morphological, physiological, and reproductive adaptations for life in inundated or saturated soils.

Hydric Soils. The EPA method handles soils similarly to the Corps method. It does mention that caution should be taken when using soil units mapped