Wetlands: An Introduction For The Non-Scientist*

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Abstract

Wetlands are difficult to understand by non-specialists, and by many specialists, too. There are differences among the general public perception of what is a wetland, the definitions used by wetland scientists, and the definitions used by regulators on jurisdictional wetlands. This primer is designed to provide an introduction to wetland defintions, how an area is determined to be wetland or upland, how the boundaries are determined, and wetland management considerations. Wetland management involves determining the functions and values of a wetland, criteria for enhancement, and design criteria for wetland creation.

Introduction

The regulatory requirements for protecting wetlands or mitigating wetland impacts can be expensive and time consuming. In addition, the permitting process when a project site contains a jurisdictional wetland creates a potential bottleneck to project development. The problem for many people is knowing what is a wetland from the perspective of laws and regulations. In those areas where wetlands tend to be seasonal, people can have a particularly difficult time identifying wetlands. This bulletin explains the criteria and methods used to identify wetlands. Unfortunately, ephemeral channels in closed basins (such as the Great Basin of the interior western US) appear to be defined under different criteria.

The definition of wetland used by wetland scientists may not be the same as that used by the wetland regulator. This article addresses the needs of the natural resource industries in working with regulators to develop projects where wetlands are involved. The regulatory definitions of wetlands was first presented by the US Fish and Wildlife Service in 1979 (1):

> "Wetlands are lands transitionional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. . . . Wetlands must have one or

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> more of the following three attributes: (1) at least periodically, the land supports predominatnly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year."

This definition is quite non-specific, but includes three components: vegetation, soils, and hydrology. Almost all jurisdictions use this definition in defining wetlands for regulatory purposes.

This is not the universal definition, however; other countries have their own definitions. In Canada, the definition adopted for use in the Canadian Wetland Registry was adopted at a workshop held the same year as the US FWS adopted the US definition (6):

> "Wetland is defined as land having the water table at, near, or above the land surface or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophytic vegetation, and various kinds of biological activity which are adapted to the wet environment."

The International Union for the Conservation of Nature and Natural Resources (IUCN) adopted the following definition in 1971 (4; 2) :

> "... areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish, or salt including areas of marine water, the depth of which at low tide does not exceed 6 meters."

and, wetlands

> "may incorporate riparian and coastal zones adjacent to the wetlands and island or bodies of marine water deepter than six meters at low tide lying within the wetlands."

Notice that the IUCN defintion does not include soils or definitions; in fact it is so broad that virtually any water-related environment could arguably be included.

In the US, the official regulatory definition comes from the Army Corps of Engineers, in their delineation guidelines manual implementing Section 404 of the Clean Water Act (7):

> "The term 'wetlands' means 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. Wetlands generally include swamps, marshes, bogs, and similar areas."

Many companies have operations outside the US, so familiarity with the idea that wetland definitions and regualations can differ greatly can facilitate planning and permitting activities.

Types of Wetlands

One problem people have in discussing wetlands is the confusing nomenclature. The terms used to define a wetland can vary regionally or nationally, and the same term can describe different conditions, depending on where that term is used. A useful list of terms is included in (3, page 32),

Bog A peat-accumulating wetland that has no significant inflows or outflows and supports acidophilic mosses, particularly sphagnum.

Bottomlands Lowlands along streams and rivers, usually on alluvial floodplains that are periodically flooded. These are usually forested and in the Southeast are sometimes called bottomland hardwood forests.

Fen A peat-accumulating wetland that receives some drainage from surrounding mineral soil and usually supports marshlike vegetation.

Marsh A frequently or continually inundated wetland characterized by emergent herbaceous vegetation adapted to saturated soil conditions. In European terminology a marsh has a mineral soil substrate and does not accumulate peat.

Mire Synonymous with any peat-accumulating wetland (European definition).

Moor Synonymous with peatland (European definition). A highmoor is a raised bog, whereas a lowmoor is a peatland in a basin or depression that is not elevated above its perimeter.

Muskeg Large expanses of peatlands or bogs; particularly used in Canada and Alaska.

Peatland A generic term of any wetland that accumulates partially decomposed plant matter.

Playa Term used in southwestern United States for marshlike ponds similar to potholes (see below) but with a different geologic origin.

Pothole Shallwo, marshlike pond, particularly as found in the Dakotas and central Canadian provinces.

Reedswamp marsh dominated by *Phragmites* (common reed); term used particularly in eastern Europe.

Slough A swamp or shallow lake system in the northern and midwestern United States. A slowly flowing shallow swamp or marsh in southeastern US.

Swamp Wetland dominated by trees for shrubs (US definition). In Europe a forested fen or reedgrass-dominated wetland is often called a swamp, for example, reedswamp.

Vernal pool Shallow, intermittently flooded wet meadow, generally dry for most of the summer and fall.

Wet meadow Grassland with waterlogged soil near the surface but without standing water for most of the year.

Wet prairie Similar to a marsh but with water leves usually intermediate between a marsh and a wet meadow.

In the late 1970s, the U.S. Fish and Wildlife Service (USFWS) developed a wetland classification system (1). This system is still used today and is seen most often on the National Wetland Inventory (NWI) maps prepared by the USFWS. It is also the preferred system to be used in reports describing wetland values and functions.

NWI maps were developed to assist communities, businesses, and individuals in locating wetlands in their area of the country. These maps were developed from high-altitude aerial photographs. Trained photointerpreters marked wetland boundaries and types on the photographs. Because most photographs were taken during the winter when deciduous trees were leafless, NWI maps for wet areas of the country (such as the Pacific Northwest) often show more wetlands than actually exist. Similarly, many small wetlands do not appear on the maps because they were too small to be seen or were hidden from the camera's view. In the process of determining and delineating wetlands, the NWI maps are only a coarse first approximation, they are not definitive.

Site-specific surveys are always required to verify the existence of wetlands shown on NWI maps. Fortunately, many communities, particularly those that are rapidly expanding, have conducted more intensive surveys for wetlands in their jurisdictions.

Identifying Wetlands

Many people mistakenly believe that all wetlands are wet all the time. Many wetlands are wet all year long; however, a lot of wetlands are wet only during a few weeks of the growing season and dry the rest of the year. Because these areas are dry most of the year, people often ask, "How wet does an area have to be before we can call it a wetland?" And, "how do I determine where the wetland stops and the uplands begin?"

The U.S. Army Corps of Engineers (Corps) and U.S. Environmental Protection Agency (EPA) jointly define wetlands as "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" (7). The phrase "normal circumstances" in the definition is important, because hydrology, soils, and vegetation can be altered in some areas reducing or eliminating the presence of wetland indicators.

Atypical situations exist when one or more of the parameters (hydrology, soils, and vegetation) have been sufficiently altered by human activities or natural events to preclude the presence of wetland indicators. Wetland delineations on agricultural lands (one of the more common atypical situations) often require different procedures than those found in the 1987 Corps Manual and these procedures may differ among the districts of the Corps.

The standard criteria for delineating wetlands in the United States is contained in the Corps of Engineers Wetlands Delineation Manual or more commonly known as the 1987 Manual. Other manuals have been developed (e.g., the 1989 Manual) but they are rarely used.

Three parameters are used to identify wetlands and delineate wetland boundaries. These parameters are hydrology (water), soils, and vegetation. For an area to be classified as a wetland, it must have at least one positive indicator for each of wetland hydrology, wetland soils, and wetland vegetation.

Wetland Hydrology

The criteria for wetland hydrology does not contain specific values for duration, frequency, and depth of soil saturation. Specific values are not appropriate because conditions vary so much from site to site across the country. Nevertheless, areas typically considered to have wetland hydrology must be inundated or saturated within a major portion of the root zone (usually within 12 inches of the surface) for at least 5 percent of the growing season (about 10 days to 2 weeks west of the Cascade Mountains in Oregon and Washington). The growing season is defined as "the portion of the year when soil temperatures at 19.7 in (50 cm) below the soil surface are higher than biologic zero ($5^oC/41^oF$)" (7). The growing season can be approximated by the number of frost-free days.

Wetland hydrology criteria can be confusing. The 1987 Manual states, "Areas with evident characteristics of wetland hydrology are those where the presence of water has an overriding influence on characteristics of vegetation and soils due to anaerobic and reducing conditions, respectively." This is circular reasoning, which leads to the confusion. The three parameters are without a doubt highly interconnected. The reason the wetland hydrology criteria exists is to confirm that current hydrologic conditions are the basis for the vegetation and soil characteristics observed at the site and that these characteristics are not remnants from a time when the site was wetter. Areas that were once wetlands but were drained may still have vegetation and soils characteristics that satisfy the 1987 Manual criteria for wetland vegetation and soils. However, the area cannot be considered a wetland unless the wetland hydrology criteria also can be satisfied.

Indicators used to determined whether wetland hydrology exists include visual observation of inundation or saturation, watermarks, drift lines, sediment deposits, drainage patterns, and oxidized rhizospheres with living roots. Oxidized rhizospheres are defined as yellowish-red zones around roots and rhizomes of some plants that grow in frequently saturated soils.

Wetland Soils

Soils found in wetlands (hydric soils) have characteristics quite different from soils found in uplands. These characteristics develop because of the anaerobic[1] conditions that result from frequent or prolonged saturation of the soil. The two most obvious characteristics of wetland soils are *gleying* and *mottling*.

Gleyed soils are found in areas with prolonged inundation or saturation during the growing season. These soils are identified by their bluish, greenish, or grayish color. Mottling describes areas of contrasting color within the soil. Mottling occurs in soils that have also been inundated or saturated during the growing season, but not long enough to produce gleyed soils. Soils with brightly-colored mottles and a soil matrix (the dominant color) of a contrasting color are indicative of soils with a fluctuating water table.

The first step in determining whether or not the soil at a site is a hydric soil is to examine the soil survey for the area published by the Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service), a unit of the US Department of Agriculture. The soil survey indicates the soil type in addition to providing useful information about soil permeability, soil texture, soil color, associated soil types, and the natural vegetation commonly found growing on each soil type.

The second step is to check the official list of hydric soils maintained by the National Technical Committee for Hydric Soils to see whether the soil at the site is listed as a hydric soil. If so, then the soil type only needs to be confirmed in the field to satisfy the wetland soil criteria. If not, then the soil must be examined for the presence of hydric soil indicators.

Indicators of hydric soils include high levels of organic matter content in the surface horizons, sulfidic material or rotten egg odor, soil color (gleying or mottling), and iron and manganese concretions. These indicators develop as a result of frequent and prolonged saturation or inundation during the growing season. However, caution must be exercised because the parent geology of a soil can significantly affect the formation or visibility of some of the hydric soil indicators.

Soil color is the most commonly used indicator, and a standard set of colors and their codes are used to record observations in the field. The Munsell®Soil Color Charts are used to identify the *hue*, *value*, and *chroma* of the soil sample. There are a number of documetned problems with reliability and longevity of this book of color charts, but that is a technical discussion to be held with regulators. The newer EarthColors book is a better choice, now that a choice is available.

Wetland Vegetation

Plants found in wetlands differ from other plant species by being able to survive in soils that are inundated or saturated for extended periods during the

[1]Water saturation limits the amounts of oxygen that the soil can contain, and that oxygen is quickly consumed by microorganisms within the soil.

Table 1: Wetland indicator categories used by the U.S. Fish and Wildlife Service to describe the likelihood of finding a specific plant species in a wetland.

Indicator Code	Status
OBL	Obligate wetland plants. Plants that occur almost always (>99% probability) in wetlands.
FACW	Facultative wetland plants. Plants that occur usually (>67% to 99% probability) in wetlands, but also occur in non-wetlands.
FAC	Facultative plants. Plants with a similar likelihood of occurring in wetlands and non-wetlands.
FACU	Facultative upland plants. Plants that occur sometimes (1% to <33% probability) in wetlands, but occur more often in non-wetlands.
UPL	Obligate upland plants. Plants that occur rarely (<1% probability) in wetlands, but occur almost always in non-wetlands.

growing season. This survival usually results from special adaptations developed by wetland plants that allows them to cope with the anaerobic conditions present in wetland soils. Upland species typically cannot survive in wetlands because their roots need a constant supply of oxygen. The USFWS maintains a list of plant species that occur in wetlands (5).

The USFWS uses five categories to distinguish among plants that are always found in wetlands, may be found in wetlands, and usually not found in wetlands (Table 1).

To determine whether or not the wetland vegetation criterion is met, the plant species in each vegetative stratum (herbaceous or non-woody plants, shrubs, and trees) are identified. From this list, the dominant plant species in each stratum are determined. If more than 50 percent of the dominant species are FAC, FACW, or OBL species (see 1), then the wetland vegetation criterion is fulfilled. The areal extent surveyed for vegetation must be clearly described in field notes and the submitted report, and it must be sufficiently large to characterize the range of plant species present and their relative dominance. Identifications must also be determined to the species level, if not to a particular variety of a species when this is possible. This indicator category is examined closely by regulators and needs to be prepared with care and competence.

Vegetation has been significantly altered in many areas (an atypical situation), so it is not always a reliable indicator of the presence of a wetland. When these atypical situations exist, the vegetation criteria is thrown out and the delineation is based entirely on the wetland hydrology and soils criteria. Often undisturbed areas exist nearby which can be used to provide clues as to the vegetation likely to occur in the area.

However, when the area being surveyed is in agricultural production but was ditched, tiled, or otherwise drained for farming some time in the past, a completely different set of criteria are applied. These are defined by the Farm Security Agency of the US Department of Agriculture and rely heavily on historical ærial photographs to determine when the wetland was converted to agricultural use and if there were extensive periods in which farming did not occur.

Delineating a Wetland

Once an area has been determined to be a wetland, it is necessary to establish the wetland's boundary. Unless the wetland is confined by a stream bank, dike, road, or some other feature, the wetland "edge" is a diffuse transition zone. In particularly flat areas, this zone can extend for 5 meters or more.

To determine where the hydric soil indicators stop, pits are dug in the soil. Each pit is only as wide as necessary to see the soil horizons and to cut a slice from the surface to a depth of at least 18 in (50 cm). Soil samples from each horizon are examined for color, texture, cohensivelness, odor, moisture, and type (humus, loam, sand, clay, or combinations of these types). Then, the presence of wetland vegetation and hydrology are examined. All observations are recorded in detail.

The boundary is set where indicators for any one of the three parameters no longer exists. Procedures for atypical situations are slightly different. The investigator's experience is used to decide just where to place the boundary flags. Once the boundary has been defined the most efficient and cost-effective way of recording the boundary is to use a calibrated global positioning system (GPS) receiver and locate the boundary with an accuracy appropriate to the topography. This means that on a very flat area, 5 m would include the entire transition zone, while in a steeper area 30–100 cm might be appropriate. Because most wetland boundaries are diffuse transition zones, this degree of accuracy is typically sufficient.

Wetland Management

Functions and Values

Wetlands provide four broad categories of functions:

1. Flood and storm storage; aquifer recharge.

2. Water quality improvements.

3. Migratory and resident animal habitats.

4. Nurseries and refugia for aquatic animals.

Flood and Storm Storage; Aquifer Recharge

Wetlands along the banks of streams and rivers (the riparian zone) may be saturated or flooded only during snowmelt runoff and storm events that raise the water levels above the banks of the channel. Because the area now covered by the flooding river is much broader than that area only within the banks, and because there can be extensive vegetation from grasses to trees within this area, the velocity of the stream or river decreases. The discharge may remain high (that is, the total volume of water passing a line perpendicular to the direction of flow), but the slower current reduces the power of the moving water so it is less destructive than otherwise. When the flood surge passes, the water slowly returns to within the channel banks because the riparian zone vegetation traps and stills the water. Much of the water may infiltrate into the soils and return to the channel as groundwater in the vadose zone (or deeper) rather than via the surface. This increased storage capacity delivers nutrients and sediments to the floodplain as well as reducing (or eliminating) destruction further down river.

In a similar way, detenstion ponds created as wetlands can store storm water to prevent the flooding that might occur down stream if the surface runoff of the storm is allowed to flow directly into the receiving stream. Vegetation within these storm basins slow the water, assist in infiltration of the water into the surface aquifer (or a deeper one if that's how the wetland was constructed), and can filter toxic chemicals (metals and organics) from the water before it enters the receiving stream. The functions of such a storm water detention pond can easily accommodate several desired objectives simultaneously.

Many areas of the country are depleting ground water aquifers at rates greater than can be recharged under existing conditions. Most of these problems are a result of increased human populations and urbanization, with the result of more impervious surfaces over which water runs off rather than infiltrating and percolating into the ground to recharge the aquifers. A well designed storm water system can incorporate wetlands that retain the water, lower evaporation rates because of the vegetation, and permit the water to percolate deep into the ground for aquifer recharge.

Water Quality Improvements

Wetlands filled with emergent vegetation in dense stands certainly do an outstanding job of removing sediments from inflowing waters. They slow the velocity so that almost all particles can settle out of suspension, and the stems and leaves of the macrophytes growing in the wetland trap most of the rest. More importantly, plants can remove both organic compounds and metals dissolved in the incoming waters so the measured concentrations of water entering the receiving stream are much lower than the incoming water. Depending on the chemical being removed and the plant species doing the work, there are practical limits on the removal capacity of many chemicals, particularly the inorganic metals. Research on this process is still in the earlier stages, but more practical information will be developed each year.

Animal Habitats

Wetlands are commonly used by migrating waterfowl, shorebirds, fish, amphibians, and mammals. Factors affecting the use of a wetland by different animals include the wetland's size, relationship to an open water body such as a lake or river, the density of vegetation, area of surface water, whether vegetation is submerged, floating, or emergent.

If the wetland has islands of dry ground surrounded by water animals such as the Western pond turtle and ducks will build nests on the raised area because it provides some protection of their eggs and young. Frogs will use floating vegetation (such as lily pads) while redwinged and tri-color blackbirds will use large emergent plants such as cattails for resting while foraging for insects.

The values associated with wetlands are how society thinks about the wetland functions. Many of these values (e.g., æsthetics, educational opportunities, recreation) are based on the wildlife found in wetlands.

Nurseries and Refugia

In addition to the use of wetlands by resident and migratory animals, they frequently provide protected nurseries for fish (especially shallow water and anadromous species) and refugia from predation for both juveniles and adults. This is particularly true of esturarine wetlands at the mouths of rivers that flow into oceans. Saltwater fish and shellfish species that are highly dependent upon wetlands include menhaden, shrimp, blue crab, oyster, mullet, sea trout, Atlantic croaker, hard clam, fluke, soft clam, bluefish, drum, and spot. Among the anadromous fish species dependent upon estuarine wetlands are the salmon, striped bass, shad, and alewife.

Inland, freshwater wetlands also provide nurseries and refugia for animals such as the muskrat, nutria, and alligator. Many fish depend on freshwater wetlands at different phases of their life cycle. These fish include catfish, bullhead, carp, buffalo, perch, pickerel, sunfish, and trout.

Improvement and Creation

Because the US federal government and many states have a policy of "no net loss" of wetland area and function, industrial and developmental activities that fill or remove wetlands almost always require mitigation for the loss. The mitigation can involve improving existing wetlands (either on- or off-site) or creating new wetlands. Because these activities involve the expenditure of large amounts of money (particulary when monitoring and continual maintenance are required), it behooves companies to invest in comprehensive planning in order to minimize costs and extract the maximum value of the improvement or creation efforts.

Design Criteria

There are so many variables to be considered in designing wetland enhancement or creation that it is impossible to provide a cookbook approach. Regardless, there are three factors that must be comprehensively considered when designing the project: purposes, water table elevations, and the overall topography and hydrology of the basin in which the wetland is located.

A wetland's purpose dictates how much open water needs to be available, and for what portion of the year. The type of vegetation must be carefully planned to avoid both monocultures and the need for physical maintenance. The species themselves may be subject to state control. For example, the common cattail, *Typha latifolia*, is considered an invasive weed in Florida and must be removed by hand if it appears in an enhanced or created wetland, while in Oregon this species is highly desired in wetlands. If you want the wetland to support fish such as suckers, there needs to be safe locations for adults to spawn and lay eggs and for the young to find refuge from predation. If the wetland is to serve primarily for flood and storm water storage and water quality improvements, then a different physical design and vegetative composition is needed compared with a wetland used for fish and wildlife.

Too many wetlands are built too shallowly to permit standing water on the surface or within 12 in (30 cm) of the surface during the dryest time of the year. If such a wetland was created as a permit condition for developmental activities, the developer might be responsible for watering the wetland during the summer. This can be expensive in both direct costs and labor. It is much better to have a comprehensive hydrograph for the area that reveals how deep the wetland area must be for it to maintain itself naturally.

Part of determining the above is to examine the topography and hydrology of the basin in which the new or enhanced wetland is located. If it is hydrologically connected to a stream or river the design criteria will be different than if it is hydrologically connected to upland areas with surface runoff and shallow ground water flows during only part of the year.

The important point to remember is that more data, thinking, and planning during the conceptual and design phases of wetland enhancement and creation can much less costly than either trying to fix mistakes later or being responsbile for perpetual maintenance.

About The Author

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References

[1] Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-79/31.

[2] Finlayson, M. and M. Moser, eds. 1991. *Wetlands*. Facts On File, Oxford, England. 224pp.

[3] Mitsch, W.J. and J.Gl Gosselink. 1993. *Wetlands, Second Edition*. John Wiley & Sons, New York. 722 pp.

[4] Navid, D. 1989. The international law of migratory species: The Ramsar Convention, *Natural Resources Journal* **29**:1001-1016.

[5] Reed, P.B. Jr. 1988. National list of plant species that occur in wetlands: northwest (region 9). U.S. Fish and Wildlife Service, St. Petersburg, FL. Biological Report 88(26.9).

[6] Tarnocai, C. 1979. Canadian wetland registry, in *Proceedings of a Workshop on Canadian Wetlands Environment*, C.D.A. Rubec and F.C. Pollett, eds. Canada Land Directorate, Ecological Land Classification Series, No. 12, pp. 9–38.

[7] U.S. Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Technical Report Y-87-1.