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Environmental Laboratory

US Army Corps of Engineers®
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Wetlands Regulatory Assistance Program

Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region

U.S. Army Corps of Engineers

September 2008

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U.S. Army Corps of Engineers

U.S. Army Engineer Research and Development Center
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Final report

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Abstract: This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual, which provides technical guidance and procedures for identifying and delineating wetlands that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act. The development of Regional Supplements is part of a nationwide effort to address regional wetland characteristics and improve the accuracy and efficiency of wetland-delineation procedures. This supplement is applicable to the Midwest Region, which consists of all or portions of 14 states: Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, and Wisconsin.

Contents

Figures and Tables

Figures

Tables

Preface

This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual. It was developed by the U.S. Army Engineer Research and Development Center (ERDC) at the request of Headquarters, U.S. Army Corps of Engineers (USACE), with funding provided through the Wetlands Regulatory Assistance Program (WRAP).

This document was developed in cooperation with the Midwest Regional Working Group. Working Group meetings were held in Cincinnati, OH, on 6-8 November 2006 and Chicago, IL, on 13-15 March 2007. Members of the Regional Working Group and contributors to this document were:

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Independent peer reviews were performed in accordance with Office of Management and Budget guidelines. The peer-review team consisted of Joseph Hmieleski, Chair, Lake County Stormwater Management Commission, Libertyville, IL; Hugh Crowell, Hull and Associates, Inc., Dublin, OH; Mark Dilley, MAD Scientist LLC, Westerville, OH; Eric Ellingson, Earth Source, Inc., Fort Wayne, IN; Richard Gitar, Fond du Lac Indian Reservation, Cloquet, MN; Judy Krieg, EarthView Environmental LLC, Coralville, IA; Frank Norman, Applied Ecological Services, Inc., Kansas City, MO; Joe Pagliara, Natural Resources Consulting, Inc., Stevens Point, WI; Stephen Parker, Adaptive Ecosystems, Inc., Grandview, MO; and Daniel Zay, DLZ, Inc., Lansing, MI.

Technical editors for this Regional Supplement were Dr. James S. Wakeley, Robert W. Lichvar, and Chris V. Noble, ERDC. Katherine Trott was the project proponent and coordinator at Headquarters, USACE. During the conduct of this work, Dr. Morris Mauney was Chief of the Wetlands and Coastal Ecology Branch; Dr. David Tazik was Chief, Ecosystem Evaluation and Engineering Division; Bob Lazor was Director of WRAP; and Dr. Elizabeth Fleming was Director, EL. COL Gary E. Johnston was Commander and Executive Director of ERDC. Dr. James R. Houston was Director.

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1 Introduction

Purpose and use of this regional supplement

This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual (hereafter called the Corps Manual). The Corps Manual provides technical guidance and procedures, from a national perspective, for identifying and delineating wetlands that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act (33 U.S.C. 1344) or Section 10 of the Rivers and Harbors Act (33 U.S.C. 403). According to the Corps Manual, identification of wetlands is based on a three-factor approach involving indicators of hydrophytic vegetation, hydric soil, and wetland hydrology. This Regional Supplement presents wetland indicators, user notes, delineation guidance, and other information that is specific to the Midwest Region. User notes provide important guidance for proper application of this supplement.

This Regional Supplement is part of a nationwide effort to address regional wetland characteristics and improve the accuracy and efficiency of wetland-delineation procedures. Regional differences in climate, geology, soils, hydrology, plant and animal communities, and other factors are important to the identification and functioning of wetlands. These differences cannot be considered adequately in a single national manual. The development of this supplement follows National Academy of Sciences recommendations to increase the regional sensitivity of wetland-delineation methods (National Research Council 1995). The intent of this supplement is to bring the Corps Manual up to date with current knowledge and practice in the region and not to change the way wetlands are defined or identified. The procedures given in the Corps Manual, in combination with wetland indicators and guidance provided in this supplement, can be used to identify wetlands for a number of purposes, including resource inventories, management plans, and regulatory programs. The determination that a wetland is subject to regulatory jurisdiction under Section 404 or Section 10 must be made independently of procedures described in this supplement.

This Regional Supplement is designed for use with the current version of the Corps Manual (Environmental Laboratory 1987) and all subsequent versions. Where differences in the two documents occur, this Regional

Supplement takes precedence over the Corps Manual for applications in the Midwest Region. Table 1 identifies specific sections of the Corps Manual that are replaced by this supplement. Other guidance and procedures given in this supplement and not listed in Table 1 are intended to augment the Corps Manual but not necessarily to replace it. The Corps of Engineers has final authority over the use and interpretation of the Corps Manual and this supplement in the Midwest Region.

Indicators and procedures given in this Supplement are designed to identify wetlands as defined jointly by the Corps of Engineers (33 CFR 328.3) and Environmental Protection Agency (40 CFR 230.3). Wetlands are a subset of the "waters of the United States" that may be subject to regulation under Section 404. One key feature of the definition of wetlands is that, under normal circumstances, they support "a prevalence of vegetation typically adapted for life in saturated soil conditions." Many waters of the United States are unvegetated and thus are excluded from the Corps/EPA definition of wetlands, although they may still be subject to Clean Water Act regulation. Other potential waters of the United States in the Midwest include, but are not limited to, unvegetated seasonal pools, lakes, mud flats, and perennial, intermittent, and ephemeral stream channels. Delineation of these waters is based on the "ordinary high water mark" (33 CFR 328.3e) or other criteria and is beyond the scope of this Regional Supplement.

Amendments to this document will be issued periodically in response to new scientific information and user comments. Between published versions, Headquarters, U.S. Army Corps of Engineers, may provide updates to this document and any other supplemental information used to make wetland determinations under Section 404 or Section 10. Wetland delineators should use the most recent approved versions of this document and supplemental information. See the Corps of Engineers Headquarters regulatory web site for information and updates (http://www.usace.army.mil/inet/functions/cw/cecwo/reg/). The Corps of Engineers has established an interagency National Advisory Team for Wetland Delineation whose role is to review new data and make recommendations for needed changes in wetland-delineation procedures to Headquarters, U.S. Army Corps of Engineers. Items for consideration by the team, including full documentation and supporting data, should be submitted to:

National Advisory Team for Wetland Delineation
Regulatory Branch (Attn: CECW-CO)
U.S. Army Corps of Engineers
441 G Street, N.W.
Washington, DC 20314-1000

Table 1. Sections of the Corps Manual replaced by this Regional Supplement for applications in the Midwest Region.

Item	Replaced Portions of the Corps Manual (Environmental Laboratory 1987)	Replacement Guidance (this Supplement)
Hydrophytic Vegetation Indicators	Paragraph 35, all subparts, and all references to specific indicators in Part IV.	Chapter 2
Hydric Soil Indicators	Paragraphs 44 and 45, all subparts, and all references to specific indicators in Part IV.	Chapter 3
Wetland Hydrology Indicators	Paragraph 49(b), all subparts, and all references to specific indicators in Part IV.	Chapter 4
Growing Season Definition	Glossary	Chapter 4, Growing Season; Glossary
Hydrology Standard for Highly Disturbed or Problematic Wetland Situations	Paragraph 48, including Table 5 and the accompanying User Note in the online version of the Manual	Chapter 5, Wetlands that Periodically Lack Indicators of Wetland Hydrology, Procedure item 3(g)

Applicable region

This supplement is applicable to the Midwest Region, which consists of all or portions of 14 states: Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, Ohio, South Dakota, and Wisconsin (Figure 1). The region encompasses a variety of landforms and ecosystems, but is differentiated from surrounding regions mainly by the combination of a relatively low level of topographic relief, a humid climate with moderate to abundant rainfall, mixed prairie and hardwood natural vegetation, and the predominance of agricultural land uses including the extensive use of agricultural drainage systems.

The approximate spatial extent of the Midwest Region is shown in Figure 1. The region is equivalent to Land Resource Region (LRR) M recognized by the U. S. Department of Agriculture (USDA Natural Resources Conservation Service 2006a). All of the wetland indicators presented in this supplement are applicable throughout the entire Midwest Region.

Region boundaries are depicted in Figure 1 as sharp lines. However, climatic conditions and the physical and biological characteristics of landscapes do not change abruptly at the boundaries. In reality, regions and subregions often grade into one another in broad transition zones that may be tens or hundreds of miles wide. The lists of wetland indicators presented in these Regional Supplements may differ between adjoining regions or subregions. In transitional areas, the investigator must use experience and good judgment to select the supplement and indicators that are appropriate to the site based on its physical and biological characteristics. Wetland boundaries are not likely to differ between two supplements in transitional areas, but one supplement may provide more detailed treatment of certain problem situations encountered on the site. If in doubt about which supplement to use in a transitional area, apply both supplements and compare the results. For additional guidance, contact the appropriate Corps of Engineers District Regulatory Office. Contact information for District regulatory offices is available at the Corps Headquarters web site (http://www.usace.army.mil/inet/functions/cw/cecwo/reg/district.htm).

Figure 1. Approximate boundaries of the Midwest Region. This supplement is applicable throughout the highlighted area (see text for details).

Physical and biological characteristics of the region

The Midwest Region today is the agricultural heartland of the United States. It is a region of generally flat to rolling topography, fertile soils, and moderate to abundant rainfall, ideally suited to the production of crops and livestock. Elevation ranges from approximately 100 to 2,000 ft (30 to 600 m) above sea level. Except in Oklahoma and southern Kansas, the region was shaped and smoothed by continental glaciers, the last of which receded 10,000 to 15,000 years ago. The Driftless Area in southwestern Wisconsin and adjacent portions of Minnesota, Iowa, and Illinois was surrounded but not overridden by glacial ice during the most recent, or Wisconsinan, glacial advance, resulting in an older, more eroded, and steeper topography than in most of the region. Floristically, the Midwest is a region of broad transitions or ecotones between the prairie ecosystems to the west, humid deciduous forests to the east and south, and coniferous and mixed forests to the north (Bailey 1995, USDA Natural Resources Conservation Service 2006a, World Wildlife Fund 2006).

Average annual precipitation across the region ranges from 19 to 48 in. (485 to 1,220 mm) but is mostly between 32 and 39 in. (815 to 990 mm). Precipitation generally increases from north to south, and falls primarily during the growing season. Annual precipitation is variable and the region is subject to prolonged wet periods alternating with prolonged droughts. Average annual temperature across much of the region ranges from 47 to 53 °F (8 to 12 °C) (USDA Natural Resources Conservation Service 2006a). In this climate, annual precipitation exceeds evapotranspiration, groundwater recharge occurs in both uplands and lowlands, water tables tend to follow the contours of the land surface, and many wetlands are maintained in part by groundwater discharge (Richardson et al. 2001).

The principal soil parent materials in the Midwest Region are glacial tills and outwash, glacial lake sediments, wind-blown loess, and alluvium deposited along major rivers and streams. Dark-surfaced prairie soils (Mollisols) dominate the western part of the region, grading to lighter colored forest soils (Alfisols) toward the east. Organic soils (Histosols) occur in many current and former wetlands (USDA Natural Resources Conservation Service 2006a).

Tall-grass prairie once dominated the pre-settlement vegetation of the Midwest west of the Mississippi River in Iowa, southern Minnesota, eastern South Dakota, and eastern Nebraska. East of the Mississippi River the prairie peninsula extended into western Wisconsin, much of Illinois, and northwestern Indiana (Transeau 1935). Important species include big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), and Indian grass (*Sorghastrum nutans*). The prairies were maintained, at least in part, by fire, hydrologic conditions, and grazing. Deciduous forest is encroaching upon the prairies due to the suppression of wildfires and loss of bison (*Bison bison*) (Bailey 1995, World Wildlife Fund 2006).

The natural vegetation of Illinois, southeastern Wisconsin, western Indiana, northern Missouri, southeastern Kansas, and northeastern Oklahoma is a mixture of savanna, prairie, and woodlands (World Wildlife Fund 2006). Deciduous forests often occur in strips along streams and on north-facing slopes where soil moisture is more plentiful. Important tree species include oaks (*Quercus* spp.), hickories (*Carya* spp.), and maples (*Acer* spp.). In the western part of the Midwest Region, eastern cottonwood (*Populus deltoides*), black willow (*Salix nigra*), and American elm (*Ulmus americana*) are common in floodplains (Bailey 1995).

Portions of Indiana, Ohio, and southern Michigan in the region were covered by deciduous forests before the development of agriculture, industry, and municipalities. Historically, these forests were dominated by maples and American beech (*Fagus grandifolia*) with oaks, hickories, and American basswood (*Tilia americana*) as secondary species. Patches of prairie grasslands, oak openings, and oak savannas exist in areas affected by fire and shallow water tables (Lindsey et al. 1969, World Wildlife Fund 2006).

Types and distribution of wetlands

Following the Wisconsinan glaciation – the last major advance of continental glaciers – the Midwest Region was rich in wetlands in terms of numbers, acreage, and types. The region includes a portion of the Prairie Pothole Region where wetland basins numbered in the dozens per square mile and ranged from less than a quarter acre to over a thousand acres in size. North-central Iowa (the Des Moines Lobe) was so wetland-rich that it was first considered inhospitable, if not uninhabitable, by early European explorers (Galatowitsch and van der Valk 1998). Early European settlers described interminable “sloughs” that impeded travel to the extent that an entire day could be spent moving wagons and livestock a few hundred yards. European settlement eventually brought drainage and large-scale conversion of Midwestern wetlands to agriculture, creating some of the richest farmland in the world but also resulting in one of the most intensively drained regions in the United States. In southern and western Minnesota, for example, 80 percent of historic wetlands have been converted to agriculture and other uses. Iowa has lost 89 percent of its historic wetlands, Missouri 87 percent, Illinois 85 percent, Indiana 87 percent, and Ohio 90 percent (Dahl 1990).

In many cases, however, the use of Midwestern wetlands for agricultural purposes has been accomplished without loss of the underlying wetland hydrology or some of the natural functions of those wetlands. Often the only alteration of the wetland system has been the removal or management of natural vegetation to facilitate the production of crops (e.g., corn (*Zea mays*) and soybeans (*Glycine max*)) or livestock, particularly during dry years. Unless the conversion to agriculture included the installation of an effective drainage system, many farmed wetlands retain their natural hydrologic regimes and would revert to one or more of the wetland types described in this section if they were not tilled, planted, mowed, or grazed regularly. Guidance for identifying wetlands in areas currently used for agriculture is provided in Chapter 5.

Most of the remaining wetlands in the Midwest Region that are not in agricultural use can be classified generally as prairie wetlands, riverine wetlands, and eastern forested wetlands. General descriptions of these wetland types are provided in the following paragraphs. Even in relatively undisturbed situations, species composition can be highly variable and some species occur widely across different subregions and wetland types. Furthermore, many wetlands in the region are degraded to varying extents by human activities and invasive species. Therefore, lists of plant species mentioned in these descriptions are intended as examples and are not exhaustive.

Prairie wetlands

Prairie wetlands occur throughout the region and consist of a continuum of types along interacting gradients of water permanence, depth, and quality. Examples of prairie wetlands include seasonally flooded basins, wet prairies, sedge meadows, shallow and deep marshes, and open water systems.

Seasonally flooded basins hold water for only a few weeks in the early part of the growing season of most years. Mudflats left by the receding water are often taken over by annual species including pinkweed (*Polygonum pensylvanicum*), nodding smartweed (*P. lapathifolium*), wild millet (*Echinochloa crusgalli*), blunt spikerush (*Eleocharis obtusa*), and beggarticks (*Bidens* spp.).

Wet prairies typically have saturated soils and are dominated by perennial, native grasses such as prairie cord-grass (*Spartina pectinata*), Canada blue-joint grass (*Calamagrostis canadensis*), bog reed-grass (*C. stricta*), and big bluestem. Sedges (*Carex* spp.), such as woolly sedge (*C. pellita*), are often present. Perennial wet-prairie forbs may include gayfeather (*Liatris pycnostachya*), white lady's-slipper (*Cypripedium candidum*), sawtooth sunflower (*Helianthus grosseserratus*), mountain mint (*Pycnanthemum virginianum*), and Riddell's goldenrod (*Solidago riddellii*). Reed canary grass (*Phalaris arundinacea*) often dominates disturbed, former wet-prairie sites, such as those impacted by drainage and cultivation.

Sedge meadow communities are dominated by sedges (e.g., *Carex* spp., *Eleocharis* spp.) as opposed to the native grasses of wet prairie communities. Soil saturation and inundation are of greater duration and frequency compared to wet prairies (Galatowitsch and van der Valk 1998). Many of the same forbs occur in wet prairies and sedge meadows. In substantially disturbed sites, reed canary grass replaces many or all of the sedge meadow species.

The hydrology of prairie marshes ranges from saturated only to inundated with several feet of water. Shallow marshes are seasonal in that shallow inundation during the first part of the growing season may draw down to saturated soils by late in the growing season. Deep marshes are typically semi-permanent, drying out only during drought years. Perennial emergent vegetation includes hardstem bulrush (*Schoenoplectus acutus = Scirpus acutus*), giant bur-reed (*Sparganium eurycarpum*), broad-leaved arrowhead (*Sagittaria latifolia*), slough sedge (*Carex atherodes*), lake sedge (*C. lacustris*), three-square bulrush (*Schoenoplectus pungens = Scirpus pungens*), broad-leaved cattail (*Typha latifolia*), common reed (*Phragmites australis*), water smartweed (*Polygonum amphibium*), and river bulrush (*Bolboschoenus fluviatilis = Scirpus fluviatilis*). Floating and submergent vegetation is similar to that listed for open-water prairie potholes (see below). Non-native and/or invasive species that can be problematic in prairie marshes include purple loosestrife (*Lythrum salicaria*), hybrid cattail (*Typha* x *glauca*), Eurasian water-milfoil (*Myriophyllum spicatum*), and curly pondweed (*Potamogeton crispus*).

Open-water prairie wetlands are up to 6.6 ft (2 m) in depth and typically are permanent, as most do not dry out completely even during drought years. Vegetation includes sago pondweed (*Potamogeton pectinatus*), floating-leaved pondweed (*P. natans*), coontail (*Ceratophyllum demersum*), bladderwort (*Utricularia macrorhiza*), white water crowfoot (*Ranunculus longirostris*), and duckweeds (*Lemna, Spirodela*, and *Wolffia*).

As mentioned previously, the Prairie Pothole Region extends into the western part of the Midwest Region and represents a subset of prairie wetlands in the region. Prairie potholes are shallow, water-holding depressions of glacial origin found in the prairies of the north-central United States and south-central Canada (Sloan 1972). They occur in greatest abundance in undulating deposits of glacial till (Mitsch and Gosselink 2000). In the Midwest, the Prairie Pothole Region includes eastern South Dakota, southern and western Minnesota, and Iowa as far south as present-day Des Moines. Prairie potholes have great variability in size, depth, water permanence, and water chemistry (Sloan 1972, Stewart and Kantrud 1972). Water chemistry can be fresh, mixosaline, saline, or hypersaline. Prairie pothole wetlands range from seasonally flooded basins, to wet prairies, to sedge meadows, to shallow and deep marshes, to permanent open water. Prairie potholes exhibit a zonal pattern with wetter conditions in the center of the basin and concentric outlying zones that have shorter duration inundation and/or saturation (Stewart and Kantrud 1971, Galatowitsch and van der Valk 1998). This diversity of wetland types, combined with a variety of upland prairie communities, results in a mosaic with high biodiversity and productivity. Multi-year wet and drought cycles are typical in the Prairie Pothole Region.

Riverine wetlands

Extensive wetland complexes remain along major rivers in the Midwest Region, such as the Mississippi, Minnesota, Missouri, Wisconsin, Illinois, and Wabash Rivers. Most of the larger rivers have been altered by dams. Wetlands associated with riverine systems include floodplain forests, hardwood swamps, shrub swamps, and backwater marshes.

Floodplain forested wetlands occur on alluvial soils that are periodically inundated during spring and following heavy precipitation events in summer. Inundation is temporary, leaving these communities relatively well-drained for much of the growing season (Shaw and Fredine 1971). Tree species include silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), eastern cottonwood, river birch (*Betula nigra*), American elm, box elder (*Acer negundo*), sycamore (*Platanus occidentalis*), Ohio buckeye (*Aesculus glabra*), pin oak (*Quercus palustris*), overcup oak (*Q. lyrata*), shellbark hickory (*Carya laciniosa*), and black willow. The shrub layer is typically sparse to absent because of frequent flooding. Vines include riverbank grape (*Vitis riparia*) and poison ivy (*Toxicodendron radicans*). Typical herbaceous species include wood nettle (*Laportea canadensis*), false nettle (*Boehmeria cylindrica*), jewelweed (*Impatiens capensis*), cardinal flower (*Lobelia cardinalis*), and Gray's sedge (*Carex grayi*).

In riverine systems, hardwood swamps typically occur in ancient oxbows and are wet longer than other floodplain forests. Hydrology of hardwood swamps ranges from saturated soils to shallow inundation. Black ash (*Fraxinus nigra*) may be a primary dominant, and swamp red maple (*Acer rubrum* var. *drummondii*) occurs in swamps in the southern portion of the Midwest Region. Some of the tree species of the floodplain forest community may occur as non-dominants in swamps. The shrub layer includes red-osier dogwood (*Cornus stolonifera*), buttonbush (*Cephalanthus occidentalis*), winterberry (*Ilex verticillata*), and various willows (*Salix* spp.). Herbaceous species include wood-reed (*Cinna arundinacea*), lake sedge, skunk cabbage (*Symplocarpus foetidus*), and blue flag iris (*Iris versicolor*). Hardwood swamps also occur in ancient lake basins. Their vegetation is similar to that described above for hardwood swamps of riverine oxbows.

Shrub swamps occur in riverine settings and in some prairie wetland situations, particularly in areas sheltered from fire and cultivation. They may support buttonbush, red-osier dogwood, gray dogwood (*Cornus racemosa*), beaked willow (*Salix bebbiana*), pussy willow (*S. discolor*), and other shrub species. Hydrology of these wetlands ranges from saturated soils to short periods of inundation. Ground-layer species include giant goldenrod (*Solidago gigantea*), red-stem aster (*Aster puniceus*), marsh milkweed (*Asclepias incarnata*), joe-pye weed (*Eupatorium maculatum*), and fowl bluegrass (*Poa palustris*).

Backwater marshes may have saturated soils to several feet of surface water. They support a diversity of emergent, floating, and submergent species, which may include cattails (*Typha* spp.), softstem bulrush (*Schoenoplectus tabernaemontani = Scirpus validus*), giant bur-reed, American lotus (*Nelumbo lutea*), bottlebrush sedge (*Carex comosa*), pickerelweed (*Pontederia cordata*), broad-leaved arrowhead, yellow water-lily (*Nuphar lutea*), white water-lily (*Nymphaea odorata*), floating-leaved pondweed, large-leaved pondweed (*Potamogeton amplifolius*), wild celery (*Vallisneria americana*), coontail, and duckweeds. Non-native and/or invasive species that can be problematic in backwater marshes include the same species listed above for prairie marshes.

Eastern forested wetlands

Portions of Indiana, Ohio, and southern Michigan that were forested before European settlement contain scattered remnants of depressional and other wetland systems. Sometimes called eastern vernal pools, ephemeral ponds occupy isolated depressions within generally forested landscapes. Primary sources of hydrology are rainfall and surface runoff, although some pools are connected to local groundwater sources. Typically, pools are filled from late winter until early summer, but timing and duration of inundation are highly variable depending upon precipitation patterns (Colburn 2004). Soils in ephemeral pools often have organic surface layers that may be an inch or two to many feet thick. Although located in forested areas, the bulk of the depression is often unvegetated beneath the forest canopy. Common tree and shrub species found around the perimeter and growing on hummocks within the pools include green ash, black ash, red maple, silver maple, pin oak, American elm, buttonbush, spicebush (*Lindera benzoin*), winterberry, and black chokeberry (*Aronia melanocarpa*) (Mack 2004, 2007). The ground layer is usually sparse with bare soil or leaf litter comprising most of the surface area. Typical ground-layer species include Gray's sedge, brome-like sedge (*Carex bromoides*), wood-reed, jewelweed, creeping jenny (*Lysimachia nummularia*), skunk cabbage, cinnamon fern (*Osmunda cinnamomea*), and liverworts (e.g., *Riccia fluitans*). After pools dry out in early summer, or in dry years, the basins are often colonized by upland annual plants.

Oak openings are areas dominated by scattered black oak (*Quercus velutina*) and white oak (*Q. alba*) growing on sandy beach ridges that originated as ancient lakeshores from the Pleistocene period. Oak openings are found near the southern ends of present-day Lakes Michigan and Erie along the northern fringe of the Midwest Region in Illinois, Indiana, and Ohio. Prairie wetlands dominated by grasses and sedges often occupy the low areas between ancient dunes. Underlying clay till slows the infiltration of snowmelt and spring rainfall, causing water to perch within the sandy deposits above. In wet prairie habitats in the swales, water often ponds in the spring but gradually dries out in summer and fall. The sandy soils are often mucky and alkaline in wet prairie areas. Twig rush (*Cladium mariscoides*) and slender sedge (*Carex lasiocarpa*) are found in swales. In some areas, wet forest communities dominated by pin oak and swamp white oak (*Quercus bicolor*) occupy low areas (Brewer and Vankat 2004).

Flatwoods wetlands and forested seeps (slope wetlands) are seasonally inundated or saturated systems that occur in nonriverine settings. Common species in northeastern Illinois include swamp white oak and black ash (*Fraxinus nigra*). In Ohio and Indiana, common species include swamp white oak, red maple, and pin oak.

Other wetland types

Calcareous fens are a rare wetland type in the Midwest Region and occur at scattered locations. Soils are typically sloping deposits of muck or peat, or raised peat "mounds" formed by upwelling of groundwater. Calcareous fens occur where discharging groundwater (e.g., in springs and seeps) is rich in calcium and magnesium carbonates or sulfates (Curtis 1959). Only a select group of calcium-tolerant species – calciphiles – can tolerate the harsh, alkaline soil conditions. These include sterile sedge (*Carex sterilis*), beaked spikerush (*Eleocharis rostellata*), grass-of-Parnassus (*Parnassia glauca*), and brook lobelia (*Lobelia kalmii*). Disturbed calcareous fens are often dominated by invasive species including reed canary grass, hybrid cattail, common reed, and/or European buckthorns (*Rhamnus frangula*, *R. cathartica*).

Bogs are wetlands formed in depressions, such as kettle holes, where precipitation is the primary hydrologic input. Bogs develop soils that are rich in organic matter and support plant species adapted to acidic and nutrient-poor conditions. Generally the ground layer is dominated by *Sphagnum* or other acid-loving mosses. Typical vascular plant species include tamarack (*Larix laricina*) trees; ericaceous shrubs, such as leatherleaf (*Chamaedaphne calyculata*); cranberries (*Vaccinium* spp.); and pitcher plants (*Sarracenia purpurea*) (Mack 2004, 2007).

A small finger of the Midwest Region includes dune-and-swale complexes along the southwest shore of Lake Michigan. Wetlands occur on hydric sandy soils in the swales. Vegetation consists of wet prairie, sedge meadow, calcareous fen, shallow marsh, and shrub swamp communities.

2 Hydrophytic Vegetation Indicators

Introduction

The Corps Manual defines hydrophytic vegetation as the community of macrophytes that occurs in areas where inundation or soil saturation is either permanent or of sufficient frequency and duration to exert a controlling influence on the plant species present. The manual uses a plant-community approach to evaluate vegetation. Hydrophytic vegetation decisions are based on the assemblage of plant species growing on a site, rather than the presence or absence of particular indicator species. Hydrophytic vegetation is present when the plant community is dominated by species that can tolerate prolonged inundation or soil saturation during the growing season. Hydrophytic vegetation in the Midwest Region is identified by using the indicators described in this chapter.

Many factors besides site wetness affect the composition of the plant community in an area, including regional climate, local weather patterns, topography, soils, natural and human-caused disturbances, and current and historical plant distributional patterns at various spatial scales. The Midwestern flora of today is best described as a composite of many surrounding floras that has been highly modified for agricultural purposes. The flora of the Midwest is composed of species from Canada, the Great Lakes, and New England; the Ozark, Allegheny, and Great Smoky Mountains; the Mississippi embayment; and prairie regions (Curtis 1959). Historically, the region was dominated by a mix of hardwood and pine forests and prairies, and included the western edge of the eastern deciduous forest, the northernmost extension of southern floodplain forests, peatlands in selected areas, and expansive swamps along parts of the Great Lakes that have now mostly been drained and farmed.

Agricultural land use has been one of the greatest influences on the present-day flora. Some of the most fertile soils in the world are associated with the historic range of extensive, Midwestern prairie grasslands (Barkley 1986). With the conversion of these areas to agricultural and other land uses, the best remaining examples of the historic Midwest flora include riparian corridors, remnant prairie stands, and blocks of woodlands that have never been farmed or are reverting to native vegetation. These land-use changes have increased the number and occurrence of invasive species within the flora. It is estimated that more than 54 percent of the flora in some locations, such as the Chicago area, now consists of non-native species (Swink and Wilhelm 1994).

Other influences on Midwestern wetland plant communities include seasonal changes in availability of water, short- and long-term droughts, and natural and human-caused disturbances (e.g., floods, fires, grazing). Wetlands subject to seasonal hydrology in the Midwest Region include prairie potholes, wet meadows, springs, seeps, and ephemeral ponds in forested landscapes, known locally as vernal pools. These wetlands often exhibit seasonal shifts in vegetation composition, potentially changing the status of the community from hydrophytic during the wet season to non-hydrophytic during the dry season. Multi-year droughts can also change the composition of plant communities over longer periods (Barkley 1986). Woody shrubs and trees in wetlands are often resistant to droughts, while herbaceous vegetation may show dramatic turnover in species composition from drought years to pluvial years. See Chapter 5 for discussions of these and other problematic vegetation situations in the Midwest.

Hydrophytic vegetation decisions are based on the wetland indicator status (Reed 1988, or current approved list) of species that make up the plant community. Species in the facultative categories (FACW, FAC, and FACU) are recognized as occurring in both wetlands and uplands to varying degrees. Although most wetlands are dominated mainly by species rated OBL, FACW, and FAC, some wetland communities may be dominated primarily by FACU species and cannot be identified by dominant species alone. In those cases, other indicators of hydrophytic vegetation must also be considered, particularly where indicators of hydric soils and wetland hydrology are present. This situation is not necessarily due to inaccurate wetland indicator ratings; rather, it is due to the broad tolerances of certain plant species that allow them to be widely distributed across the moisture gradient. Therefore, for some species, it is difficult to assign a single indicator status rating that encompasses all of the various landscape and ecological settings it can occupy.

Hydrophytic vegetation indicators and procedures presented in this chapter are designed to identify the majority of wetland plant communities in the Midwest. However, some wetland communities may lack any of these indicators, at least at certain times. These situations are considered in Chapter 5 (Difficult Wetland Situations in the Midwest Region).

Guidance on vegetation sampling and analysis

General guidance on sampling of vegetation for wetland-delineation purposes is given in the Corps Manual for both the Routine and Comprehensive methods. Those procedures are intended to be flexible and may need to be modified for application in a given region or on a particular site. Vegetation sampling done as part of a routine wetland delineation is designed to characterize the site in question rapidly. A balance must be established between the need to accomplish the work quickly and the need to characterize the site's heterogeneity accurately and at an appropriate scale. The following guidance on vegetation sampling is intended to supplement the Corps Manual for applications in the Midwest.

The first step is to identify the major landscape or vegetation units so that they can be evaluated separately. This may be done in advance using an aerial photograph or topographic map, or by walking over the site. In general, routine wetland determinations are based on visual estimates of percent cover of plant species that can be made either (1) within the vegetation unit as a whole, or (2) within one or more sampling plots established in representative locations within each unit. Percent cover estimates are more accurate and repeatable if taken within a defined plot. This also facilitates field verification of another delineator's work. The sizes and shapes of plots, if used, may be modified as appropriate to adapt to site conditions and should be recorded on the field data form. Near the wetland boundary, it may be necessary to adjust plot size or shape to avoid overlapping the boundary and extending into an adjacent community having different vegetation, soils, or hydrologic conditions.

If it is not possible to locate one or a few plots in a way that adequately represents the vegetation unit being sampled, then percent cover estimates for each species can be made during a meandering survey of the broader community. If additional quantification of cover estimates is needed, then the optional procedure for point-intercept sampling along transects (see Appendix B) or other sampling procedures may be used to characterize the vegetation unit. To use either of these sampling methods, soil and hydrologic conditions must be uniform across the sampled area.

Plot and sample sizes

Hydrophytic vegetation determinations under the Corps Manual are based on samples taken in representative locations within each community. Random sampling of the vegetation is not required except for certain sampling approaches in Comprehensive determinations or in rare cases where representative sampling might give misleading results. For Routine determinations in fairly uniform vegetation, one or more plots in each community are usually sufficient for an accurate determination. Sampling of a multi-layered community is usually accomplished using a graduated series of plots, one for each stratum, or a number of small plots nested within the largest plot (Figure 2). Nested plots to sample the herb stratum can be helpful in forested areas with highly variable understories or in very diverse communities. The smaller plots should be randomly distributed within the large plot, and plant abundance data averaged across the small plots.

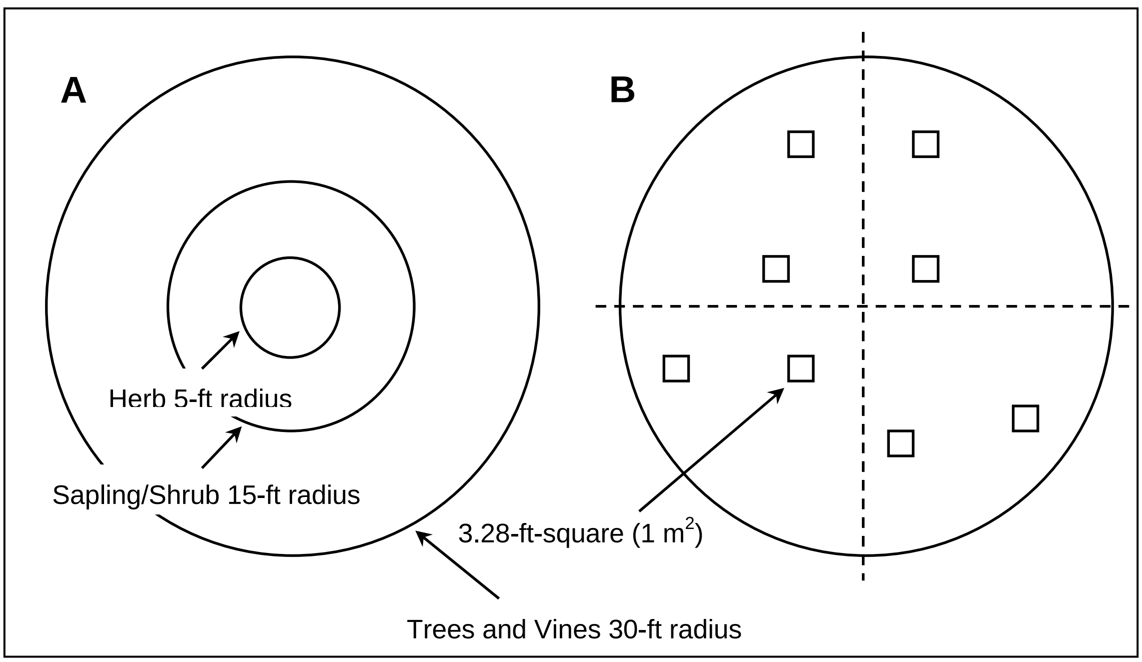

Figure 2. Suggested plot arrangements for vegetation sampling. (A) Single plots in graduated sizes. (B) Nested 3.28- by 3.28-ft square (1-m^2) plots for herbs within the 30-ft radius plot.

The appropriate size and shape for a sample plot depend on the type of vegetation (i.e., trees, shrubs, herbaceous plants, etc.) and the size or shape of the plant community or patch being sampled. The size of a plot needs to be large enough to include significant numbers of individuals in all strata, but small enough so that plant species or individuals can be separated and measured without duplication or omission, and the sampling can be done in a timely fashion (Cox 1990, Barbour et al. 1999). For hydrophytic vegetation determinations, the abundance of each species is determined by using areal cover estimates. Plot sizes should make visual sampling both accurate and efficient. In the Midwest, the following examples of plot sizes are suggested.

1. Trees – 30-ft (9.1-m) radius
2. Saplings and shrubs – 15-ft (4.6-m) radius
3. Herbaceous plants – 5-ft (1.5-m) radius or 3.28- by 3.28-ft square (1-m^2) quadrat
4. Woody vines – 30-ft (9.1-m) radius

The sampling plot should not be allowed to extend beyond the edges of the plant community being sampled or to overlap an adjacent community having different vegetation, soil, or hydrologic conditions. This may happen if vegetation patches are small or occur as narrow bands or zones along a topographic gradient. In such cases, plot sizes and shapes should be adjusted to fit completely within the vegetation patch or zone. For example, in linear riparian communities where the width of a standard plot may exceed the width of the plant community, an elongated rectangular plot or belt transect that follows the stream is recommended. If possible, the area sampled should be equivalent to the 30-ft-radius plot (2,827 ft^2 (263 m^2)) for the tree stratum or the 15-ft-radius plot (707 ft^2 (65.7 m^2)) for the sapling/shrub stratum. Thus the sapling/shrub stratum could be sampled using a 10- by 71-ft (3.1- by 21.6-m) plot lying completely within the riparian fringe. An alternative approach involves sampling a series of small subplots (e.g., 5 by 5 ft (1.5 by 1.5 m), or 10 by 10 ft (3.1 by 3.1 m)) in the riparian community and averaging the data across subplots.

A 30-ft radius tree plot works well in most forests but can be increased to 35 ft (10.7 m) or 40 ft (12.2 m) or more in a nonlinear forest stand if tree diversity is high or diameters are large. Highly diverse or patchy communities of herbs or other low vegetation may be sampled with nested 3.28- by 3.28-ft (1-m^2) quadrats randomly located within a 30-ft radius (Figure 2B). Furthermore, point-intercept sampling performed along a transect is an alternative to plot-based methods that can improve the accuracy and repeatability of vegetation sampling in diverse or heterogeneous communities (see Appendix B). To use this method, soil and hydrologic conditions must be uniform across the area where transects are located.

Vegetation sampling guidance presented here should be adequate for hydrophytic vegetation determinations in most situations. However, many variations in vegetation structure, diversity, and spatial arrangement exist on the landscape that are not addressed in this supplement. If alternative sampling techniques are used, they should be derived from the scientific literature and described in field notes or in the delineation report. The basic data must include abundance values for each species present. Typical abundance measures include basal area for tree species, percent areal cover, stem density, or frequency based on point-intercept sampling. In any case, the data must be in a format that can be used in the dominance test or prevalence index for hydrophytic vegetation (see Hydrophytic Vegetation Indicators).

In this supplement, absolute percent cover is the preferred abundance measure for all species. For percent cover estimates, plants do not need to be rooted in the plot as long as they are growing under the same soil and hydrologic conditions. It may be necessary to exclude plants that overhang the plot if they are rooted in areas having different soil and hydrologic conditions, particularly when sampling near the wetland boundary.

Definitions of strata

Vegetation strata within a plot are sampled separately when evaluating indicators of hydrophytic vegetation. In the Midwest Region, the vegetation strata described in the Corps Manual are recommended (see below). Unless otherwise noted, a stratum for sampling purposes is defined as having 5 percent or more total plant cover. If a stratum has less than 5 percent cover during the peak of the growing season, then those species and their cover values should be recorded on the data form but should not be used in the calculations for the dominance test, unless it is the only stratum present.

1. *Tree stratum* – Consists of woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.
2. *Sapling/shrub stratum* – Consists of woody plants less than 3 in. DBH and greater than 3.28 ft (1 m) tall.
3. *Herb stratum* – Consists of all herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants less than 3.28 ft tall.
4. *Woody vines* – Consists of all woody vines greater than 3.28 ft in height.

Seasonal considerations and cautions

To the extent possible, the hydrophytic vegetation decision should be based on the plant community that is normally present during the wet portion of the growing season in a normal rainfall year. However, wetland determinations often must be performed at other times of year, or in years with unusual or atypical weather conditions. The Midwest Region has a seasonal climate, with a cool wet spring, a warmer and drier summer, and a cold, often snowy winter. Vegetation sampling for a wetland determination can be challenging when some plants die back in response to seasonal or long-term drought, freezing temperatures, or other factors. At these times, experience and professional judgment may be required to adapt the vegetation sampling scheme or use other sources of information to determine the plant community that is normally present.

For example, vegetation sampling during the winter may be hampered by snow and ice that cover the ground and make it impractical to identify plant species and estimate plant cover. When an on-site evaluation of the vegetation is impractical due to excessive snow and ice, one option is to use existing off-site data sources, such as National Wetlands Inventory (NWI) maps, soil surveys, and aerial photographs, to make a preliminary hydrophytic-vegetation determination. These sources may be supplemented with limited on-site data, including those plant species that can be identified. Later, when conditions are favorable, an on-site investigation must be made to verify the preliminary determination and complete the wetland delineation.

Other factors can alter the plant community on a site and affect a hydrophytic vegetation determination, including seasonal changes in species composition, intensive grazing, wildfires and other natural disturbances, and human land-use practices. These factors are considered in Chapter 5.

Hydrophytic vegetation indicators

The following indicators should be applied in the sequence presented. The stepwise procedure is designed to reduce field effort by requiring that only one indicator, the dominance test, be evaluated in the majority of wetland determinations. Hydrophytic vegetation is present if any of the indicators is satisfied. All of these indicators are applicable throughout the entire Midwest Region.

Indicators of hydrophytic vegetation involve looking up the wetland indicator status of plant species on the wetland plant list (Reed 1988 or current list). For the purposes of this supplement, only the five basic levels of wetland indicator status (i.e., OBL, FACW, FAC, FACU, and UPL) are used in hydrophytic vegetation indicators. Plus (+) and minus (–) modifiers are not used (e.g., FAC–, FAC, and FAC+ plants are all considered to be FAC). For species listed as NI (reviewed but given no regional indicator) or NO (no known occurrence in the region at the time the list was compiled), apply the indicator status assigned to the species in the nearest adjacent region. If the species is listed as NI or NO but no adjacent regional indicator is assigned, do not use the species to calculate hydrophytic vegetation indicators. In general, species that are not listed on the wetland plant list are assumed to be upland (UPL) species. However, recent changes in plant nomenclature have resulted in a number of species that are not listed by Reed (1988) but are not necessarily UPL plants. Procedures described in Chapter 5, section on Problematic Hydrophytic Vegetation, can be used if it is believed that individual FACU, NI, NO, or unlisted plant species are functioning as hydrophytes on a particular site. For Clean Water Act purposes, wetland delineators should use the latest plant lists approved by Headquarters, U.S. Army Corps of Engineers (Figure 3) (http://www.usace.army.mil/inet/functions/cw/cecwo/reg/reg_supp.htm).

The dominance test (Indicator 1) is the basic hydrophytic vegetation indicator and should be applied in every wetland determination. Most wetlands in the Midwest have plant communities that will pass the dominance test. This is the only indicator that needs to be used to determine hydrophytic vegetation in most situations. However, some wetland plant communities may fail a test based only on dominant species. Therefore, in those cases where indicators of hydric soil and wetland hydrology are present, the vegetation should be reevaluated with the prevalence index (Indicator 2), which takes non-dominant plant species into consideration, and then by observing plant morphological adaptations for life in wetlands (Indicator 3). Finally, certain disturbed or problematic wetland situations may lack any of these indicators and are described in Chapter 5.

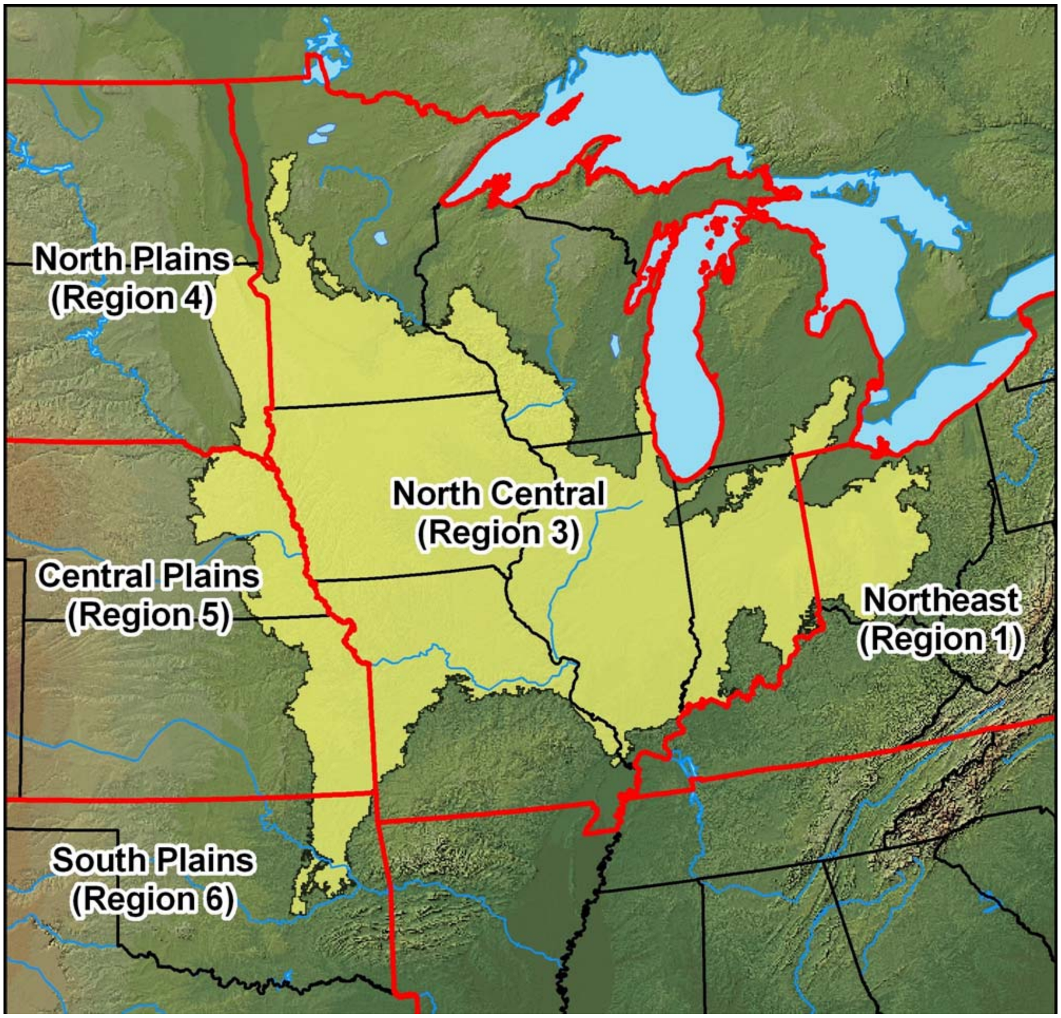

Figure 3. Plant list regional boundaries (red lines) currently used by the U.S. Fish and Wildlife Service, National Wetlands Inventory, in the Midwest.

Procedure

The procedure for using hydrophytic vegetation indicators is as follows:

1. Apply Indicator 1 (Dominance Test).

    a. If the plant community passes the dominance test, then the vegetation is hydrophytic and no further vegetation analysis is required.
    b. If the plant community fails the dominance test, and indicators of hydric soil and/or wetland hydrology are absent, then hydrophytic vegetation is absent unless the site meets requirements for a problematic wetland situation (see Chapter 5).
    c. If the plant community fails the dominance test, but indicators of hydric soil and wetland hydrology are both present, proceed to step 2.

2. Apply Indicator 2 (Prevalence Index). This and the following step assume that at least one indicator of hydric soil and one primary or two secondary indicators of wetland hydrology are present.

    a. If the plant community satisfies the prevalence index, then the vegetation is hydrophytic. No further vegetation analysis is required.
    b. If the plant community fails the prevalence index, proceed to step 3.

3. Apply Indicator 3 (Morphological Adaptations).

    a. If the indicator is satisfied, the vegetation is hydrophytic.
    b. If none of the indicators is satisfied, then hydrophytic vegetation is absent unless indicators of hydric soil and wetland hydrology are present and the site meets the requirements for a problematic wetland situation (Chapter 5).

Indicator 1: Dominance test

Description: More than 50 percent of the dominant plant species across all strata are rated OBL, FACW, or FAC.

User Notes: Use the "50/20 rule" described below to select dominant species from each stratum of the community. Combine dominant species across strata and apply the dominance test to the combined list. Once a species is selected as a dominant, its cover value is not used in the dominance test; each dominant species is treated equally. Thus, a plant community with seven dominant species across all strata would need at least four dominant species that are OBL, FACW, or FAC to be considered hydrophytic by this indicator. Species that are dominant in two or more strata should be counted two or more times in the dominance test.

Procedure for Selecting Dominant Species by the 50/20 Rule: Dominant plant species are the most abundant species in the community; they contribute more to the character of the community than do the other non-dominant species present. The 50/20 rule is a repeatable and objective procedure for selecting dominant plant species and is recommended when data are available for all species in the community. The rule can also be used to guide visual sampling of plant communities in rapid wetland determinations.

Dominant species are chosen independently from each stratum of the community. In general, dominants are the most abundant species that individually or collectively account for more than 50 percent of the total coverage of vegetation in the stratum, plus any other species that, by itself, accounts for at least 20 percent of the total. For the purposes of this regional supplement, absolute percent cover is the recommended abundance measure for plants in all vegetation strata. See Table 2 for an example application of the 50/20 rule in evaluating a plant community. Steps in selecting dominant species by the 50/20 rule are as follows:

1. Estimate the absolute percent cover of each species in the first stratum. Since the same data may be used later to calculate the prevalence index, the data should be recorded as absolute cover and not converted to relative cover.

2. Rank all species in the stratum from most to least abundant.

3. Calculate the total coverage of all species in the stratum (i.e., sum their individual percent cover values). Absolute cover estimates do not necessarily sum to 100 percent.

4. Calculate the 50-percent threshold for the stratum by multiplying the total cover of that stratum by 50 percent.

5. Calculate the 20-percent threshold for the stratum by multiplying the total cover of that stratum by 20 percent.

6. Select plant species from the ranked list, in decreasing order of coverage, until the cumulative coverage of selected species *exceeds* the threshold representing 50 percent of the total coverage for the stratum. If two or more species are equal in coverage (i.e., they are tied in rank), they should all be selected. The selected plant species are all considered to be dominants. All dominants must be identified to species.

7. In addition, select any other species that, by itself, is at least 20 percent of the total percent cover in the stratum. Any such species is also considered to be a dominant and must be accurately identified.

8. Repeat steps 1-7 for any other stratum present. Combine the lists of dominant species across all strata. Note that a species may be dominant in

more than one stratum (e.g., a woody species may be dominant in both the tree and sapling/shrub strata).

Table 2. Example of the selection of dominant species by the 50/20 rule and determination of hydrophytic vegetation by the dominance test.

Stratum	Species Name	Wetland Indicator Status	Absolute Percent Cover	Dominant?
Herb	*Impatiens capensis*	FACW	15	Yes
	Geranium carolinianum	UPL	7	Yes
	Toxicodendron radicans	FAC	5	No
	Lonicera tatarica	FACU	2	No
	Glyceria striata	OBL	2	No
	Parthenocissus quinquefolia	FACU	1	No
	Arisaema triphyllum	FACW	0.5	No
	Carex laxiflora	FACU	0.5	No
		Total cover	33.0	
		50/20 Thresholds: 50% of total cover = 16.5% 20% of total cover = 6.6%		
Sapling/shrub	*Carpinus caroliniana*	FAC	35	Yes
	Carya ovata	FACU	10	No
	Acer saccharum	FACU	5	No
	Quercus rubra	FACU	5	No
		Total cover	55.0	
		50/20 Thresholds: 50% of total cover = 27.5% 20% of total cover = 11.0%		
Tree	*Quercus bicolor*	FACW	40	Yes
	Fraxinus pennsylvanica	FACW	17	Yes
	Ulmus americana	FACW	10	No
	Carya ovata	FACU	8	No
		Total Cover	75.0	
		50/20 Thresholds: 50% of total cover = 37.5% 20% of total cover = 15.0%		
Woody vine	*Toxicodendron radicans*	FAC	1	No[1]
Hydrophytic Vegetation Determination	Total number of dominant species across all strata = 5. Percent of dominant species that are OBL, FACW, or FAC = 80%. Therefore, this community is hydrophytic by Indicator 1 (Dominance Test).			

[1] A stratum with less than 5 percent cover is not considered in the dominance test, unless it is the only stratum present.

Indicator 2: Prevalence index

Description: The prevalence index is 3.0 or less.

User Notes: The prevalence index ranges from 1 to 5. A prevalence index of 3.0 or less indicates that hydrophytic vegetation is present. If practical, all species in the plot should be identified and recorded on the data form. At a minimum, at least 80 percent of the total vegetation cover on the plot (summed across all strata) must be of species that have been correctly identified and have assigned wetland indicator statuses (Reed 1988 or current list) or are upland (UPL) species.

Procedure for Calculating a Plot-Based Prevalence Index: The prevalence index is a weighted-average wetland indicator status of all plant species in the sampling plot, where each indicator status category is given a numeric value (OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5) and weighting is by abundance (absolute percent cover). It is a more comprehensive analysis of the hydrophytic status of the community than one based on just a few dominant species. It is particularly useful in (1) communities with only one or two dominants, (2) highly diverse communities where many species may be present at roughly equal coverage, and (3) cases where strata differ greatly in total plant cover (e.g., total herb cover is 80 percent but sapling/shrub cover is only 10 percent). The prevalence index is used in this supplement to determine whether hydrophytic vegetation is present on sites where indicators of hydric soil and wetland hydrology are present but the vegetation initially fails the dominance test.

The following procedure is used to calculate a plot-based prevalence index. The method was described by Wentworth et al. (1988) and modified by Wakeley and Lichvar (1997). It uses the same field data (i.e., percent cover estimates for each plant species) that were used to select dominant species by the 50/20 rule, with the added constraint that at least 80 percent of the total vegetation cover on the plot must be of species that have been correctly identified and have an assigned indicator status (including UPL). For any species that occurs in more than one stratum, cover estimates are summed across strata. Steps for determining the prevalence index are as follows:

1. Identify and estimate the absolute percent cover of each species in each stratum of the community. Sum the cover estimates for any species that is present in more than one stratum.

2. Organize all species (across all strata) into groups according to their wetland indicator status (i.e., OBL, FACW, FAC, FACU, or UPL) and sum their cover values within groups. Do not include species that were not identified.

3. Calculate the prevalence index using the following formula:

$$PI = \frac{A_{OBL} + 2A_{FACW} + 3A_{FAC} + 4A_{FACU} + 5A_{UPL}}{A_{OBL} + A_{FACW} + A_{FAC} + A_{FACU} + A_{UPL}}$$

where:

PI = Prevalence index
A_{OBL} = Summed percent cover values of obligate (OBL) plant species
A_{FACW} = Summed percent cover values of facultative wetland (FACW) plant species
A_{FAC} = Summed percent cover values of facultative (FAC) plant species
A_{FACU} = Summed percent cover values of facultative upland (FACU) plant species
A_{UPL} = Summed percent cover values of upland (UPL) plant species

See Table 3 for an example calculation of the prevalence index using the same data set as in Table 2. The following web link provides free public-domain software for simultaneous calculation of the 50/20 rule, dominance test, and prevalence index: http://www.crrel.usace.army.mil/rsgisc/wetshed/wetdatashed.htm.

Table 3. Example of the Prevalence Index using the same data as in Table 2.

Indicator Status Group	Species name	Absolute Percent Cover by Species	Total Cover by Group	Multiply by:[1]	Product
OBL species	*Glyceria striata*	2	2	1	2
FACW species	*Impatiens capensis* *Arisaema triphyllum* *Quercus bicolor* *Fraxinus pennsylvanica* *Ulmus americana*	15 0.5 40 17 10	82.5	2	165
FAC species	*Toxicodendron radicans*[2] *Carpinus caroliniana*	6 35	41	3	123
FACU species	*Lonicera tatarica* *Parthenocissus quinquefolia* *Carex laxiflora* *Carya ovata*[2] *Acer saccharum* *Quercus rubra*	2 1 0.5 18 5 5	31.5	4	126
UPL species	*Geranium carolinianum*	7	7	5	35
Sum			164 (A)		451 (B)
Hydrophytic Vegetation Determination		Prevalence Index = B/A = 451/164 = 2.75 Therefore, this community is hydrophytic by Indicator 2 (Prevalence Index).			

[1] Where OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5.

[2] This species was recorded in two or more strata (see Table 2), so the cover estimates were summed across strata.

Indicator 3: Morphological adaptations

Description: The plant community passes either the dominance test (Indicator 1) or the prevalence index (Indicator 2) after reconsideration of the indicator status of certain plant species that exhibit morphological adaptations for life in wetlands.

User Notes: Some hydrophytes in the Midwest develop easily recognized physical characteristics, or morphological adaptations, when they occur in wetland areas. Some of these adaptations may help them to survive prolonged inundation or saturation in the root zone; others may simply be a consequence of living under such wet conditions. Common morphological adaptations in the Midwest include but are not limited to adventitious roots, multi-stemmed trunks, shallow root systems developed on or near the soil surface, and buttressing in tree species. Users need to be cautious that shallow roots were not caused by erosion or near-surface bedrock, and that multi-trunk plants were not the result of sprouting after logging activities. Morphological adaptations may develop on FACU species when they occur in wetlands, indicating that those individuals are functioning as hydrophytes in that setting.

To apply this indicator, these morphological features must be observed on more than 50 percent of the individuals of a FACU species living in an area where indicators of hydric soil and wetland hydrology are present. Follow this procedure:

1. Confirm that the morphological feature is present mainly in the potential wetland area and is not also common on the same species in the surrounding non-wetlands.

2. For each FACU species that exhibits morphological adaptations, estimate the percentage of individuals that have the features. Record this percentage on the data form.

3. If more than 50 percent of the individuals of a FACU species have morphological adaptations for life in wetlands, that species is considered to be a hydrophyte and its indicator status on that plot should be re-assigned as FAC. All other species retain their published indicator statuses. Record any supporting information on the data sheet, including a description of the morphological adaptation(s) present and any other observations of the growth habit of the species in adjacent wetland and non-wetland locations (photo documentation is recommended).

4. Recalculate the dominance test (Indicator 1) and/or the prevalence index (Indicator 2) using a FAC indicator status for this species. The vegetation is hydrophytic if either test is satisfied.

3 Hydric Soil Indicators

Introduction

The National Technical Committee for Hydric Soils (NTCHS) defines a hydric soil as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service 1994). Nearly all hydric soils exhibit characteristic morphologies that result from repeated periods of saturation or inundation for more than a few days. Saturation or inundation, when combined with microbial activity in the soil, causes the depletion of oxygen. This anaerobiosis promotes certain biogeochemical processes, such as the accumulation of organic matter and the reduction, translocation, or accumulation of iron and other reducible elements. These processes result in distinctive characteristics that persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils in the field (USDA Natural Resources Conservation Service 2006b).

This chapter presents indicators that are designed to help identify hydric soils in the Midwest Region. Indicators are not intended to replace or relieve the requirements contained in the definition of a hydric soil. Therefore, a soil that meets the definition of a hydric soil is hydric whether or not it exhibits indicators. Guidance for identifying hydric soils that lack indicators can be found later in this chapter (see the sections on documenting the site and its soils) and in Chapter 5 (Difficult Wetland Situations in the Midwest).

This list of indicators is dynamic; changes and additions are anticipated with new research and field testing. The indicators presented in this supplement are a subset of the NTCHS *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b or current version) that are commonly found in the Midwest. Any change to the NTCHS *Field Indicators of Hydric Soils in the United States* represents a change to this subset of indicators for the Midwest. The current version of the indicators can be found on the NRCS hydric soils web site (http://soils.usda.gov/use/hydric). To use the indicators properly, a basic knowledge of soil/landscape relationships is necessary.

All of the hydric soil indicators presented in this supplement are applicable throughout the Midwest Region. It is important to understand that boundaries between regions and subregions are actually broad transition zones. Although an indicator may be listed as applicable in a specific region, it may also be applicable in the transition to an adjacent region or subregion.

Concepts

Hydric soil indicators are formed predominantly by the accumulation or loss of iron, manganese, sulfur, or carbon compounds in a saturated and anaerobic environment. These processes and the features that develop are described in the following paragraphs.

Iron and manganese reduction, translocation, and accumulation

In an anaerobic environment, soil microbes reduce iron from the ferric (Fe^{3+}) to the ferrous (Fe^{2+}) form, and manganese from the manganic (Mn^{4+}) to the manganous (Mn^{2+}) form. Of the two, evidence of iron reduction is more commonly observed in soils. Areas in the soil where iron is reduced often develop characteristic bluish-gray or greenish-gray colors known as *gley*. Ferric iron is insoluble but ferrous iron easily enters the soil solution and may be moved or translocated to other areas of the soil. Areas that have lost iron typically develop characteristic gray or reddish-gray colors and are known as *redox depletions*. If a soil reverts to an aerobic state, iron that is in solution will oxidize and become concentrated in patches and along root channels and other pores. These areas of oxidized iron are called *redox concentrations*. Since water movement in these saturated or inundated soils can be multi-directional, redox depletions and concentrations can occur anywhere in the soil and have irregular shapes and sizes. Soils that are saturated and contain ferrous iron at the time of sampling may change color upon exposure to the air, as ferrous iron is rapidly converted to ferric iron in the presence of oxygen. Such soils are said to have a *reduced matrix* (Vepraskas 1992).

While indicators related to iron or manganese depletion or concentration are the most common in hydric soils, they cannot form in soils whose parent materials are low in Fe or Mn. Soils formed in such materials may have low-chroma colors that are not related to saturation and reduction. For such soils, features formed through accumulation of organic carbon may be present.

Sulfate reduction

Sulfur is one of the last elements to be reduced by microbes in an anaerobic environment. The microbes convert SO_4^{2-} to H_2S, or hydrogen sulfide gas. This results in a very pronounced “rotten egg” odor in some soils that are inundated or saturated for very long periods. In non-saturated or non-inundated soils, sulfate is not reduced and there is no rotten egg odor. The presence of hydrogen sulfide is a strong indicator of a hydric soil, but this indicator is found only in the wettest sites in soils that contain sulfur-bearing compounds.

Organic matter accumulation

Soil microbes use carbon compounds found in organic matter as an energy source. However, the rate at which organic carbon is utilized by soil microbes is considerably lower in a saturated and anaerobic environment than under aerobic conditions. Therefore, in saturated soils, partially decomposed organic matter may accumulate. The result in wetlands is often the development of thick organic surfaces, such as peat or muck, or dark organic-rich mineral surface layers.

Determining the texture of soil materials high in organic carbon. Material high in organic carbon could fall into three categories: organic, mucky mineral, or mineral. In lieu of laboratory data, the following estimation method can be used for soil material that is wet or nearly saturated with water. This method may be inconclusive with loamy or clayey textured mineral soils. Gently rub the wet soil material between forefinger and thumb. If upon the first or second rub the material feels gritty, it is mineral soil material. If after the second rub the material feels greasy, it is either mucky mineral or organic soil material. Gently rub the material two or three more times. If after these additional rubs it feels gritty or plastic, it is mucky mineral soil material; if it still feels greasy, it is organic soil material. If the material is organic soil material, a further division should be made, as follows.

Organic soil materials are classified as sapric, hemic, or fibric. Differentiating criteria are based on the percentage of visible fibers observable with a hand lens in an undisturbed state and after rubbing between thumb and fingers 10 times (Table 4). Sapric, hemic, and fibric correspond to the textures muck, mucky peat, and peat. If there is a conflict between unrubbed and rubbed fiber content, rubbed content is used. *Live roots are not considered.*

Table 4. Proportion of fibers visible with a hand lens.

Soil Texture	Unrubbed	Rubbed	Horizon Descriptor
Muck	<33%	<17%	Sapric
Mucky peat	33-67%	17-40%	Hemic
Peat	>67%	>40%	Fibric

Adapted from USDA Natural Resources Conservation Service (1999).

Another field method for determining the degree of decomposition for organic materials is a system modified from a method originally developed by L. von Post and described in detail in ASTM standard D 5715-00. This method is based on a visual examination of the color of the water that is expelled and the soil material remaining in the hand after a saturated sample is squeezed (Table 5). If a conflict occurs between results for sapric, hemic, or fibric material using percent visible fiber (Table 4) and degree of humification (Table 5), then percent visible fiber should be used.

Cautions

A soil that is artificially drained or protected (for instance, by dikes, levees, ditches, or subsurface drains) is still hydric if the soil in its undisturbed state would meet the definition of a hydric soil. To be identified as hydric, these soils should generally have one or more of the indicators. However, not all areas that have hydric soils will qualify as wetlands, if they no longer have wetland hydrology or support hydrophytic vegetation.

Morphological features that do not reflect contemporary or recent conditions of saturation and anaerobiosis are called relict features. Stream downcutting is a common cause of relict hydric soils in the Midwest. However, portions of former floodplains may still have wetland hydrology due to rainfall, surface runoff from uplands, or groundwater discharge. Typically, contemporary and recent hydric soil features have diffuse boundaries; relict hydric soil features have sharp boundaries (Vepraskas 1992). Additional guidance for some of the most common problem hydric soils can be found in Chapter 5. When soil morphology seems inconsistent with the landscape, vegetation, or observable hydrology, it may be necessary to obtain the assistance of an experienced soil or wetland scientist to determine whether the soil is hydric.

Table 5. Determination of degree of decomposition of organic materials.

Degree of Humification	Nature of Material Extruded on Squeezing	Nature of Plant Structure in Residue	Horizon Descriptor
H1	Clear, colorless water; no organic solids squeezed out	Unaltered, fibrous, undecomposed	Fibric
H2	Yellowish water; no organic solids squeezed out	Almost unaltered, fibrous	
H3	Brown, turbid water; no organic solids squeezed out	Easily identifiable	
H4	Dark brown, turbid water; no organic solids squeezed out	Visibly altered but identifiable	Hemic
H5	Turbid water and some organic solids squeezed out	Recognizable but vague, difficult to identify	
H6	Turbid water; 1/3 of sample squeezed out	Indistinct, pasty	
H7	Very turbid water; 1/2 of sample squeezed out	Faintly recognizable; few remains identifiable, mostly amorphous	Sapric
H8	Thick and pasty; 2/3 of sample squeezed out	Very indistinct	
H9	No free water; nearly all of sample squeezed out	No identifiable remains	
H10	No free water; all of sample squeezed out	Completely amorphous	

Procedures for sampling soils

Observe and document the site

Before making any decision about the presence or absence of hydric soils, the overall site and how it interacts with the soil should be considered. The questions below, while not required to identify a hydric soil, can help to explain why one is or is not present. Always look at the landscape features of the immediate site and compare them to the surrounding areas. Try to contrast the features of wet and dry sites that are in close proximity. When observing slope features, look first at the area immediately around the sampling point. For example, a nearly level bench or depression at the sampling point may be more important to site wetness than the overall landform on which it occurs. By understanding how water moves across the site, the reasons for the presence or absence of hydric soil indicators should be clear.

If one or more of the hydric soil indicators given later in this chapter is present, then the soil is hydric. If no hydric soil indicator is present, the additional site information below may be useful in documenting whether the soil is indeed non-hydric or if it might represent a “problem” hydric soil that meets the hydric soil definition despite the absence of indicators.

- *Hydrology*–Is standing water observed on the site or is water observed in the soil pit? What is the depth of the water table in the area? Is there indirect evidence of ponding or flooding? Is the site adjacent to a downcut or channelized stream? Is the hydrology impacted by ditches or subsurface drainage lines?

- *Slope*–Is the site level or nearly level so that surface water does not run off readily, or is it steeper where surface water would run off from the soil?

- *Slope shape*–Is the surface concave (e.g., depressions), where water would tend to collect and possibly pond on the soil surface? On hillsides, are there convergent slopes (Figure 4), where surface or groundwater may be directed toward a central stream or swale? Or is the surface or slope shape convex, causing water to run off or disperse?

- *Landform*–Is the soil on a low terrace or floodplain that may be subject to seasonal high water tables or flooding? Is it at the toe of a slope (Figure 5) where runoff may tend to collect or groundwater emerge at or near the surface? Has the microtopography been altered by cultivation?

- *Soil materials*–Is there a restrictive layer in the soil that would slow or prevent the infiltration of water? This could include consolidated bedrock, compacted layers, cemented layers such as duripans and petrocalcic horizons, layers of silt or substantial clay content, seasonal ice, or strongly contrasting soil textures (e.g., silt over sand). Platy or prismatic soil structure may also result in restrictive layers. Is there relatively loose soil material (sand, gravel, or rocks) or fractured bedrock that would allow the water to flow laterally down slope?

- *Vegetation*–Does the vegetation at the site indicate wetter conditions than at other nearby sites, or is it similar to what is found at nearby upland sites?

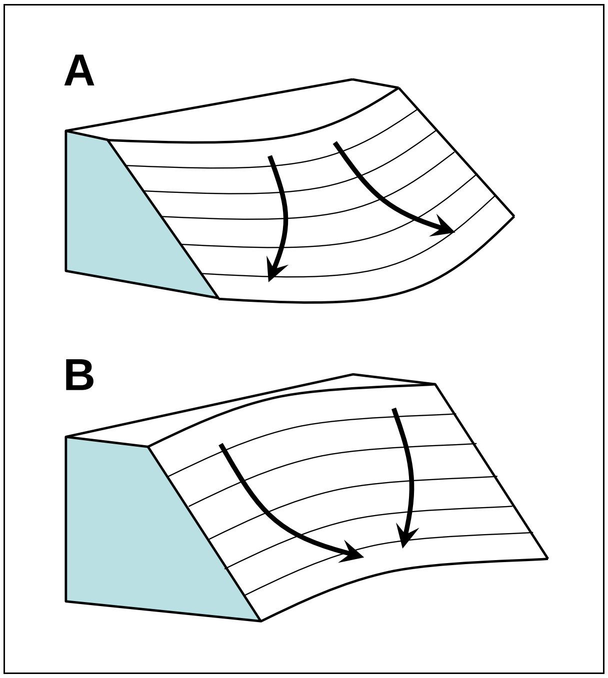

Figure 4. Divergent slopes (A) disperse surface water, whereas convergent slopes (B) concentrate water. Surface flow paths are indicated by the arrows.

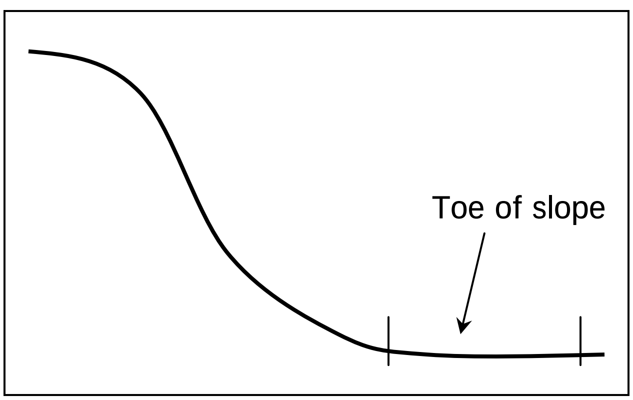

Figure 5. At the toe of a hill slope, the gradient is only slightly inclined or nearly level.

Observe and document the soil

To observe and document a hydric soil, first remove any loose leaves, needles, or bark from the soil surface. Do not remove the organic surface layers of the soil, which usually consist of plant remains in varying stages of decomposition. Dig a hole and describe the soil profile. In general, the hole should be dug to the depth needed to document an indicator or to confirm the absence of indicators. For most soils, the recommended excavation depth is approximately 20 in. (50 cm) from the soil surface, although a shallower soil pit may suffice for some indicators (e.g., A2 – Histic Epipedon). Digging may be difficult in some areas due to rocks and hardpans. Use the completed profile description to determine which hydric soil indicators have been met (USDA Natural Resources Conservation Service 2006b).

For soils with deep, dark surface layers, deeper examination may be required when field indicators are not easily seen within 20 in. (50 cm) of the surface. The accumulation of organic matter in these soils may mask redoximorphic features in the surface layers. Examination to 40 in. (1 m) or more may be needed to determine whether the soils meet the requirements of indicator A12 (Thick Dark Surface). A soil auger or probe may be useful for sampling soil materials below 20 in.

Whenever possible, excavate the soil deep enough to determine if there are layers or materials present that might restrict soil drainage. This will help to understand why the soil may or may not be hydric. Consider taking photographs of both the soil and the overall site, including a clearly marked measurement scale in soil pictures.

Depths used in the indicators are measured from the muck surface, or from the mineral soil surface if a muck surface is absent. For indicators A1 (Histosol), A2 (Histic Epipedon), A3 (Black Histic), and S3 (5 cm Mucky Peat or Peat) depths are measured from the top of the organic material (peat, mucky peat, or muck).

All colors noted in this supplement refer to moist Munsell® colors (Gretag/Macbeth 2000). Dry soils should be moistened until the color no longer changes and wet soils should be allowed to dry until they no longer glisten. Care should be taken to avoid over-moistening dry soil. Soil colors specified in the indicators do not have decimal points; however, intermediate colors do occur between Munsell chips. Soil chroma should not be rounded to qualify as meeting an indicator. For example, a soil matrix with a chroma between 2 and 3 should be recorded as having a chroma of 2+. This soil material does not have a chroma of 2 and would not meet any indicator that requires a chroma of 2 or less. Always examine soil matrix colors in the field immediately after sampling.

Ferrous iron, if present, can oxidize rapidly and create colors of higher chroma or redder hue.

Soils that are saturated at the time of sampling may contain reduced iron and/or manganese that are not detectable by eye. Under saturated conditions, redox concentrations may be absent or difficult to see, particularly in dark-colored soils. It may be necessary to let the soil dry to a moist state (5 to 30 minutes or more) for the iron or manganese to oxidize and redox features to become visible.

Particular attention should be paid to changes in microtopography over short distances. Small changes in elevation may result in repetitive sequences of hydric/non-hydric soils, making the delineation of individual areas of hydric and non-hydric soils difficult. Often the dominant condition (hydric or non-hydric) is the only reliable interpretation (also see the section on Wetland/Non-Wetland Mosaics in Chapter 5). The shape of the local landform can greatly affect the movement of water through the landscape. Significant changes in parent material or lithologic discontinuities in the soil can affect the hydrologic properties of the soil. After a sufficient number of exploratory excavations have been made to understand the soil-hydrologic relationships at the site, subsequent excavations can be limited to the depth needed to identify hydric soil indicators.

Use of existing soil data

Soil surveys

Soil surveys are available for most areas of the Midwest and can provide useful information regarding soil properties and soil moisture conditions for an area. A list of available soil surveys is located at http://soils.usda.gov/survey/online_surveys/, and soil maps and data are available online from the Web Soil Survey at http://websoilsurvey.nrcs.usda.gov/. Soil survey maps divide the landscape into areas called map units. Map units usually contain more than one soil type or component. They often contain several minor components or inclusions of soils with properties that may be similar to or quite different from the major component. Those soils that are hydric are noted in the *Hydric Soils List* published separately from the soil survey report. Soil survey information can be valuable for planning purposes, but it is not site-specific and does not preclude the need for an on-site investigation.

Hydric soils lists

Hydric Soils Lists are developed for each detailed soil survey. Using criteria approved by the NTCHS, these lists rate each soil component as either hydric or non-hydric based on soil property data. If the soil is rated as hydric, information is provided regarding which hydric criteria are met and on what landform the soil typically occurs. Hydric Soils Lists are useful as general background information for an on-site delineation. However, not all areas within a mapping unit or polygon identified as having hydric soils may be hydric. Conversely, inclusions of hydric soils may be found within soil mapping units where no hydric soils have been identified. The Hydric Soils List should be used as a tool, indicating that hydric soil will likely be found within a given area, but should never be used as a substitute for onsite investigation and field indicators of hydric soils.

Hydric Soils Lists developed for individual detailed soil surveys are known as Local Hydric Soils Lists. They are available from state or county NRCS offices and over the internet from the Soil Data Mart (http://soildatamart.nrcs.usda.gov/). Local Hydric Soils Lists have been compiled into a National Hydric Soils List available at http://soils.usda.gov/use/hydric/. However, use of Local Hydric Soils Lists is preferred since they are more current and reflect local variations in soil properties.

Hydric soil indicators

Many of the hydric soil indicators were developed specifically for wetland-delineation purposes. During the development of these indicators, soils in the interior of wetlands were not always examined; therefore, there are wetlands that lack any of the approved hydric soil indicators in the wettest interior portions. Wetland delineators and other users of the hydric soil indicators should concentrate their sampling efforts near the wetland edge and, if these soils are hydric, assume that soils in the wetter, interior portions of the wetland are also hydric even if they lack an indicator.

Hydric soil indicators are presented in three groups. Indicators for "All Soils" are used in any soil regardless of texture. Indicators for "Sandy Soils" are used in soil layers with USDA textures of loamy fine sand or coarser. Indicators for "Loamy and Clayey Soils" are used with soil layers of loamy very fine sand and finer. Both sandy and loamy/clayey layers may be present in the same soil profile. Therefore, a soil that contains a loamy surface layer over sand is hydric if it meets all of the requirements of matrix color, amount and contrast of redox concentrations, depth, and thickness for a specific A (All Soils), F (Loamy and Clayey Soils), or S (Sandy Soils) indicator.

It is permissible to combine certain hydric soil indicators if all requirements of the indicators are met except thickness (see Hydric Soil Technical Note 4, http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html). The most restrictive requirements for thickness of layers in any indicators used must be met. Not all indicators are possible candidates for combination. For example, indicator F2 (Loamy Gleyed Matrix) has no thickness requirement, so a site would either meet the requirements of this indicator or it would not. Table 6 lists the indicators that are the most likely candidates for combining in the region.

Table 6. Minimum thickness requirements for commonly combined indicators in the Midwest Region.

Indicator	Thickness Requirement
S5 – Sandy Redox	4 in. (10 cm) thick starting within 6 in. (15 cm) of the soil surface
F1 – Loamy Mucky Mineral	4 in. (10 cm) thick starting within 6 in. (15 cm) of the soil surface
F3 – Depleted Matrix	6 in. (15 cm) thick starting within 10 in. (25 cm) of the soil surface
F6 – Redox Dark Surface	4 in. (10 cm) thick entirely within the upper 12 in. (30 cm)
F7 – Depleted Dark Surface	4 in. (10 cm) thick entirely within the upper 12 in. (30 cm)

Table 7 presents an example of a soil in which a combination of layers meets the requirements for indicators F6 (Redox Dark Surface) and F3 (Depleted Matrix). The second layer meets the morphological characteristics of F6 and the third layer meets the morphological characteristics of F3, but neither meets the thickness requirements for the indicators. However, the combined thickness of the second and third layers meets the more restrictive conditions of thickness for F3 (i.e., 6 in. (15 cm) starting within 10 in. (25 cm) of the soil surface). Therefore, the soil is considered to be hydric based on the combination of indicators.

Table 7. Example of a soil that is hydric based on a combination of indicators F6 and F3.

Depth (inches)	Matrix Color	Redox Concentrations			Texture
		Color	Abundance	Contrast	
0 – 3	10YR 2/1	--	--	--	Loamy
3 – 6	10YR 3/1	7.5YR 5/6	3 percent	Prominent	Loamy
6 – 10	10YR 5/2	7.5YR 5/6	5 percent	Prominent	Loamy
10 – 14	2.5Y 4/2	--	--	--	Loamy

Another common situation in which it is appropriate to combine the characteristics of hydric soil indicators is when stratified textures of sandy (i.e., loamy fine sand and coarser) and loamy (i.e., loamy very fine sand and finer) material occur in the upper 12 in. of the soil. For example, the soil shown in Table 8 is hydric based on a combination of indicators F6 (Redox Dark Surface) and S5 (Sandy Redox). This soil meets the morphological characteristics of F6 in the first layer and S5 in the second layer, but neither layer by itself meets the thickness requirements for the indicators. However, the combined thickness of the two layers (6 in.) meets the more restrictive thickness requirement of either indicator (4 in.).

Table 8. Example of a soil that is hydric based on a combination of indicators F6 and S5.

Depth (inches)	Matrix Color	Redox Concentrations			Texture
		Color	Abundance	Contrast	
0 – 3	10YR 3/1	10YR 5/6	3 percent	Prominent	Loamy
3 – 6	10YR 4/1	10YR 5/6	3 percent	Prominent	Sandy
6 – 16	10YR 4/1	--	--	--	Loamy

All soils

“All soils” refers to soils with any USDA soil texture. Use the following indicators regardless of soil texture.

Unless otherwise indicated, all mineral layers above any of the indicators must have a dominant chroma of 2 or less, or the layer(s) with dominant chroma of more than 2 must be less than 6 in. (15 cm) thick to meet any hydric soil indicator. Nodules and concretions are not considered to be redox concentrations unless otherwise noted.

Indicator A1: Histosol

Technical Description: Classifies as a Histosol (except Folists)

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: In a Histosol, 16 in. (40 cm) or more of the upper 32 in. (80 cm) is organic soil material (Figure 6). Histosols also include soils that have organic soil material of any thickness over rock or fragmental soil material that has interstices filled with organic soil material. Organic soil material has an organic carbon content (by weight) of 12 to 18 percent or more, depending on the clay content of the soil. The material includes muck (sapric soil material), mucky peat (hemic soil material), or peat (fibric soil material). See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b) for definitions of muck, mucky peat, peat, and organic soil material. See the Concepts section of this chapter for field methods to identify organic soil materials.

Figure 6. Example of a Histosol, in which muck (sapric soil material) is greater than 3 ft (0.9 m) thick.

This indicator is more common in the northern and eastern portions of the region, and rare in the western and southern portions of the region. It is most likely associated with fens and slope wetlands that are saturated to the surface, or depressions that are ponded or saturated nearly all of the growing season in most years.

Indicator A2: Histic Epipedon

Technical Description: A histic epipedon underlain by mineral soil material with chroma of 2 or less.

Applicable Subregions: Applicable throughout the Midwest Region.

Figure 7. Example of an organic surface layer less than 16 in. (40.6 cm) thick.

User Notes: Most histic epipedons are surface horizons 8 in. (20 cm) or more thick of organic soil material (Figure 7). Aquic conditions or artificial drainage are required (see *Soil Taxonomy*, USDA Natural Resources Conservation Service 1999); however, aquic conditions can be assumed if indicators of hydrophytic vegetation and wetland hydrology are present. See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b) for definitions. See the Concepts section of this chapter for field methods to identify organic soil materials. See indicator A1 for organic carbon requirements. Slightly lower organic carbon contents are allowed in plowed soils.

This indicator is more common in the northern and eastern portions of the region, and rare in the western and southern portions of the region. It is most likely associated with fens and slope wetlands that are saturated to the surface, or depressions that are ponded or saturated nearly all of the growing season in most years.

Indicator A3: Black Histic

Figure 8. In this soil, the organic surface layer is about 9 in. (23 cm) thick.

Technical Description: A layer of peat, mucky peat, or muck 8 in. (20 cm) or more thick that starts within 6 in. (15 cm) of the soil surface; has hue of 10YR or yellower, value of 3 or less, and chroma of 1 or less; and is underlain by mineral soil material with chroma of 2 or less (Figure 8).

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: This indicator does not require proof of aquic conditions or artificial drainage. See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b) for definitions of peat, mucky peat, and muck. See the Concepts section of this chapter for field methods to identify organic soil materials. See indicator A1 for organic carbon requirements.

This indicator is more common in the northern and eastern portions of the region, and rare in the western and southern portions of the region. It is most likely associated with fens and slope wetlands that are saturated to the surface, or depressions that are ponded or saturated nearly all of the growing season in most years.

Indicator A4: Hydrogen Sulfide

Technical Description: A hydrogen sulfide (rotten egg) odor within 12 in. (30 cm) of the soil surface.

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: Any time the soil smells of hydrogen sulfide (rotten egg odor), sulfur is currently being reduced and the soil is definitely in an anaerobic state. In some soils, the odor is well pronounced; in others it is very fleeting as the gas dissipates rapidly. If in doubt, quickly open several small holes in the area of concern to determine if a hydrogen sulfide odor is really present. This indicator is most commonly found in areas that are permanently saturated or inundated and is often found in conjunction with other hydric soil indicators. This indicator sometimes occurs in the "Soils with High-Chroma Subsoils" problem soils (see Chapter 5).

Indicator A5: Stratified Layers

Technical Description: Several stratified layers starting within 6 in. (15 cm) of the soil surface. One or more of the layers has a value of 3 or less with chroma of 1 or less and/or it is muck, mucky peat, or peat, or has a mucky modified mineral texture. The remaining layers have chroma of 2 or less (Figures 9 and 10).

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: Use of this indicator may require assistance from a soil scientist with local experience. An undisturbed sample must be observed. Individual strata are dominantly less than 1 in. (2.5 cm) thick. A hand lens is an excellent tool to aid in the identification of this indicator. Many alluvial soils have stratified layers at greater depths; these are not hydric soils. Many alluvial soils have stratified layers at the required depths, but lack chroma 2 or less; these do not fit this indicator. Stratified layers occur in any type of soil material, generally in floodplains and other areas where wet soils are subject to rapid and repeated burial with thin deposits of sediment.

Figure 9. Stratified layers in loamy material.

Figure 10. Stratified layers in sandy material. Scale in inches.

Indicator A10: 2 cm Muck

Technical Description: A layer of muck 0.75 in. (2 cm) or more thick with value of 3 or less and chroma of 1 or less, starting within 6 in. (15 cm) of the soil surface.

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: This indicator is commonly found at the interior of potholes and other depressions that are ponded for several months each year. Normally the muck layer is at the soil surface; however, it may occur at any depth within 6 in. (15 cm) of the surface. Muck is sapric soil material with at least 12 to 18 percent organic carbon. Organic soil material is called muck (sapric soil material) if virtually all of the material has undergone sufficient decomposition to limit recognition of the plant parts. Hemic (mucky peat) and fibric (peat) soil materials do not qualify. To determine if muck is present, first remove loose leaves, needles, bark, and other easily identified plant remains. This is sometimes called leaf litter, a duff layer, or a leaf or root mat. Then examine for decomposed organic soil material. Generally, muck is black and has a greasy feel; sand grains should not be evident (see the Concepts section of this chapter for field methods to identify organic soil materials). Determination of this indicator is made below the leaf or root mat; however, root mats that meet the definition of hemic or fibric soil material are included in the decision-making process for indicators A1 (Histosol) and A2 (Histic Epipedon). This indicator is commonly found in the "Soils with High-Chroma Subsoils" problem soils (see Chapter 5).

Indicator A11: Depleted Below Dark Surface

Technical Description: A layer with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less, starting within 12 in. (30 cm) of the soil surface, and having a minimum thickness of either:

- 6 in. (15 cm), or
- 2 in. (5 cm) if the 2 in. (5 cm) consists of fragmental soil material.

Loamy/clayey layer(s) above the depleted or gleyed matrix must have a value of 3 or less and chroma of 2 or less. Any sandy material above the depleted or gleyed matrix must have a value of 3 or less and chroma of 1 or less, and at least 70 percent of the visible soil particles must be covered, coated, or similarly masked with organic material.

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: This indicator often occurs in prairie soils (Mollisols), but also applies to other soils that have dark-colored surface layers, such as umbric epipedons and dark-colored ochric epipedons (Figure 11). For soils that have dark surface layers greater than 12 in. (30 cm) thick, use indicator A12. Two percent or more distinct or prominent redox concentrations, including iron/manganese soft masses, pore linings, or both, are required in soils that have matrix values/chromas of 4/1, 4/2, and 5/2 (Figure A1). If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. Redox concentrations are not required for soils with matrix values of 5 or more and chroma of 1, or values of 6 or more and chromas of 2 or 1. The low-chroma matrix must be caused by wetness and not be a relict or parent material feature. See the Glossary (Appendix A) for definitions of depleted matrix, gleyed matrix, distinct and prominent features, and fragmental soil material.

In some places, the gleyed matrix may change color upon exposure to air (reduced matrix). This phenomenon is included in the concept of a gleyed matrix (USDA Natural Resources Conservation Service 2002).

This indicator is commonly found at the boundary of wetlands in Mollisols or other dark-colored soils. It is often found in soils formed on alluvial terraces along larger river systems in areas subject to ponding due to high water tables.

Figure 11. In this soil, a depleted matrix starts immediately below the black surface layer at approximately 11 in. (28 cm).

Indicator A12: Thick Dark Surface

Technical Description: A layer at least 6 in. (15 cm) thick with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less starting below 12 in. (30 cm) of the surface. The layer(s) above the depleted or gleyed matrix must have a value of 2.5 or less and chroma of 1 or less to a depth of at least 12 in. (30 cm) and a value of 3 or less and chroma of 1 or less in any remaining layers above the depleted or gleyed matrix. Any sandy material above the depleted or gleyed matrix must have at least 70 percent of the visible soil particles covered, coated, or similarly masked with organic material.

Applicable Subregions: Applicable throughout the Midwest Region.

Figure 12. Deep observations may be necessary to identify the depleted or gleyed matrix below the dark surface layer.

User Notes: The soil has a depleted matrix or gleyed matrix below a black or very dark gray surface layer 12 in. (30 cm) or more thick (Figure 12). This indicator is most often associated with overthickened soils in concave landscape positions. Two percent or more distinct or prominent redox concentrations (Table A1), including iron/manganese soft masses, pore linings, or both, are required in soils that have matrix values/chromas of 4/1, 4/2, and 5/2 (Figure A1). If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. Redox concentrations are not required for soils with matrix values of 5 or more and chroma of 1, or values of 6 or more and chromas of 2 or 1. The low-chroma matrix must be caused by wetness and not be a relict or parent material feature. See the Glossary (Appendix A) for the definitions of depleted matrix and gleyed matrix.

In some places, the gleyed matrix may change color upon exposure to air (reduced matrix). This phenomenon is included in the concept of a gleyed matrix (USDA Natural Resources Conservation Service 2002).

This indicator is almost never found at the wetland/non-wetland boundary and is much less common than indicators A11 (Depleted Below Dark Surface), F3 (Depleted Matrix), and F6 (Redox Dark Surface).

Sandy soils

"Sandy soils" refers to soil materials with a USDA soil texture of loamy fine sand and coarser. Use the following indicators in soil layers consisting of sandy soil materials.

Unless otherwise indicated (e.g., see indicator S6 – Stripped Matrix), all mineral layers above any of the indicators must have a dominant chroma of 2 or less, or the layer(s) with dominant chroma of more than 2 must be less than 6 in. (15 cm) thick to meet any hydric soil indicator. Nodules and concretions are not considered to be redox concentrations unless otherwise noted.

Indicator S1: Sandy Mucky Mineral

Technical Description: A layer of mucky modified sandy soil material 2 in. (5 cm) or more thick starting within 6 in. (15 cm) of the soil surface (Figure 13).

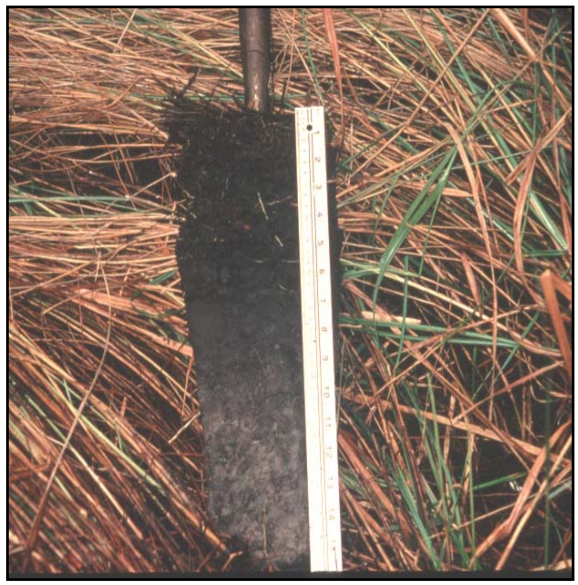

Figure 13. The mucky modified sandy layer is approximately 3 in. (7.5 cm) thick. Scale in inches on the right side of ruler.

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: This indicator is rare in this region. *Mucky* is a USDA texture modifier for mineral soils. The organic carbon content is at least 5 percent and ranges to as high as 14 percent for sandy soils. The percentage requirement is dependent upon the clay content of the soil; the higher the clay content, the higher the organic carbon requirement. See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b) for the definition of mucky modified mineral texture. A field procedure for identifying mucky mineral soil material is presented in the Concepts section of this chapter.

This indicator is most commonly found in the northeast portion of the region and is most often found at the edges of depressions that have thicker organic soils in the interior (e.g., indicator A10 – 2 cm Muck).

Indicator S3: 5 cm Mucky Peat or Peat

Technical Description: A layer of mucky peat or peat 2 in. (5 cm) or more thick with a value of 3 or less and chroma of 2 or less, starting within 6 in. (15 cm) of the soil surface, and underlain by sandy soil material.

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: Mucky peat (hemic soil material) and peat (fibric soil material) have at least 12 to 18 percent organic carbon. Organic soil material is called peat if virtually all of the plant remains are sufficiently intact to permit identification of plant remains. Mucky peat is an intermediate stage of decomposition between peat and highly decomposed muck. Field procedures for identifying mucky peat and peat were presented in the Concepts section of this chapter. This indicator is most commonly found in the northeast portion of the region.

Indicator S4: Sandy Gleyed Matrix

Technical Description: A gleyed matrix that occupies 60 percent or more of a layer starting within 6 in. (15 cm) of the soil surface (Figure 14).

Applicable Subregions: Applicable throughout the Midwest Region.

Figure 14. In this example, the gleyed matrix begins at the soil surface.

User Notes: Gley colors are not synonymous with gray colors. Gley colors are those colors that are on the gley pages (Gretag/Macbeth 2000). They have hue N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB, with a value of 4 or more. The gleyed matrix only has to be present within 6 in. (15 cm) of the surface. Soils with gleyed matrices are saturated for significant periods; therefore, *no minimum thickness of* *gleyed layer is required.* See the Glossary (Appendix A) for the complete definition of a gleyed matrix.

This indicator is most frequently found on floodplains and generally is not found at the boundary between wetlands and non-wetlands. It is often found in oxbows associated with high water tables that remain wet most of the year. This indicator is most commonly found in the northeast portion of the region.

Indicator S5: Sandy Redox

Technical Description: A layer starting within 6 in. (15 cm) of the soil surface that is at least 4 in. (10 cm) thick and has a matrix with 60 percent or more chroma of 2 or less with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings (Figure 15).

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: Distinct and prominent are defined in the Glossary (Appendix A). Redox concentrations include iron and manganese masses (reddish mottles) and pore linings (Vepraskas 1992). Included within the concept of redox concentrations are iron/manganese bodies as soft masses with diffuse boundaries. Common (2 to less than 20 percent) to many (20 percent or more) redox concentrations (USDA Natural Resources Conservation Service 2002) are required. If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible.

This is a very common indicator of hydric soils and is often used to identify the hydric/non-hydric boundary in sandy soils. This indicator is often associated with forested depressions in the eastern portion of the Midwest region, swales within dune/swale complexes, and within the Missouri River floodplain. It is also commonly found in the “Soils with High-Chroma Subsoils” problem soils (see Chapter 5).

Figure 15. Redox concentrations (orange areas) in sandy soil material.

Indicator S6: Stripped Matrix

Technical Description: A layer starting within 6 in. (15 cm) of the soil surface in which iron/manganese oxides and/or organic matter have been stripped from the matrix and the primary base color of the soil material has been exposed. The stripped areas and translocated oxides and/or organic matter form a faint, diffuse splotchy pattern of two or more colors. The stripped zones are 10 percent or more of the volume; they are rounded and approximately 0.5 to 1 in. (1 to 3 cm) in diameter (Figure 16).

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: This indicator includes the indicator previously named streaking (Environmental Laboratory 1987) or polychromatic matrix. It requires common to many (USDA Natural Resources Conservation Service 2002) areas of stripped (uncoated) soil materials usually 0.5 to 1 in. (1 to 3 cm) in size, but they may be smaller. Commonly, the splotches of color have a value of 5 or more and chroma of 1 and/or 2 (stripped) and chroma of 3 and/or 4 (unstripped). However, there are no specific color requirements for this indicator. The mobilization and translocation of the oxides and/or organic matter are the important processes involved in this indicator and should result in splotchy coated and uncoated soil areas. Faint stripped areas can be difficult to see. A 10-power hand lens can be helpful in seeing stripped and unstripped areas. Use care to ensure that the splotchy pattern was not due to mixing of soil layers by burrowing animals. It may be helpful to involve a soil scientist or wetland scientist familiar with the stripped matrix indicator.

Figure 16. The layer stripped of organic matter begins beneath the dark surface layer (approximately 2 in. (5 cm)).

This is a very common indicator of hydric soils and is often used to identify the hydric/non-hydric boundary in sandy soils. This indicator is found in all wetland types and all wet landscape positions. It is more common in the northeast portion of the region and rare in the western portion of the region.

Loamy and clayey soils

"Loamy and clayey soils" refers to soil materials with USDA textures of loamy very fine sand and finer. Use the following indicators in soil layers consisting of loamy or clayey soil materials.

Unless otherwise indicated (e.g., see indicator F8 – Redox Depressions), all mineral layers above any of the indicators must have a dominant chroma of 2 or less, or the layer(s) with dominant chroma of more than 2 must be less than 6 in. (15 cm) thick to meet any hydric soil indicator. Nodules and concretions are not considered to be redox concentrations unless otherwise noted.

Indicator F1: Loamy Mucky Mineral

Technical Description: A layer of mucky modified loamy or clayey soil material 4 in. (10 cm) or more thick starting within 6 in. (15 cm) of the soil surface.

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: *Mucky* is a USDA texture modifier for mineral soils. The organic carbon is at least 8 percent, but can range to as high as 18 percent. The percentage requirement is dependent upon the clay content of the soil; the higher the clay content, the higher the organic carbon requirement. See the Concepts section of this chapter for guidance on identifying mucky mineral soil materials in the field; however, loamy mucky soil material is difficult to distinguish. This indicator is commonly associated with the interiors of potholes.

Indicator F2: Loamy Gleyed Matrix

Technical Description: A gleyed matrix that occupies 60 percent or more of a layer starting within 12 in. (30 cm) of the soil surface (Figure 17).

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: Gley colors are not synonymous with gray colors. Gley colors are those colors that are on the gley pages (Gretag/Macbeth 2000). They have hue N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB, with a value of 4 or more. The gleyed matrix only has to be present within 12 in. (30 cm) of the surface. Soils with gleyed matrices are saturated for significant periods; therefore, *no minimum thickness of gleyed layer is required*. See the Glossary (Appendix A) for the definition of a gleyed matrix.

This indicator is found in soils that are inundated or saturated nearly all of the growing season in most years (e.g., in oxbows with permanent water) and is not usually found at the boundary between wetlands and non-wetlands.

Figure 17. This gleyed matrix begins at the soil surface.

Indicator F3: Depleted Matrix

Technical Description: A layer that has a depleted matrix with 60 percent or more chroma of 2 or less and that has a minimum thickness of either:

- 2 in. (5 cm) if the 2 in. (5 cm) is entirely within the upper 6 in. (15 cm) of the soil, or
- 6 in. (15 cm) starting within 10 in. (25 cm) of the soil surface.

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: This is one of the most commonly observed hydric soil indicators at wetland boundaries. Redox concentrations including iron/manganese soft masses or pore linings, or both, are required in soils with matrix values/chromas of 4/1, 4/2, and 5/2 (Figures 18 and 19). If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. Redox concentrations are not required in soils with matrix values of 5 or more and chroma of 1, or values of 6 or more and chromas of 2 or 1. The low-chroma matrix must be caused by wetness and not be a relict or parent material feature. See the Glossary (Appendix A) for the definition of a depleted matrix.

Figure 18. Indicator F3, Depleted Matrix. Redox concentrations are present within a low-chroma matrix.

Figure 19. Redox concentrations at 2 in. (5 cm).

Indicator F6: Redox Dark Surface

Technical Description: A layer that is at least 4 in. (10 cm) thick, is entirely within the upper 12 in. (30 cm) of the mineral soil, and has a:

- Matrix value of 3 or less and chroma of 1 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings, or

- Matrix value of 3 or less and chroma of 2 or less and 5 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings.

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: This is a very common indicator used to delineate wetlands in soils with dark-colored surface layers. It is commonly found at the boundaries of pothole wetlands and in the "Soils with High-Chroma Subsoils" problem soils (see Chapter 5). Redox concentrations in high organic-content mineral soils with dark surfaces are often small and difficult to see (Figure 20). The organic matter masks some or all of the concentrations that may be present. Careful examination is required to see what are often brownish redox concentrations in the darkened materials. If the soil is saturated at the time of sampling, it may be necessary to let it dry at least to a moist condition for redox features to become visible. In some cases, further drying of the samples makes the concentrations (if present) easier to see. A hand lens may be helpful in seeing and describing small redox concentrations. Care should be taken to examine the interior of soil peds for redox concentrations. Dry colors, if used, also need to have matrix chromas of 1 or 2, and the redox concentrations need to be distinct or prominent (see Glossary, Appendix A).

In soils that are wet because of subsurface saturation, the layer immediately below the dark epipedon will likely have a depleted or gleyed matrix (see the Glossary for definitions). Soils that are wet because of ponding or have a shallow, perched layer of saturation may not always have a depleted/gleyed matrix below the dark surface. It is recommended that delineators evaluate the hydrologic source and examine and describe the layer below the dark-colored epipedon when applying this indicator.

Figure 20. Redox features can be small and difficult to see within a dark soil layer.

Indicator F7: Depleted Dark Surface

Technical Description: Redox depletions with a value of 5 or more and chroma of 2 or less in a layer that is at least 4 in. (10 cm) thick, is entirely within the upper 12 in. (30 cm) of the mineral soil (Figure 21), and has a:

- Matrix value of 3 or less and chroma of 1 or less and 10 percent or more redox depletions, or
- Matrix value of 3 or less and chroma of 2 or less and 20 percent or more redox depletions.

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: Care should be taken not to mistake the mixing of eluvial layers that have high value and low chroma (E horizon) or illuvial layers that have accumulated carbonates (calcic horizon) into the surface layer as depletions. Mixing of layers can be caused by burrowing animals or cultivation. Pieces of deeper layers that become incorporated into the surface layer are not redox depletions. Knowledge of local conditions is required in areas where light-colored eluvial layers and/or layers high in carbonates may be present. In soils that are wet because of subsurface saturation, the layer immediately below the dark surface is likely to have a depleted or gleyed matrix. Redox depletions will usually have associated microsites with redox concentrations that occur as pore linings or masses within the depletion(s) or surrounding the depletion(s). This indicator is uncommon throughout the region.

Figure 21. Redox depletions (lighter colored areas) are scattered within the darker matrix. Scale is in centimeters.

Indicator F8: Redox Depressions

Technical Description: In closed depressions subject to ponding, 5 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings in a layer that is 2 in. (5 cm) or more thick and is entirely within the upper 6 in. (15 cm) of the soil (Figure 22).

Applicable Subregions: Applicable throughout the Midwest Region.

User Notes: This indicator occurs at the edges of depressional landforms, such as forested depressions and potholes; but not microdepressions on convex landscapes. Closed depressions often occur within flats or floodplain landscapes. *Note that there is no color requirement for the soil matrix.* The layer containing redox concentrations may extend below 6 in. (15 cm) as long as at least 2 in. (5 cm) occurs within 6 in. (15 cm) of the surface. If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. See the Glossary for definitions of distinct and prominent.

This is a common but often overlooked indicator found at the wetland/non-wetland boundary on depressional sites. It commonly occurs in wetland/non-wetland mosaics with indicators F6 (Redox Dark Surface) and F3 (Depleted Matrix) in the eastern portion of the region.

Figure 22. In this example, the layer containing more than 5 percent redox concentrations begins at the soil surface and is slightly more than 2 in. (5 cm) thick.

Hydric soil indicators for problem soils

The following indicators are not currently recognized for general application by the NTCHS, or they are not recognized in the specified geographic area. However, these indicators may be used in problem wetland situations in the Midwest where there is evidence of wetland hydrology and hydrophytic vegetation, and the soil is believed to meet the definition of a hydric soil despite the lack of other indicators of a hydric soil. To use these indicators, follow the procedure described in the section on Problematic Hydric Soils in Chapter 5. If any of the following indicators is observed, it is recommended that the NTCHS be notified by following the protocol described in the "Comment on the Indicators" section of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b).

Indicator A16: Coast Prairie Redox

Technical Description: A layer starting within 6 in. (15 cm) of the soil surface that is at least 4 in. (10 cm) thick and has a matrix chroma of 3 or less with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings.

Applicable Subregions: For use with problem soils throughout the Midwest Region.

User Notes: These hydric soils occur mainly on depressional and intermound landforms. Redox concentrations occur mainly as iron-dominated pore linings. Common to many redox concentrations are required. If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. Chroma 3 matrices are allowed because they may be the color of stripped sand grains, or because few to common sand-sized reddish particles may be present and may prevent obtaining a chroma of 2 or less.

Indicator F12: Iron-Manganese Masses

Technical Description: On floodplains, a layer 4 in. (10 cm) or more thick with 40 percent or more chroma of 2 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft iron/manganese masses with diffuse boundaries. The layer occurs entirely within 12 in. (30 cm) of the soil surface. Iron-manganese masses have a value and chroma of 3 or less. Most commonly, they are black. The thickness requirement is waived if the layer is the mineral surface layer.

Applicable Subregions: For use with problem soils throughout the Midwest Region.

User Notes: These iron-manganese masses generally are small (2 to 5 mm in size) and have a value and chroma of 3 or less. They can be dominated by manganese and, therefore, have a color approaching black. If the soil is saturated at the time of sampling, it may be necessary to let it dry to a moist condition for redox features to become visible. The low matrix chroma must be the result of wetness and not be a relict or parent material feature. Iron-manganese masses should not be confused with the larger and redder iron nodules associated with plinthite or with concretions that have sharp boundaries.

4 Wetland Hydrology Indicators

Introduction

Wetland hydrology indicators are used in combination with indicators of hydric soil and hydrophytic vegetation to determine whether an area is a wetland under the Corps Manual. Indicators of hydrophytic vegetation and hydric soil generally reflect a site's medium- to long-term wetness history. They provide readily observable evidence that episodes of inundation or soil saturation lasting more than a few days during the growing season have occurred repeatedly over a period of years and that the timing, duration, and frequency of wet conditions have been sufficient to produce a characteristic wetland plant community and hydric soil morphology. If hydrology has not been altered, vegetation and soils provide strong evidence that wetland hydrology is present (National Research Council 1995). Wetland hydrology indicators provide evidence that the site has a *continuing* wetland hydrologic regime and that hydric soils and hydrophytic vegetation are not relicts of a past hydrologic regime. Wetland hydrology indicators confirm that an episode of inundation or soil saturation occurred recently, but may provide little additional information about the timing, duration, or frequency of such events (National Research Council 1995).

Hydrology indicators are often the most transitory of wetland indicators. Some hydrology indicators are naturally temporary or seasonal, and many are affected by recent or long-term meteorological conditions. For example, indicators involving direct observation of surface water or saturated soils often are present only during the normal wet portion of the growing season and may be absent during the dry season or during drier-than-normal years. Hydrology indicators also may be subject to disturbance or destruction by natural processes or human activities. Most wetlands in the Midwest Region will exhibit one or more of the hydrology indicators presented in this chapter. However, some wetlands may lack any of these indicators due to temporarily dry conditions, disturbance, or other factors. Therefore, the lack of an indicator is not evidence for the absence of wetland hydrology. See Chapter 5 (Difficult Wetland Situations in the Midwest Region) for help in identifying wetlands that may lack wetland hydrology indicators at certain times.

The Midwest Region has a humid climate with moderate to abundant rainfall during normal years. Wetlands in the region are associated with both surface and subsurface water sources. In wetlands maintained by subsurface saturation, hydrology indicators may be difficult to find, particularly during dry periods. On the other hand, some indicators may be present on non-wetland sites immediately after a heavy rain or during periods of unusually high precipitation, river stages, reservoir releases, runoff, or snowmelt. Therefore, it is important to take weather and climatic conditions into account to minimize both false-positive and false-negative wetland hydrology decisions. An understanding of normal seasonal and annual variations in rainfall, temperature, and other climatic conditions is important in interpreting hydrology indicators in the region. Some useful sources of climatic data are described in Chapter 5.

Areas that have hydrophytic vegetation and hydric soils generally also have wetland hydrology unless the hydrologic regime has changed due to natural events or human activities (National Research Council 1995). Therefore, when wetland hydrology indicators are absent from an area that has indicators of hydric soil and hydrophytic vegetation, further information may be needed to determine whether or not wetland hydrology is present. If possible, one or more site visits should be scheduled to coincide with the normal wet portion of the growing season, the period of the year when the presence or absence of wetland hydrology indicators is most likely to reflect the true wetland/non-wetland status of the site. In areas that are disturbed or problematic, aerial photography or other remote-sensing data, stream gauge data, monitoring well data, runoff estimates, scope-and-effect equations for ditches and subsurface drainage systems, or groundwater modeling are tools that may help to determine whether wetland hydrology is present when indicators are equivocal or lacking (e.g., USDA Natural Resources Conservation Service 1997). Off-site procedures developed under the National Food Security Act Manual (USDA Natural Resources Conservation Service 1994), including wetland mapping conventions developed by NRCS state offices, can help identify areas that have wetland hydrology on agricultural lands. The technique is based on wetness signatures visible on standard high-altitude aerial photographs or on annual crop-compliance slides taken by the USDA Farm Service Agency. Finally, on highly disturbed or problematic sites, direct hydrologic monitoring may be needed to determine whether wetland hydrology is present. The U. S. Army Corps of Engineers (2005) provides a technical standard for monitoring hydrology on such sites. This standard requires 14 or more consecutive days of flooding or ponding, or a water table 12 in. (30 cm) or less below the soil surface, during the growing season at a minimum frequency of 5 years in 10 (50 percent or higher probability) (National Research Council 1995) unless an alternative standard has been established for a particular region or wetland type. See Chapter 5 for further information on these techniques.

Growing season

Beginning and ending dates of the growing season may be needed to evaluate certain wetland indicators, such as visual observations of flooding, ponding, or shallow water tables on potential wetland sites. In addition, growing season dates are needed in the event that recorded hydrologic data, such as stream gauge or water-table monitoring data, must be analyzed to determine whether wetland hydrology is present on highly disturbed or problematic sites.

Depletion of oxygen and the chemical reduction of nitrogen, iron, and other elements in saturated soils during the growing season is the result of biological activity occurring in plant roots and soil microbial populations (National Research Council 1995). Two indicators of biological activity that are readily observable in the field are (1) above-ground growth and development of vascular plants, and (2) soil temperature. Therefore, if information about the growing season is needed and on-site data gathering is practical, the following approaches should be used in this region to determine growing season dates in a given year. The growing season has begun and is ongoing if either of these conditions is met.

1. The growing season has begun on a site in a given year when two or more different non-evergreen vascular plant species growing in the wetland or surrounding areas exhibit one or more of the following indicators of biological activity:

    a. Emergence of herbaceous plants from the ground
    b. Appearance of new growth from vegetative crowns (e.g., in graminoids, bulbs, and corms)
    c. Coleoptile/cotyledon emergence from seed
    d. Bud burst on woody plants (i.e., some green foliage is visible between spreading bud scales)
    e. Emergence or elongation of leaves of woody plants

f. Emergence or opening of flowers

The end of the growing season is indicated when woody deciduous species lose their leaves and/or the last herbaceous plants cease flowering and their leaves become dry or brown, generally in the fall due to cold temperatures or reduced moisture availability. Early plant senescence due to the initiation of the summer dry season in some areas does not necessarily indicate the end of the growing season and alternative procedures (e.g., soil temperature) should be used.

This determination should not include evergreen species. Observations should be made in the wetland or in surrounding areas subject to the same climatic conditions (e.g., similar elevation and aspect); however, soil moisture conditions may differ. Supporting data should be reported on the data form, in field notes, or in the delineation report, and should include the species observed (if identifiable), their abundance and location relative to the potential wetland, and the type of biological activity observed. A one-time observation of biological activity during a single site visit is sufficient, but is not required unless growing season information is necessary to evaluate particular wetland hydrology indicators. However, if long-term hydrologic monitoring is planned, then plant growth, maintenance, and senescence should be monitored for continuity over the same period.

2. The growing season has begun in spring, and is still in progress, when soil temperature measured at the 12-in. (30-cm) depth is 41 °F (5 °C) or higher. A one-time temperature measurement during a single site visit is sufficient, but is not required unless growing season information is necessary to evaluate particular wetland hydrology indicators. However, if long-term hydrologic monitoring is planned, then soil temperature should also be monitored to ensure that it remains continuously at or above 41 °F during the monitoring period. Soil temperature can be measured directly in the field by inserting a soil thermometer into the wall of a freshly dug soil pit.

If the timing of the growing season based on vegetation growth and development and/or soil temperature is unknown and on-site data collection is not practical, such as when analyzing previously recorded stream-gauge or monitoring-well data, then growing season dates may be approximated by the median dates (i.e., 5 years in 10, or 50 percent probability) of 28 °F (−2.2 °C) air temperatures in spring and fall, based on long-term records gathered at National Weather Service meteorological stations (U.S. Army Corps of Engineers 2005). These dates are reported in WETS tables available from the NRCS National Water and Climate Center (http://www.wcc.nrcs.usda.gov/climate/wetlands.html) for the nearest appropriate weather station.

Wetland hydrology indicators

In this chapter, wetland hydrology indicators are presented in four groups. Indicators in Group A are based on the direct observation of surface water or groundwater during a site visit. Group B consists of evidence that the site is subject to flooding or ponding, although it may not be inundated currently. These indicators include water marks, drift deposits, sediment deposits, and similar features. Group C consists of other evidence that the soil is saturated currently or was saturated recently. Some of these indicators, such as oxidized rhizospheres surrounding living roots and the presence of reduced iron or sulfur in the soil profile, indicate that the soil has been saturated for an extended period. Group D consists of landscape and vegetation characteristics that indicate contemporary rather than historical wet conditions. Wetland hydrology indicators are intended as one-time observations of site conditions that are sufficient evidence of wetland hydrology. Unless otherwise noted, all indicators are applicable throughout the Midwest Region.

Within each group, indicators are divided into two categories – *primary* and *secondary* – based on their estimated reliability in this region. Primary indicators provide stand-alone evidence of a current or recent hydrologic event; some of these also indicate that inundation or saturation was long-lasting. Secondary indicators provide evidence of recent inundation or saturation when supported by one or more other primary or secondary wetland hydrology indicators, but should not be used alone.

One primary indicator from any group is sufficient to conclude that wetland hydrology is present; the area is a wetland if indicators of hydric soil and hydrophytic vegetation are also present. In the absence of a primary indicator, two or more secondary indicators from any group are required to conclude that wetland hydrology is present. Indicators of wetland hydrology include, but are not necessarily limited to, those listed in Table 9 and described on the following pages. Other evidence of wetland hydrology may also be used with appropriate documentation.

Table 9. Wetland hydrology indicators for the Midwest Region.

Indicator	Category	
	Primary	Secondary
Group A – Observation of Surface Water or Saturated Soils		
A1 – Surface water	X	
A2 – High water table	X	
A3 – Saturation	X	
Group B – Evidence of Recent Inundation		
B1 – Water marks	X	
B2 – Sediment deposits	X	
B3 – Drift deposits	X	
B4 – Algal mat or crust	X	
B5 – Iron deposits	X	
B7 – Inundation visible on aerial imagery	X	
B8 – Sparsely vegetated concave surface	X	
B9 – Water-stained leaves	X	
B13 – Aquatic fauna	X	
B14 – True aquatic plants	X	
B6 – Surface soil cracks		X
B10 – Drainage patterns		X
Group C – Evidence of Current or Recent Soil Saturation		
C1 – Hydrogen sulfide odor	X	
C3 – Oxidized rhizospheres along living roots	X	
C4 – Presence of reduced iron	X	
C6 – Recent iron reduction in tilled soils	X	
C7 – Thin muck surface	X	
C2 – Dry-season water table		X
C8 – Crayfish burrows		X
C9 – Saturation visible on aerial imagery		X
Group D – Evidence from Other Site Conditions or Data		
D9 – Gauge or well data	X	
D1 – Stunted or stressed plants		X
D2 – Geomorphic position		X
D5 – FAC-neutral test		X

Group A – Observation of surface water or saturated soils

Indicator A1: Surface water

Category: Primary

General Description: This indicator consists of the direct, visual observation of surface water (flooding or ponding) during a site visit (Figure 23).

Cautions and User Notes: Care must be used in applying this indicator because surface water may be present in non-wetland areas immediately after a rainfall event or during periods of unusually high precipitation, runoff, tides, or river stages. Furthermore, some non-wetlands flood frequently for brief periods. Surface water observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. If this is questionable and other hydrology indicators are absent, a follow-up visit during the growing season may be needed. Water perched on seasonal soil ice is included in this indicator if the resulting inundation is normally present well into the growing season. Note that surface water may be absent from a wetland during the normal dry season or during extended periods of drought. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., wetlands are inundated or saturated at least 5 out of 10 years, or 50 percent or higher probability). In addition, groundwater-dominated wetland systems may never or rarely contain surface water. Use caution in areas with functioning ditches and/or subsurface drains that may remove surface water quickly.

Figure 23. Wetland with surface water present.

Indicator A2: High water table

Category: Primary

General Description: This indicator consists of the direct, visual observation of the water table 12 in. (30 cm) or less below the surface in a soil pit, auger hole, or shallow monitoring well (Figure 24). This indicator includes water tables derived from perched water, throughflow, and discharging groundwater (e.g., in seeps) that may be moving laterally near the soil surface.

Cautions and User Notes: Sufficient time must be allowed for water to infiltrate into a newly dug hole and to stabilize at the water-table level. The required time will vary depending upon soil texture. In some cases, the water table can be determined by examining the wall of the soil pit and identifying the upper level at which water is seeping into the pit. A water table within 12 in. of the surface observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. If this is questionable and other hydrology indicators are absent, a follow-up visit during the growing season may be needed. Water perched on seasonal soil ice is included in this indicator if the resulting high water table is normally present well into the growing season. Care must be used in interpreting this indicator because water-table levels normally vary seasonally and are a function of both recent and long-term precipitation. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., wetlands are inundated or saturated at least 5 out of 10 years, or 50 percent or higher probability). For an accurate determination of the water-table level, the soil pit, auger hole, or well should not penetrate any restrictive soil layer capable of perching water near the surface. Use caution in areas with functioning ditches and/or subsurface drains that may improve soil drainage and reduce the duration of episodes of high water tables.

Figure 24. High water table observed in a soil pit.

Indicator A3: Saturation

Category: Primary

General Description: Visual observation of saturated soil conditions 12 in. (30 cm) or less from the soil surface as indicated by water glistening on the surfaces and broken interior faces of soil samples removed from the pit or auger hole (Figure 25). This indicator must be associated with an existing water table located immediately below the saturated zone; however, this requirement is waived under episaturated conditions if there is a restrictive soil layer or bedrock within 12 in. (30 cm) of the surface.

Cautions and User Notes: Glistening is evidence that the soil sample was taken either below the water table or within the saturated capillary fringe above the water table. Recent rainfall events and the proximity of the water table at the time of sampling must be considered in applying and interpreting this indicator. Water observed in soil cracks or on the faces of soil aggregates (peds) does not meet this indicator unless ped interiors are also saturated. Depth to the water table must be recorded on the data form or in field notes. A water table is not required below the saturated zone under episaturated conditions if the restrictive layer or bedrock is present within 12 in. (30 cm) of the surface. Note the restrictive layer in the soils section of the data form. The restrictive layer may be at the surface. Use caution in areas with functioning ditches and/or subsurface drains.

Figure 25. Water glistens on the surface of a saturated soil sample.

Group B – Evidence of recent inundation

Indicator B1: Water marks

Category: Primary

General Description: Water marks are discolorations or stains on the bark of woody vegetation, rocks, bridge supports, buildings, fences, or other fixed objects as a result of inundation (Figure 26).

Cautions and User Notes: When several water marks are present on an object, the highest reflects the maximum extent of inundation. Water marks indicate a water-level elevation and can be extrapolated from nearby objects across lower elevation areas. Water marks on different trees or other objects should form a level plane that can be viewed from one object to another. Use caution with water marks that may have been caused by extreme, infrequent, or very brief flooding events, or by flooding that occurred outside the growing season. In areas with altered hydrology, use care with relict water marks that may reflect the historic rather than the current hydrologic regime. In regulated systems, such as reservoirs, water-level records can be used to distinguish unusually high pools from normal operating levels.

Figure 26. Water marks (dark stains) on trees in a seasonally flooded wetland.

Indicator B2: Sediment deposits

Category: Primary

General Description: Sediment deposits are thin layers or coatings of fine-grained mineral material (e.g., silt or clay) or organic matter (e.g., pollen), sometimes mixed with other detritus, remaining on tree bark (Figure 27), plant stems or leaves, rocks, and other objects after surface water recedes.

Cautions and User Notes: Sediment deposits most often occur in riverine backwater and ponded situations where water has stood for sufficient time to allow suspended sediment to settle. Sediment deposits may remain for a considerable period before being removed by precipitation or subsequent inundation. Sediment deposits on vegetation or other objects indicate the minimum inundation level. This level can be extrapolated across lower elevation areas. Use caution with sediment left after infrequent high flows or very brief flooding events. This indicator does not include thick accumulations of sand or gravel in fluvial channels that may reflect historic flow conditions or recent extreme events. Use caution in areas where silt and other material trapped in the snowpack may be deposited directly on the ground surface during spring thaw.

Figure 27. Silt deposit left after a recent high-water event forms a tan coating on these tree trunks (upper edge indicated by the arrow).

Indicator B3: Drift deposits

Category: Primary

General Description: Drift deposits consist of rafted debris that has been deposited on the ground surface or entangled in vegetation or other fixed objects. Debris consists of remnants of vegetation (e.g., branches, stems, and leaves), man-made litter, or other waterborne materials. Drift material may be deposited at or near the high water line in ponded or flooded areas, piled against the upstream sides of trees, rocks, and other fixed objects (Figure 28), or widely distributed within the dewatered area.

Cautions and User Notes: Deposits of drift material are often found adjacent to streams or other sources of flowing water in wetlands. They also occur in tidal marshes, along lake shores, and in other ponded areas. The elevation of a drift line can be extrapolated across lower elevation areas. Use caution with drift lines that may have been caused by extreme, infrequent, or very brief flooding events, and in areas with functioning drainage systems capable of removing excess water quickly.

Figure 28. Drift deposit on the upstream side of a sapling in a floodplain wetland.

Indicator B4: Algal mat or crust

Category: Primary

General Description: This indicator consists of a mat or dried crust of algae, perhaps mixed with other detritus, left on or near the soil surface after dewatering.

Cautions and User Notes: Algal deposits include but are not limited to those produced by green algae (Chlorophyta) and blue-green algae (cyanobacteria). They may be attached to low vegetation or other fixed objects, or may cover the soil surface (Figure 29). Dried crusts of blue-green algae may crack and curl at plate margins (Figure 30). Algal deposits are usually seen in seasonally ponded areas, lake fringes, and low-gradient stream margins. They reflect prolonged wet conditions sufficient for algal growth and development.

Figure 29. Dried algal deposit clinging to low vegetation.

Figure 30. Dried crust of blue-green algae on the soil surface.

Indicator B5: Iron deposits

Category: Primary

General Description: This indicator consists of a thin orange or yellow crust or gel of oxidized iron on the soil surface or on objects near the surface.

Cautions and User Notes: Iron deposits form in areas where reduced iron discharges with groundwater and oxidizes upon exposure to air. The oxidized iron forms a film or sheen on standing water (Figure 31) and an orange or yellow deposit (Figure 32) on the ground surface after dewatering.

Figure 31. Iron sheen on the water surface may be deposited as an orange or yellow crust after dewatering.

Figure 32. Iron deposit (orange streaks) in a small channel.

Indicator B7: Inundation visible on aerial imagery

Category: Primary

General Description: One or more recent aerial photographs or satellite images show the site to be inundated.

Cautions and User Notes: Care must be used in applying this indicator because surface water may be present on a non-wetland site immediately after a heavy rain or during periods of unusually high precipitation, runoff, tides, or river stages. See Chapter 5 for procedures to evaluate the normality of precipitation. Surface water observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. Surface water may be absent from a wetland during the normal dry season or during extended periods of drought. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., wetlands are inundated or saturated at least 5 out of 10 years, or 50 percent or higher probability). If available, it is recommended that multiple years of photography be evaluated. If 5 or more years of aerial photography are available, the procedure described by the USDA Natural Resources Conservation Service (1997, section 650.1903) is recommended (see Chapter 5, section on Wetlands that Periodically Lack Indicators of Wetland Hydrology, for additional information).

Indicator B8: Sparsely vegetated concave surface

Category: Primary

General Description: On concave land surfaces (e.g., depressions and swales), the ground surface is either unvegetated or sparsely vegetated (less than 5 percent ground cover) due to long-duration ponding during the growing season (Figure 33).

Cautions and User Notes: Ponding during the growing season can limit the establishment and growth of ground-layer vegetation. Sparsely vegetated concave surfaces should contrast with vegetated slopes and convex surfaces in the same area. A woody overstory of trees or shrubs may or may not be present. Examples in the region include concave positions on floodplains, potholes, and seasonally ponded depressions in forested areas.

Figure 33. A sparsely vegetated, seasonally ponded depression.

Indicator B9: Water-stained leaves

Category: Primary

General Description: Water-stained leaves are fallen or recumbent dead leaves that have turned grayish or blackish in color due to inundation for long periods.

Cautions and User Notes: Water-stained leaves are most often found in depressional wetlands and along streams in shrub-dominated or forested habitats; however, they also occur in herbaceous communities. Staining often occurs in leaves that are in contact with the soil surface while inundated for long periods (Figure 34). Overlapping leaves may become matted together due to wetness and decomposition. Water-stained leaves maintain their blackish or grayish colors when dry. They should contrast strongly with fallen leaves in nearby non-wetland landscape positions.

Figure 34. Water-stained leaves in a seasonally ponded depression, with an unstained leaf for comparison.

Indicator B13: Aquatic fauna

Category: Primary

General Description: Presence of live individuals, diapausing insect eggs or crustacean cysts, or dead remains of aquatic fauna, such as, but not limited to, clams, aquatic snails, aquatic insects, ostracods, shrimp, other crustaceans, tadpoles, or fish, either on the soil surface or clinging to plants or other emergent objects.

Cautions and User Notes: Examples of dead remains include clam shells, chitinous exoskeletons, insect head capsules, aquatic snail shells (Figure 35), and skins or skeletons of aquatic amphibians or fish. Aquatic fauna or their remains should be reasonably abundant; one or two individuals are not sufficient. Use caution in areas where faunal remains may have been transported by high winds, unusually high water, or other animals into non-wetland areas. Shells and exoskeletons are resistant to tillage but may be moved by equipment beyond the boundaries of the wetland. They may also persist in the soil for years after dewatering.

Figure 35. Shells of aquatic snails in a seasonally ponded fringe wetland.

Indicator B14: True aquatic plants

Category: Primary

General Description: This indicator consists of the presence of live individuals or dead remains of true aquatic plants.

Cautions and User Notes: True aquatic plants are species that are normally submerged, have floating leaves or stems, require water for support, or desiccate in the absence of standing water. Examples in the region include watershield (*Brasenia schreberi*), water-milfoil (*Myriophyllum* spp.), cow-lily (*Nuphar luteum*), water-lily (*Nymphaea* spp.), American lotus (*Nelumbo lutea*), pondweeds (*Potamogeton* spp.), bladderworts (*Utricularia* spp.), and duckweeds (*Lemna* spp.) (Figure 36).

Figure 36. Dried remains of water-lilies in a semipermanently ponded wetland.

Indicator B6: Surface soil cracks

Category: Secondary

General Description: Surface soil cracks consist of shallow cracks that form when fine-grained mineral or organic sediments dry and shrink, often creating a network of cracks or small polygons (Figure 37).

Cautions and User Notes: Surface soil cracks are often seen in fine sediments and in areas where water has ponded long enough to destroy surface soil structure in depressions, lake fringes, and floodplains. Use caution, however, as they may also occur in temporary ponds and puddles in non-wetlands and in areas that have been effectively drained. This indicator does not include deep cracks due to shrink-swell action in clay soils (e.g., Vertisols).

Figure 37. Surface soil cracks in a seasonally ponded depression.

Indicator B10: Drainage patterns

Category: Secondary

General Description: This indicator consists of flow patterns visible on the soil surface or eroded into the soil, low vegetation bent over in the direction of flow, absence of leaf litter or small woody debris due to flowing water, and similar evidence that water flowed across the ground surface.

Cautions and User Notes: Drainage patterns are usually seen in areas where water flows broadly over the surface and is not necessarily confined to a channel, such as in areas adjacent to streams (Figure 38), in seeps, and swales that convey surface water. Use caution in areas subject to high winds or affected by recent unusual flooding events, and in grassed waterways in upland agricultural areas.

Figure 38. Vegetation bent over in the direction of water flow across a stream terrace.

Group C – Evidence of current or recent soil saturation

Indicator C1: Hydrogen sulfide odor

Category: Primary

General Description: A hydrogen sulfide (rotten egg) odor within 12 in. (30 cm) of the soil surface.

Cautions and User Notes: Hydrogen sulfide is a gas produced by soil microbes in response to prolonged saturation in soils where oxygen, nitrogen, manganese, and iron have been largely reduced and there is a source of sulfur. For hydrogen sulfide to be detectable, the soil must be saturated at the time of sampling and must have been saturated long enough to become highly reduced. These soils are often permanently saturated and anaerobic at or near the surface. To apply this indicator, dig the soil pit no deeper than 12 in. to avoid release of hydrogen sulfide from deeper in the profile. Hydrogen sulfide odor serves as both an indicator of hydric soil and wetland hydrology. This one observation proves that the soil meets the definition of a hydric soil (i.e., anaerobic in the upper part), plus has an ongoing wetland hydrologic regime. Often these soils have a high water table (wetland hydrology indicator A2), but the hydrogen sulfide odor provides further proof that the soil has been saturated for a long period of time.

Indicator C3: Oxidized rhizospheres along living roots

Category: Primary

General Description: Presence of a layer containing 2 percent or more iron-oxide coatings or plaques on the surfaces of living roots and/or iron-oxide coatings or linings on soil pores immediately surrounding living roots within 12 in. (30 cm) of the soil surface (Figures 39 and 40).

Cautions and User Notes: Oxidized rhizospheres are the result of oxygen leakage from living roots into the surrounding anoxic soil, causing oxidation of ferrous iron present in the soil solution. They are evidence of saturated and reduced soil conditions during the plant's lifetime. Iron concentrations or plaques may form on the immediate root surface or may coat the soil pore adjacent to the root. In either case, the oxidized iron must be associated with living roots to indicate contemporary wet conditions and to distinguish these features from other pore linings. Care must be taken to distinguish iron-oxide coatings from organic matter associated with plant roots. Viewing with a hand lens may help to distinguish mineral from organic material and to identify oxidized rhizospheres along fine roots and root hairs. Iron coatings sometimes show concentric layers in cross section and may transfer iron stains to the fingers when rubbed. Note the location and abundance of oxidized rhizospheres in the soil profile description or remarks section of the data form. There is no minimum thickness requirement for the layer containing oxidized rhizospheres. Oxidized rhizospheres must occupy at least 2 percent of the volume of the layer.

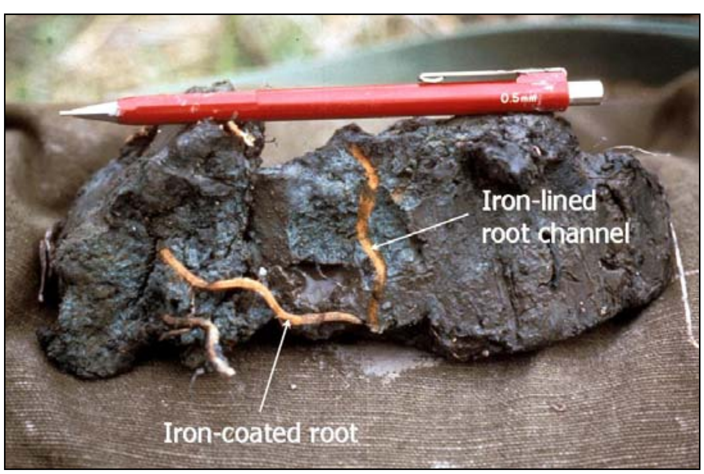

Figure 39. Iron-oxide plaque (orange coating) on a living root.
Iron also coats the channel or pore from which the root was removed.

Figure 40. This soil has many oxidized rhizospheres associated with living roots.

Indicator C4: Presence of reduced iron

Category: Primary

General Description: Presence of a layer containing reduced (ferrous) iron in the upper 12 in. (30 cm) of the soil profile, as indicated by a ferrous iron test or by the presence of a soil that changes color upon exposure to the air.

Cautions and User Notes: The reduction of iron occurs in soils that have been saturated long enough to become anaerobic and chemically reduced. Ferrous iron is converted to oxidized forms when saturation ends and the soil reverts to an aerobic state. Thus, the presence of ferrous iron indicates that the soil is saturated and anaerobic at the time of sampling, and has been saturated for an extended period. The presence of ferrous iron can be verified with alpha, alpha-dipyridyl dye (Figure 41) or by observing a soil that changes color upon exposure to air (i.e., reduced matrix). A positive reaction to alpha, alpha-dipyridyl dye should occur over more than 50 percent of the soil layer in question. Apply the dye to freshly broken samples to avoid any chance of a false positive test due to iron contamination from digging tools. The dye does not react when wetlands are dry; therefore, a negative test result is not evidence that the soil is not reduced at other times of year. Soil samples should be tested or examined immediately after opening the soil pit because ferrous iron may oxidize and colors change soon after the sample is exposed to the air. Soils that contain little weatherable iron may not react even when saturated and reduced. There are no minimum thickness requirements or initial color requirements for the soil layer in question.

Figure 41. When alpha, alpha-dipyridyl dye is applied to a soil containing reduced iron, a positive reaction is indicated by a pink or red coloration to the treated area.

Indicator C6: Recent iron reduction in tilled soils

Category: Primary

General Description: Presence of a layer containing 2 percent or more redox concentrations as pore linings or soft masses in the tilled surface layer of soils cultivated within the last two years. The layer containing redox concentrations must be within the tilled zone or within 12 in. (30 cm) of the soil surface, whichever is shallower.

Cautions and User Notes: Cultivation breaks up or destroys redox features in the plow zone. The presence of redox features that are continuous and unbroken indicates that the soil was saturated and reduced since the last episode of cultivation (Figure 42). Redox features often form around organic material, such as crop residue, incorporated into the tilled soil. Use caution with older features that may be broken up but not destroyed by tillage. The indicator is most reliable in areas that are cultivated regularly, so that soil aggregates and older redox features are more likely to be broken up. If not obvious, information about the timing of last cultivation may be available from the land owner. A plow zone 6 to 8 in. (15 to 20 cm) deep is typical but may extend deeper. There is no minimum thickness requirement for the layer containing redox concentrations.

Figure 42. Redox concentrations in the tilled surface layer of a recently cultivated soil.

Indicator C7: Thin muck surface

Category: Primary

General Description: This indicator consists of a layer of muck 1 in. (2.5 cm) or less thick on the soil surface.

Cautions and User Notes: Muck is highly decomposed organic material (see the Concepts section of Chapter 3 for guidance on identifying muck). In this region, muck accumulates only where soils are saturated to the surface for long periods each year. Thick muck layers can persist for years after wetland hydrology is effectively removed; therefore, a muck layer greater than 1 in. thick does not qualify for this indicator. However, thin muck surfaces disappear quickly or become incorporated into mineral horizons when wetland hydrology is withdrawn. Therefore, the presence of a thin muck layer on the soil surface indicates an active wetland hydrologic regime.

Indicator C2: Dry-season water table

Category: Secondary

General Description: Visual observation of the water table between 12 and 24 in. (30 and 60 cm) below the surface during the normal dry season or during a drier-than-normal year.

Cautions and User Notes: Due to normal seasonal fluctuations, water tables in wetlands often drop below 12 in. during the summer dry season. A water table between 12 and 24 in. during the dry season, or during an unusually dry year, indicates a normal wet-season water table within 12 in. of the surface. Sufficient time must be allowed for water to infiltrate into a newly dug hole and to stabilize at the water-table level. The required time will vary depending upon soil texture. In some cases, the water table can be determined by examining the wall of the soil pit and identifying the upper level at which water is seeping into the pit. For an accurate determination of the water-table level, the soil pit, auger hole, or well should not penetrate any restrictive soil layer capable of perching water near the surface. Water tables in wetlands often drop well below 24 in. during dry periods. Therefore, a dry-season water table below 24 in. does not necessarily indicate a lack of wetland hydrology. See Chapter 5 (section on Wetlands that Periodically Lack Indicators of Wetland Hydrology) to determine average dry-season dates and drought periods. In the remarks section of the data form or in a separate report, provide documentation for the conclusion that the site visit occurred during the normal dry season, recent rainfall has been below normal, or the area has been affected by drought. This indicator does not apply in agricultural areas that have controlled drainage structures for subsurface irrigation.

Indicator C8: Crayfish burrows

Category: Secondary

General Description: Presence of crayfish burrows, as indicated by openings in soft ground up to 2 in. (5 cm) in diameter, often surrounded by chimney-like mounds of excavated mud.

Cautions and User Notes: Crayfish breathe with gills and require at least periodic contact with water. Some species dig burrows for refuge and breeding (Figure 43). Crayfish burrows are usually found near streams, ditches, and ponds in areas that are seasonally inundated or have seasonal high water tables at or near the surface. They are also found in wet meadows and pastures where there is no open water. Crayfish may extend their burrows 10 ft (3 m) or more in depth to keep pace with a falling water table; thus, the eventual depth of the burrow does not reflect the level of the seasonal high water table.

Figure 43. Crayfish burrow in a saturated wetland.

Indicator C9: Saturation visible on aerial imagery

Category: Secondary

General Description: One or more recent aerial photographs or satellite images indicate soil saturation. Saturated soil signatures must correspond to field-verified hydric soils, depressions or drainage patterns, differential crop management, or other evidence of a seasonal high water table.

Cautions and User Notes: This indicator is useful when plant cover is sparse or absent and the ground surface is visible from above. Saturated areas generally appear as darker patches within the field (Figure 44). Inundated (indicator B7) and saturated areas may be present in the same field; if they cannot be distinguished, then use indicator C9 for the entire wet area. Care must be used in applying this indicator because saturation may be present on a non-wetland site immediately after a heavy rain or during periods of abnormally high precipitation, runoff, or river stages. Saturation observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. Saturation may be absent from a wetland during the normal dry season or during extended periods of drought. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., wetlands are inundated or saturated at least 5 out of 10 years, or 50 percent or higher probability). If available, it is recommended that multiple years of photography be evaluated. If 5 or more years of aerial photography are available, the procedure described by the USDA Natural Resources Conservation Service (1997, section 650.1903, and associated state wetland mapping conventions) is recommended in actively farmed areas. Use caution, as similar signatures may be caused by factors other than saturation. This indicator requires on-site verification that saturation signatures seen on photos correspond to hydric soils or other evidence of a seasonal high water table. This may be a useful tool for identifying the presence and location of subsurface drainage lines in current or former agricultural fields, and multiple years of photos may be helpful in evaluating the frequency and extent of soil saturation. This method may be inconclusive in areas with dark soil surfaces.

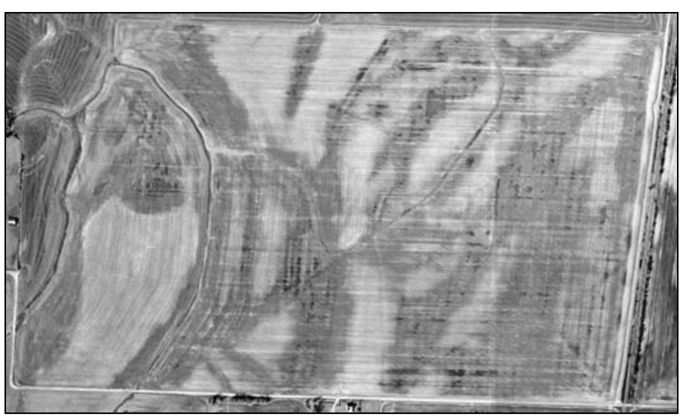

Figure 44. Aerial photograph of an agricultural field with saturated soils indicated by darker colors.

Group D – Evidence from other site conditions or data

Indicator D9: Gauge or well data

Category: Primary

General Description: Stream or lake gauge data, or groundwater well data, indicate that the site is inundated or has a water table 12 in. (30 cm) or less below the surface for 14 or more consecutive days during the growing season in most years (at least 5 years in 10, or 50 percent or higher probability), or meets an alternative wetland hydrology standard established for a particular geographic area or wetland type.

Cautions and User Notes: This indicator may be used in any area that is subject to flooding, ponding, or shallow water tables, and is not limited to highly disturbed or problematic wetland situations (U. S. Army Corps of Engineers 2005). Any combination of inundation or soil saturation is sufficient to meet the 14-day requirement. An evaluation of the normality of water levels or precipitation during the monitoring period is required if fewer than 10 years of recent gauge or well data are available. See Chapter 5 or U. S. Army Corps of Engineers (2005) for guidance. This hydrology standard is based on recommendations by the National Research Council (1995). Alternative standards for specific geographic areas or wetland types are also acceptable, if supported by appropriate scientific literature, field studies, or professional opinion. Alternative wetland hydrology standards are subject to approval by the appropriate Corps District. Sources of gauge or well data include the U. S. Geological Survey, Corps of Engineers, other federal and state agencies, cities, counties, and land developers.

Indicator D1: Stunted or stressed plants

Category: Secondary

General Description: In agricultural or planted vegetation located in a depression, swale, or other topographically low area, this indicator is present if individuals of the same species growing in the potential wetland are clearly of smaller stature, less vigorous, or stressed compared with individuals growing in nearby drier landscape situations.

Cautions and User Notes: Usually this indicator is associated with depressions or swales in crop or hay fields. Agricultural crops and other introduced or planted species, such as corn (*Zea mays*), wheat (*Triticum* spp.), and alfalfa (*Medicago* spp.), can become established in wetlands but often exhibit obvious stunting, yellowing, or stress in wet situations (Figure 45). Use caution in areas where stunting of plants on non-wetland sites may be caused by low soil fertility, excessively drained soils, salinity, cold temperatures, uneven application of agricultural chemicals, or other factors not related to wetness. For this indicator to be present, a majority of individuals in the potential wetland area must be stunted or stressed. In this region, this indicator is restricted to agricultural or planted vegetation.

Figure 45. Stunted and yellowed corn due to wet spots in an agricultural field.

Indicator D2: Geomorphic position

Category: Secondary

General Description: This indicator is present if the immediate area in question is located in a depression, drainageway, concave position within a floodplain, at the toe of a slope, on the low-elevation fringe of a pond or other water body, or in an area where groundwater discharges.

Cautions and User Notes: Excess water from precipitation and snowmelt naturally accumulates in certain geomorphic positions in the landscape, particularly in low-lying areas such as depressions, drainageways, toe slopes (Figure 5), and fringes of water bodies. These areas often, but not always, exhibit wetland hydrology. This indicator is not applicable in areas with functioning drainage systems and does not include concave positions on rapidly permeable soils (e.g., floodplains with sand and gravel substrates) that do not have wetland hydrology unless the water table is near the surface.

Indicator D5: FAC-neutral test

Category: Secondary

General Description: The plant community passes the FAC-neutral test.

Cautions and User Notes: The FAC-neutral test is performed by compiling a list of dominant plant species across all strata in the community, and dropping from the list any species with a facultative indicator status (i.e., FAC, FAC–, and FAC+). The FAC-neutral test is met if more than 50 percent of the remaining dominant species are rated FACW and/or OBL. This indicator can be used in communities that contain no FAC dominants. If there are an equal number of dominants that are OBL and FACW versus FACU and UPL, non-dominant species should be considered.

5 Difficult Wetland Situations in the Midwest Region

Introduction

Some wetlands can be difficult to identify because wetland indicators may be missing at times due to natural processes or recent disturbances. This chapter provides guidance for making wetland determinations in difficult-to-identify wetland situations in the Midwest Region. It includes regional examples of problem area wetlands and atypical situations as defined in the Corps Manual, as well as other situations that can make wetland delineation more challenging. Problem area wetlands are naturally occurring wetland types that lack indicators of hydrophytic vegetation, hydric soil, or wetland hydrology periodically due to normal seasonal or annual variability, or permanently due to the nature of the soils or plant species on the site. Atypical situations are wetlands in which vegetation, soil, or hydrology indicators are absent due to recent human activities or natural events. In addition, this chapter addresses certain procedural problems (e.g., wetland/non-wetland mosaics) that can make wetland determinations in the Midwest difficult or confusing. The chapter is organized into the following sections:

- Agricultural Lands
- Problematic Hydrophytic Vegetation
- Problematic Hydric Soils
- Wetlands that Periodically Lack Indicators of Wetland Hydrology
- Wetland/Non-Wetland Mosaics

The list of difficult wetland situations presented in this chapter is not intended to be exhaustive and other problematic situations may exist in the region. See the Corps Manual for general guidance. Furthermore, more than one wetland factor (i.e., vegetation, soil, and/or hydrology) may be disturbed or problematic on a given site. In general, *wetland determinations on difficult or problematic sites must be based on the best information available to the field inspector, interpreted in light of his or her professional experience and knowledge of the ecology of wetlands in the region.*

Agricultural lands

The predominant land use in the Midwest Region is agriculture, which presents a number of challenges to wetland identification and delineation. Wetlands used for agriculture may be considered atypical because they generally lack a natural plant community and may be planted in crops or pasture species or altered by mowing, grazing, or other management practices. Soils may be disturbed by regular cultivation, at least in the surface layers, and hydrology may be manipulated. Throughout the Midwest, vast areas of historic wetlands have been drained and converted to croplands or pastures. Drainage may be partial so that the site still meets wetland hydrology standards, or it may be effective in removing wetland hydrology completely. Wetland indicators, particularly for hydric soils, may still be present in these areas, making it difficult to distinguish current wetlands from those that have been effectively drained. In addition, recent trends in agricultural drainage include improved groundwater management, involving the manipulation of water tables to conserve both water and nutrients (Frankenberger et al. 2006).

Agricultural drainage systems use ditches, subsurface drainage lines or “tiles,” and water-control structures to manipulate the water table and improve conditions for crops (University of Minnesota Extension Service 2006). A freely flowing ditch or drainage line depresses the water table within a certain lateral distance or zone of influence (Figure 46). The effectiveness of drainage in an area depends in part on soil characteristics, the timing and amount of rainfall, and the depth and spacing of ditches or drains. Wetland determinations on current and former agricultural lands must consider whether a drainage system is present, how it is designed to function, and whether it is effective in removing wetland hydrology from the area.

A number of information sources and tools are listed below to help determine whether wetlands are present on agricultural lands where vegetation, soils, hydrology, or a combination of these factors have been manipulated. Some of these options are discussed in more detail later in this chapter under the appropriate section headings.

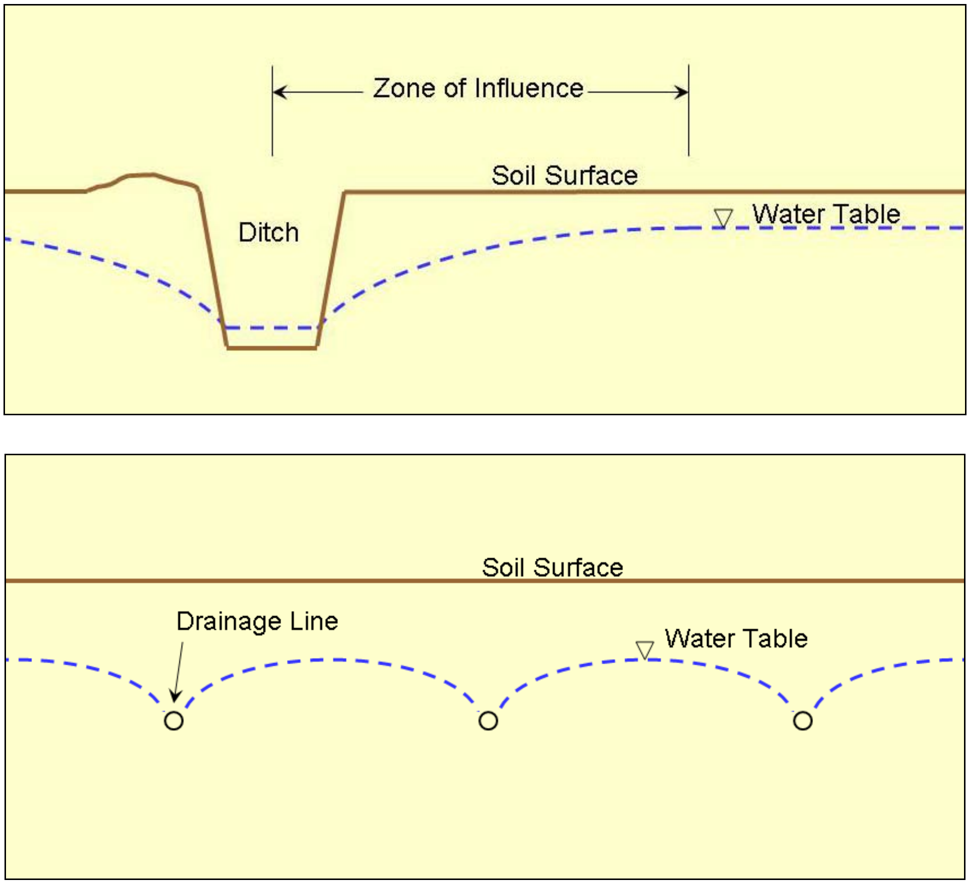

Figure 46. Effects of ditches (upper) and parallel subsurface drainage lines (lower) on the water table.

1. **Vegetation** – The goal is to determine the plant community that would occupy the site under normal circumstances, if the vegetation were not cleared or manipulated.

    a. Examine the site for volunteer vegetation that becomes established between cultivations or plantings.
    b. Examine the vegetation on an undisturbed reference area with soils, hydrology, landscape position, and other conditions similar to those on the site.
    c. Check NRCS soil survey reports for information on the typical vegetation on soil map units (hydrology of the site must be unaltered).
    d. If the conversion to agriculture was recent and the hydrology of the site was not manipulated, examine pre-disturbance aerial photography, NWI maps, and other sources for information on the previous vegetation.
    e. Cease the clearing or manipulation of the site for one or more growing seasons and examine the plant community that develops.

f. Use accepted state wetland mapping conventions to determine whether the area would support hydrophytic vegetation under unmanaged conditions.

2. **Soils** – Tilling of agricultural land mixes the surface layer(s) of the soil and may cause compaction below the tilled zone (i.e., a "plow pan") due to the weight and repeated passage of farm machinery. Nonetheless, a standard soil profile description and examination for hydric soil indicators are usually sufficient to determine whether hydric soils are present. Other options and information sources include the following:

    a. Examine NRCS soil survey maps and the local hydric soils list for the likely presence of hydric soils on the site.
    b. Examine the soils on an undisturbed reference area with landscape position, parent materials, and hydrology similar to those on the site.
    c. Use alpha, alpha-dipyridyl dye to check for the presence of reduced iron during the normal wet portion of the growing season in a normal rainfall year, or note whether the soil changes color upon exposure to the air.
    d. Monitor the hydrology of the site in relation to the appropriate wetland hydrology or hydric soils technical standard.

3. **Hydrology** – The goal is to determine whether wetland hydrology is present on agricultural lands under normal circumstances. These lands may or may not have been hydrologically manipulated.

    a. Examine the site for existing indicators of wetland hydrology. If the natural hydrology of the site has been permanently altered, discount any indicators known to have been produced before the alteration (e.g., relict water marks or drift lines).
    b. Examine five or more years of annual Farm Service Agency aerial photographs, or aerial photos from other sources, for wetness signatures listed in Part 513.30 of the National Food Security Act Manual (USDA Natural Resources Conservation Service 1994) or in wetland mapping conventions available from NRCS offices or online in the electronic Field Office Technical Guide (eFOTG) (http://www.nrcs.usda.gov/technical/efotg/). Use the procedure given by the USDA Natural Resources Conservation Service (1997) to determine whether wetland hydrology is present.

c. Estimate the effects of ditches and subsurface drainage systems using scope-and-effect equations (USDA Natural Resources Conservation Service 1997). A web application to analyze data using various models is available at http://www.wli.nrcs.usda.gov/technical/web_tool/tools_java.html. Scope-and-effect equations are approximations only and may not reflect actual field conditions. Their results should be verified by comparison with other techniques for evaluating drainage and should not overrule onsite evidence of wetland hydrology.
d. Use state drainage guides to estimate the effectiveness of an existing drainage system (USDA Natural Resources Conservation Service 1997). Drainage guides are available from NRCS offices or online (e.g., the Illinois drainage guide is available at http://www.wq.uiuc.edu/dg/). Cautions noted in item *c* above also apply to the use of drainage guides. In addition, Corps of Engineers district offices should be consulted for locally developed techniques to evaluate wetland drainage.
e. Use hydrologic models (e.g., runoff, surface water, and groundwater models) to determine whether wetland hydrology is present (USDA Natural Resources Conservation Service 1997).
f. Monitor the hydrology of the site in relation to the appropriate wetland hydrology technical standard (U.S. Army Corps of Engineers 2005).

Problematic hydrophytic vegetation

Description of the problem

Many factors affect the structure and composition of plant communities in the Midwest, including climatic variability, spread of exotic species, agricultural use, and other human land-use practices. As a result, some wetlands may exhibit indicators of hydric soil and wetland hydrology but lack any of the hydrophytic vegetation indicators presented in Chapter 2, at least at certain times. To identify and delineate these wetlands may require special sampling procedures or additional analysis of factors affecting the site. To the extent possible, the hydrophytic vegetation decision should be based on the plant community that is normally present during the wet portion of the growing season in a normal rainfall year. The following procedure addresses several examples of problematic vegetation situations in the Midwest.

Procedure

Problematic hydrophytic vegetation can be identified using a combination of observations made in the field and/or supplemental information from the scientific literature and other sources. These procedures should be applied only where indicators of hydric soil and wetland hydrology are present, unless one or both of these factors is also disturbed or problematic, but no indicators of hydrophytic vegetation are evident. The following procedures are recommended:

1. Verify that at least one indicator of hydric soil and one primary or two secondary indicators of wetland hydrology are present. If indicators of either hydric soil or wetland hydrology are absent, the area is likely non-wetland unless soil and/or hydrology are also disturbed or problematic. If indicators of hydric soil and wetland hydrology are present (or are absent due to disturbance or other problem situations), proceed to step 2.

2. Verify that the area is in a landscape position that is likely to collect or concentrate water. Appropriate settings include the following. If the landscape setting is appropriate, proceed to step 3.

   a. Concave surface (e.g., depression or swale)
   b. Active floodplain or low terrace
   c. Level or nearly level area (e.g., 0- to 3-percent slope)
   d. Toe slope (Figure 5) or an area of convergent slopes (Figure 4)
   e. Fringe of another wetland or water body
   f. Area with a restrictive soil layer or aquitard within 24 in. (60 cm) of the surface
   g. Area where groundwater discharges (e.g., a seep)
   h. Other (explain in field notes why this area is likely to be inundated or saturated for long periods)

3. Use one or more of the approaches described in step 4 (Specific Problematic Vegetation Situations below) or step 5 (General Approaches to Problematic Hydrophytic Vegetation on page 106) to determine whether the vegetation is hydrophytic. In the remarks section of the data form or in the delineation report, explain the rationale for concluding that the plant community is hydrophytic even though indicators of hydrophytic vegetation described in Chapter 2 were not observed.

4. Specific Problematic Vegetation Situations

   a. *Temporal shifts in vegetation.* As described in Chapter 2, the species composition of some wetland plant communities in the Midwest can change in response to seasonal weather patterns and long-term climatic fluctuations. Wetland types that are influenced by these shifts include prairie potholes, ephemeral pools, seeps, and springs. Lack of hydrophytic vegetation during the dry season, when FACU and UPL warm-season grasses and annuals dominate many areas, should not immediately eliminate a site from consideration as a wetland, because the site may have been dominated by wetland species earlier in the growing season. A site qualifies for further consideration if the plant community at the time of sampling does not exhibit hydrophytic vegetation indicators, but indicators of hydric soil and wetland hydrology are present or known to be disturbed or problematic. The following sampling and analytical approaches are recommended in these situations:

      (1) Seasonal Shifts in Plant Communities

         (a) If possible, return to the site during the normal wet portion of the growing season (generally in early spring) and re-examine the site for indicators of hydrophytic vegetation.
         (b) Examine the site for identifiable plant remains, either alive or dead, or other evidence that the plant community that was present during the normal wet portion of the growing season was hydrophytic.
         (c) Use off-site data sources to determine whether the plant community that is normally present during the wet portion of the growing season is hydrophytic. Appropriate data sources include early growing season aerial photography, NWI maps, soil survey reports, remotely sensed data, public interviews, state wetland conservation plans, and previous reports about the site. If necessary, re-examine the site at a later date to verify the hydrophytic vegetation determination.
         (d) If the vegetation on the site is substantially the same as that on a wetland reference site having similar soils, landscape position, and known wetland hydrology, then consider the vegetation to be hydrophytic (see step *5b* in this procedure for more information).

(2) Drought Conditions (lasting more than one growing season)

(a) Investigate climate records (e.g., WETS tables, drought indices) to determine if the area is under the influence of a drought (for more information, see the section on Wetlands that Periodically Lack Indicators of Wetland Hydrology later in this chapter). If so, evaluate any off-site data that provide information on the plant community that exists on the site during normal years, including aerial photography, Farm Service Agency annual crop slides, NWI maps, other remote sensing data, soil survey reports, public interviews, NRCS hydrology tools (USDA Natural Resources Conservation Service 1997), and previous site reports. Determine whether the vegetation that is present during normal years is hydrophytic.

(b) If the vegetation on the drought-affected site is substantially the same as that on a wetland reference site in the same general area having similar soils and known wetland hydrology, then consider the vegetation to be hydrophytic (see step *5b* in this procedure).

b. *Riparian areas*. Riparian ecosystems are common along most rivers and streams in the Midwest, and can contain both wetland and non-wetland components. Riparian corridors can be lined with hydrophytic vegetation, upland vegetation, unvegetated areas, or a mosaic of these types. Soils may lack hydric soil indicators in recently deposited materials (i.e., Entisols) even when indicators of hydrophytic vegetation and wetland hydrology are present. Surface hydrology can vary from perennial to intermittent and, after a flooding event, water tables can drop quickly to low levels. Therefore, wetland delineation in riparian areas is often a challenge and should consider the potential interspersion of wetlands and other potential waters of the United States. In addition, many riparian areas contain remnant stands of tree species that may have germinated during unusually high water events or under wetter conditions than currently exist at the site.

c. *Areas affected by grazing*. Both short- and long-term grazing can cause shifts in dominant species in the vegetation. For instance, trampling by large herbivores can cause soil compaction, altering soil permeability and infiltration rates, and affecting the plant community. Grazers can also influence the abundance of plant species by selectively grazing certain palatable species (decreasers) or avoiding less palatable species (increasers) (Table 10). This shift in species composition due to grazing can influence the hydrophytic vegetation determination. Be aware that shifts in both directions, favoring either wetland species or upland species, can occur in these situations. Limited grazing does not necessarily affect the outcome of a hydrophytic vegetation decision. However, the following procedure is recommended in cases where the effects of grazing are so great that the hydrophytic vegetation determination would be unreliable or misleading.

Table 10. Examples of increaser and decreaser plant species in response to grazing in the Midwest[1]

Decreasers	Increasers
Andropogon gerardii	*Achillea millefolium*
Anemone canadensis	*Agrostis alba*
Campanula aparinoides	*Asclepias incarnata*
Carex stricta	*Asclepias verticillata*
Dalea purpurea	*Cirsium arvense*
Lathyrus palustris	*Erigeron strigosus*
Panicum virgatum	*Geum laciniatum*
Tradescantia ohiensis	*Helenium autumnale*
	Helianthus grosseserratus
	Physalis heterophylla
	Poa pratensis
	Ribes americanum
	Rosa multiflora
	Solidago gigantea
	Thalictrum revolutum
	Verbena stricta

[1]Source: USDI National Park Service (2006), Swink and Wilhelm (1994), and unpublished data.

(1) Examine the vegetation on a nearby, ungrazed reference site having similar soils and hydrologic conditions. Ungrazed areas may be present on adjacent properties or in fenced exclosures or streamside management zones. Assume that the same plant community would exist on the grazed site, in the absence of grazing.

(2) If feasible, remove livestock or fence representative livestock exclusion areas to allow the vegetation time to recover from grazing, and reevaluate the vegetation during the next growing season.

(3) If grazing was initiated recently, use offsite data sources such as aerial photography, NWI maps, and interviews with the land owner and other persons familiar with the site or area to determine what plant community was present on the site before grazing began. If the previously ungrazed community was hydrophytic, then consider the current vegetation to be hydrophytic.

(4) If an appropriate ungrazed area cannot be located or if the ungrazed vegetation condition cannot be determined, make the wetland determination based on indicators of hydric soils and wetland hydrology.

d. *Managed plant communities.* Natural plant communities throughout the Midwest have been replaced with agricultural crops or are otherwise managed to meet human goals. Examples include clearing of woody species on rangeland or pasture land; periodic disking, plowing, or mowing; planting of native and non-native species (including cultivars or planted species that have escaped and become established on other sites); use of herbicides; silvicultural treatments; and suppression of wildfires. These actions can result in elimination of certain species and their replacement with other species, changes in abundance of certain plants, and shifts in dominant species, possibly influencing a hydrophytic vegetation determination. The following options are recommended if the natural vegetation has been altered through management to such an extent that a hydrophytic vegetation determination is not possible or would be unreliable:

(1) Examine the vegetation on a nearby, unmanaged reference site having similar soils and hydrologic conditions. Assume that the same plant community would exist on the managed site in the absence of human alteration.

(2) Examine weedy species that become established within cropped fields. Cropped fields are often tilled or sprayed with herbicides during the growing season to eliminate all other species, including

introduced or noxious weeds. However, if present, weedy species may help to identify parts of the field that would support hydrophytic vegetation. Table 11 lists examples of common weeds whose presence, even at low cover values, can help indicate either wetland or non-wetland conditions in cropped fields.

Table 11. Examples of weedy or pioneer species often found in farmed fields in the Midwest.

Category	Species	Region 3[1]	Region 4	Region 5	Region 6
Species often found in wetlands	*Alopecurus carolinianus*	FACW	FACW	FACW	FACW
	Amaranthus rudis	FACW	FAC	FACW	FAC
	Ambrosia trifida	FAC+	FAC	FACW	FAC
	Bidens frondosa	FACW	FACW	FACW	FACW
	Cyperus esculentus	FACW	FACW	FACW	FACW
	Cyperus strigosus	FACW	FACW	FACW	FACW
	Echinochloa crus-galli	FACW	FACW	FACW	FACW-
	Polygonum lapathifolium	FACW+	OBL	OBL	FACW-
	Polygonum pensylvanicum	FACW+	FACW	FACW+	FACW-
Species often found in non-wetlands	*Abutilon theophrasti*	FACU-	UPL	UPL	NI
	Amaranthus retroflexus	FACU+	FACU	FACU	FACU-
	Ambrosia artemisiifolia	FACU	FACU	FACU	FACU-
	Convolvulus arvensis	UPL	UPL	UPL	UPL
	Hibiscus trionum	UPL	UPL	UPL	UPL
	Lamium purpureum	UPL	UPL	UPL	UPL
	Setaria faberi	FACU+	UPL	UPL	UPL
	Sida spinosa	FACU	NO	UPL	UPL
	Solanum carolinense	FACU-	UPL	UPL	UPL
	Stellaria media	FACU	UPL	UPL	FACU-

[1]Regions represent US Fish and Wildlife Service plant list regions. The wetland plant indicator statuses are from Reed (1988).

(3) For recently cleared or tilled areas (not planted or seeded), leave representative areas unmanaged for at least one growing season with normal rainfall and reevaluate the vegetation.

(4) If management was initiated recently, use offsite data sources such as aerial photography, NWI maps, and interviews with the land owner and other persons familiar with the area to determine the plant community present on the site before the management occurred.

(5) If the unmanaged vegetation condition cannot be determined, make the wetland determination based on indicators of hydric soil and wetland hydrology.

e. *Areas affected by fires, floods, and other natural disturbances.* Fires, floods, and other catastrophic disturbances can dramatically alter the vegetation on a site. Vegetation can be completely or partially removed, or its composition altered, depending upon the intensity of the disturbance. Limited disturbance does not necessarily affect the investigator's ability to determine whether the plant community is or is not hydrophytic. However, if the vegetation on a site has been removed or made unidentifiable by a recent fire, flood, or other disturbance, then one or more of the following procedures may be used to determine whether the vegetation present before the disturbance was hydrophytic. Additional guidance can be found in Part IV, Section F (Atypical Situations) of the Corps Manual.

(1) Examine the vegetation on a nearby, undisturbed reference site having similar soils and hydrologic conditions. Assume that the same plant community would exist on the disturbed site in the absence of disturbance.

(2) Use offsite data sources such as aerial photography, NWI maps, and interviews with knowledgeable people to determine the plant community present on the site before the disturbance.

(3) If the undisturbed vegetation condition cannot be determined, make the wetland determination based on indicators of hydric soil and wetland hydrology.

5. General Approaches to Problematic Hydrophytic Vegetation. The following general procedures are provided to identify hydrophytic vegetation in difficult situations not necessarily associated with specific vegetation types or management practices, including wetlands dominated by FACU, NI, NO, or unlisted species that are functioning as hydrophytes. Some examples of FACU species that sometimes dominate wetlands in the Midwest include eastern hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), jack pine (*Pinus banksiana*), common buckthorn (*Rhamnus cathartica*), and osage orange (*Maclura pomifera*) (in floodplains). The following procedures should be applied only where indicators of hydric soil

and wetland hydrology are present (or are absent due to disturbance or other problem situations) but indicators of hydrophytic vegetation are not evident. The following approaches are recommended:

a. *Direct hydrologic observations*. Verify that the plant community occurs in an area subject to prolonged inundation or soil saturation during the growing season. This can be done by visiting the site at 2- to 3-day intervals during the portion of the growing season when surface water is most likely to be present or water tables are normally high. Hydrophytic vegetation is considered to be present, and the site is a wetland, if surface water is present and/or the water table is 12 in. (30 cm) or less from the surface for 14 or more consecutive days during the growing season during a period when antecedent precipitation has been normal or drier than normal. If necessary, microtopographic highs and lows should be evaluated separately. The normality of the current year's rainfall must be considered in interpreting field results, as well as the likelihood that wet conditions will occur on the site at least every other year (for more information, see the section on "Wetlands that Periodically Lack Indicators of Wetland Hydrology" in this chapter).

b. *Reference sites*. If indicators of hydric soil and wetland hydrology are present, the site may be considered to be a wetland if the landscape setting, topography, soils, and vegetation are substantially the same as those on nearby wetland reference areas. Hydrologic characteristics of wetland reference areas should be documented through long-term monitoring or by repeated application of the procedure described in item *5a* above. Reference sites should be minimally disturbed and provide long-term access. Soils, vegetation, and hydrologic conditions should be thoroughly documented and the data kept on file in the district or field office.

c. *Technical literature*. Published and unpublished scientific literature may be used to support a decision to treat specific FACU species or species with no assigned indicator status (e.g., NI, NO, or unlisted) as hydrophytes or certain plant communities as hydrophytic. Preferably, this literature should discuss the species' natural distribution along the moisture gradient, its capabilities and adaptations for life in wetlands, wetland types in which it is typically found, or other wetland species with which it is commonly associated.

Problematic hydric soils

Description of the problem

Soils with faint or no indicators

Some soils that meet the hydric soil definition may not exhibit any of the indicators presented in Chapter 3. These problematic hydric soils exist for a number of reasons and their proper identification requires additional information, such as landscape position, presence or absence of restrictive soil layers, or information about hydrology. This section describes several soil situations in the Midwest Region that are considered hydric if additional requirements are met. In some cases, these hydric soils may appear to be non-hydric due to the color of the parent material from which the soils developed. In others, the lack of hydric soil indicators is due to conditions (e.g., high pH) that inhibit the development of redoximorphic features despite prolonged soil saturation and anoxia. In addition, recently developed wetlands may lack hydric soil indicators because insufficient time has passed for their development. Examples of problematic hydric soils in the Midwest include, but are not limited to, the following:

1. **Shallow Soils over Limestone.** Shallow soils over limestone rubble or bedrock often have a high pH reaction (i.e., pH of 7.9 or higher). High pH inhibits the biological processes that allow redoximorphic features to develop. These soils may occur in karst topography, sinkholes, near streambeds running on bedrock, tufa rock, buried reefs, or any place that limestone rock is near the surface.

2. **Fluvial Sediments within Floodplains.** These soils commonly occur on vegetated bars within the active channel and above the bankfull level of rivers and streams. In some cases, these soils lack hydric soil indicators due to seasonal or annual deposition of new soil material, low iron or manganese content, and low organic matter content. Redox concentrations can sometimes be found between stratifications where organic matter gets buried, such as along the fringes of floodplains.

3. **Recently Developed Wetlands.** Recently developed wetlands include mitigation sites, wetland management areas (e.g., for waterfowl), other wetlands intentionally or unintentionally produced by human activities,

and naturally occurring wetlands that have not been in place long enough to develop hydric soil indicators.

4. **Seasonally Ponded Soils.** Seasonally ponded, depressional wetlands occur in basins and valleys throughout the Midwest. Most are perched systems, with water ponding above a restrictive soil layer, such as a hardpan or clay layer that is at or near the surface. Ponded depressions also occur in floodplains where receding floodwaters, precipitation, and local runoff are held above a slowly permeable soil layer. Some of these wetlands lack hydric soil indicators due to the limited saturation depth, saline conditions, or other factors.

5. **Soils with High-Chroma Subsoils.** Some hydric soils have high-chroma subsoils beneath a surface layer that may or may not exhibit hydric soil indicators. For example, in the oak openings of Ohio, Indiana, and Michigan, along the boundary between Land Resource Regions L and M, about 10 to 15 percent of wetlands lack hydric soil indicators due to high-chroma subsoils (often chroma 4 or more). Soil textures are often fine sands, fine sandy loams, and loamy fine sands. Wind erosion in the oak openings can also transport soil material and bury natural soil horizons. It may be helpful to involve a soil scientist or wetland scientist familiar with these problem soils.

Soils with relict hydric soil indicators

Some soils in the Midwest exhibit redoximorphic features and hydric soil indicators that formed in the recent or distant past when conditions may have been wetter than they are today. These features have persisted even though wetland hydrology may no longer be present. Examples include soils associated with abandoned river courses and areas adjacent to deeply incised stream channels. In addition, wetlands drained for agricultural purposes starting in the 1800s, may contain persistent hydric soil features. Wetland soils drained during historic times are still considered to be hydric but may lack the hydrology to support wetlands. Relict hydric soil features may be difficult to distinguish from contemporary features. However, if indicators of hydrophytic vegetation and wetland hydrology are present, then hydric soil indicators can be assumed to be contemporary.

Procedure

Soils that are thought to meet the definition of a hydric soil but do not exhibit any of the indicators described in Chapter 3 can be identified by the following recommended procedure. This procedure should be used only where indicators of hydrophytic vegetation and wetland hydrology are present (or are absent due to disturbance or other problem situations), but indicators of hydric soil are not evident.

1. Verify that one or more indicators of hydrophytic vegetation are present or that vegetation is problematic or has been altered (e.g., by tillage or other land alteration). If so, proceed to step 2.

2. Verify that at least one primary or two secondary indicators of wetland hydrology are present or that indicators are absent due to disturbance or other factors. If so, proceed to step 3. If indicators of hydrophytic vegetation and/or wetland hydrology are absent, then the area is probably non-wetland and no further analysis is required.

3. Thoroughly describe and document the soil profile and landscape setting. Verify that the area is in a landscape position that is likely to collect or concentrate water. Appropriate settings include the following. If the landscape setting is appropriate, proceed to step 4.

   a. Concave surface (e.g., potholes, forested depressions, oxbows)
   b. Active floodplain or low terrace
   c. Level or nearly level area (e.g., 0- to 3-percent slope)
   d. Toe slope (Figure 5) or an area of convergent slopes (Figure 4) (e.g., slope wetlands, springs, seeps, fens, drainageways)
   e. Fringe of another wetland or water body
   f. Area with a restrictive soil layer or aquitard within 24 in. (60 cm) of the surface
   g. Area where groundwater discharges (e.g., a seep)
   h. Other (explain in field notes why this area is likely to be inundated or saturated for long periods)

4. Use one or more of the following approaches to determine whether the soil is hydric. In the remarks section of the data form or in the delineation report, explain why it is believed that the soil lacks any of the NTCHS

hydric soil indicators described in Chapter 3 and why it is believed that the soil meets the definition of a hydric soil.

a. Determine whether one or more of the following indicators of problematic hydric soils is present. See the descriptions of each indicator given in Chapter 3. If one or more indicators are present, then the soil is hydric.

   (1) Coast Prairie Redox (A16) (applicable throughout the Midwest Region)
   (2) Iron-Manganese Masses (F12) (applicable throughout the Midwest Region)

b. Determine whether one or more of the following problematic soil situations is present. If present, consider the soil to be hydric.

   (1) Shallow Soils over Limestone
   (2) Fluvial Sediments within Floodplains
   (3) Recently Developed Wetlands
   (4) Seasonally Ponded Soils
   (5) Soils with High-Chroma Subsoils
   (6) Other (in field notes, describe the problematic soil situation and explain why it is believed that the soil meets the hydric soil definition)

c. Soils that have been saturated for long periods and have become chemically reduced may change color when exposed to air due to the rapid oxidation of ferrous iron (Fe^{2+}) to Fe^{3+} (i.e., a reduced matrix) (Figures 47 and 48). If the soil contains sufficient iron, this can result in an observable color change, especially in hue or chroma. The soil is hydric if a mineral layer 4 in. (10 cm) or more thick starting within 12 in. (30 cm) of the soil surface that has a matrix value of 4 or more and chroma of 2 or less becomes redder by one or more pages in hue and/or increases one or more in chroma when exposed to air within 30 minutes (Vepraskas 1992).

   Care must be taken to obtain an accurate color of the soil sample immediately upon excavation. The colors should be observed closely and examined again after several minutes. Do not allow the sample to become dry. Dry soils will usually have a different color than wet or moist soils. As always, do not obtain colors while wearing sunglasses. Colors must be obtained in the field under natural light and not under artificial light.

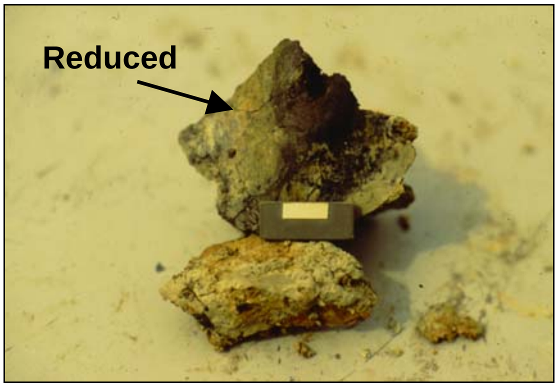

Figure 47. This soil exhibits colors associated with reducing conditions. Scale is 1 cm.

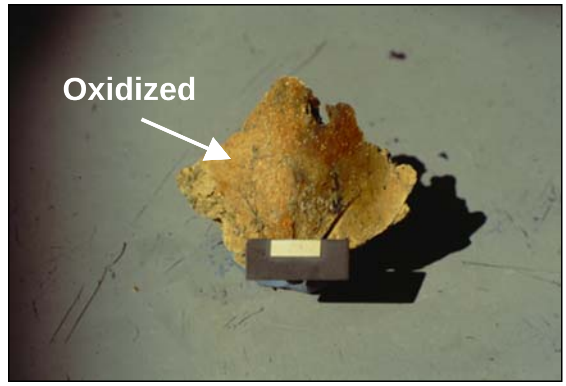

Figure 48. The same soil as in Figure 47 after exposure to the air and oxidation has occurred.

d. If the soil is saturated at the time of sampling, alpha, alpha-dipyridyl dye can be used in the following procedure to determine if reduced (ferrous) iron is present. If ferrous iron is present as described below, then the soil is hydric.

Alpha, alpha-dipyridyl is a dye that reacts with reduced iron. In some cases, it can be used to provide evidence that a soil is hydric when it lacks other hydric soil indicators. The soil is likely to be hydric if application of alpha, alpha-dipyridyl dye to mineral soil material in at least 60 percent of a layer at least 4 in. (10 cm) thick within a depth of 12 in. (30 cm) of the soil surface results in a positive reaction within 30 seconds evidenced by a pink or red coloration to the dye during the growing season.

Using a dropper, apply a small amount of dye to a freshly broken ped face to avoid any chance of a false positive test due to iron contamination from digging tools. Look closely at the treated soil for evidence of color change. If in doubt, apply the dye to a sample of known upland soil and compare the reaction to the sample of interest. A positive reaction will not occur in soils that lack iron. The lack of a positive reaction to the dye does not preclude the presence of a hydric soil. Specific information about the use of alpha, alpha-dipyridyl can be found in NRCS Hydric Soils Technical Note 8 (http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html).

e. Using gauge data, water-table monitoring data, or repeated direct hydrologic observations, determine whether the soil is ponded or flooded, or the water table is 12 in. (30 cm) or less from the surface, for 14 or more consecutive days during the growing season in most years (at least 5 years in 10, or 50 percent or higher probability) (U. S. Army Corps of Engineers 2005). If so, then the soil is hydric. Furthermore, any soil that meets the NTCHS hydric soil technical standard (NRCS Hydric Soils Technical Note 11, http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html) is hydric.

Wetlands that periodically lack indicators of wetland hydrology

Description of the problem

Wetlands are areas that are flooded or ponded, or have soils that are saturated with water, for long periods during the growing season in most years. If the site is visited during a time of normal precipitation amounts and it is inundated or the water table is near the surface, then the wetland hydrology determination is straightforward. During the dry season, however, surface water recedes from wetland margins, water tables drop, and many wetlands dry out completely. Superimposed on this seasonal cycle is a long-term pattern of multi-year droughts alternating with years of higher-than-average rainfall. Wetlands in general are inundated or saturated in most years (50 percent or higher probability) over a long-term record. However, some wetlands in the Midwest do not become inundated or saturated in some years and, during drought cycles, may not inundate or saturate for several years in a row.

Wetland hydrology determinations are based on indicators, many of which were designed to be used during dry periods when the direct observation of surface water or a shallow water table is not possible. However, some wetlands may lack any of the listed hydrology indicators, particularly during the dry season or in a dry year. Examples in the Midwest Region include ephemeral pools and potholes, flatwoods, dune swales, wet prairies, and sedge meadows. The evaluation of wetland hydrology requires special care on any site where indicators of hydrophytic vegetation and hydric soil are present but hydrology indicators appear to be absent. Among other factors, this evaluation should consider the timing of the site visit in relation to normal seasonal and annual hydrologic variability, and whether the amount of rainfall prior to the site visit has been normal. This section describes a number of approaches that can be used to determine whether wetland hydrology is present on sites where indicators of hydrophytic vegetation and hydric soil are present but hydrology indicators may be lacking due to normal variations in rainfall or runoff, human activities that destroy hydrology indicators, and other factors.

Procedure

1. Verify that indicators of hydrophytic vegetation and hydric soil are present, or are absent due to disturbance or other problem situations. If so, proceed to step 2.

2. Verify that the site is in a geomorphic position that is likely to collect or concentrate water. Appropriate settings are listed below. If the landscape setting is appropriate, proceed to step 3.

    a. Concave surface (e.g., depression or swale)
    b. Active floodplain or low terrace
    c. Level or nearly level area (e.g., 0- to 3-percent slope)
    d. Toe slope (Figure 5) or an area of convergent slopes (Figure 4)
    e. Fringe of another wetland or water body
    f. Area with a restrictive soil layer or aquitard within 24 in. (60 cm) of the surface
    g. Area where groundwater discharges (e.g., a seep)
    h. Other (explain in field notes why this area is likely to be inundated or saturated for long periods)

3. Use one or more of the following approaches to determine whether wetland hydrology is present and the site is a wetland. In the remarks section of the data form or in the delineation report, explain the rationale for concluding that wetland hydrology is present even though indicators of wetland hydrology described in Chapter 4 were not observed.

    a. *Site visits during the dry season.* Determine whether the site visit occurred during the normal annual "dry season." The dry season, as used in this supplement, is the period of the year when soil moisture is normally being depleted and water tables are falling to low levels in response to decreased precipitation and/or increased evapotranspiration, usually during late spring and summer. It also includes the beginning of the recovery period in late summer or fall. The Web-Based Water-Budget Interactive Modeling Program (WebWIMP) is one source for approximate dates of wet and dry seasons for any terrestrial location based on average monthly precipitation and estimated evapotranspiration (http://climate.geog.udel.edu/~wimp/). In general, the dry season in a typical year is indicated when potential evapotranspiration exceeds precipitation (indicated by negative values of DIFF in the WebWIMP output), resulting in drawdown of soil moisture storage (negative values of DST) and/or a moisture deficit (positive values of DEF, also called the unmet atmospheric demand for moisture). Actual dates for the dry season vary by locale and year.

In many wetlands, direct observation of flooding, ponding, or a shallow water table would be unexpected during the dry season. Wetland hydrology indicators, if present, would most likely be limited to indirect evidence, such as water marks, drift deposits, or surface cracks. In some situations, hydrology indicators may be absent during the dry season. If the site visit occurred during the dry season on a site that contains hydric soils and hydrophytic vegetation and no significant hydrologic manipulation (e.g., no dams, levees, water diversions, land grading, etc., and the site is not within the zone of influence of any ditches or subsurface drains), then consider the site to be a wetland. If necessary, revisit the site during the normal wet season and check again for the presence or absence of wetland hydrology indicators.

b. *Periods with below-normal rainfall.* Determine whether the amount of rainfall that occurred in the 2 to 3 months preceding the site visit was normal, above normal, or below normal based on the normal range reported in WETS tables. WETS tables are provided by the NRCS National Water and Climate Center (http://www.wcc.nrcs.usda.gov/climate/wetlands.html) and are calculated from long-term (30-year) weather records gathered at National Weather Service meteorological stations. To determine whether precipitation was normal prior to the site visit, actual rainfall in the current month and previous 2 to 3 months should be compared with the normal ranges for each month given in the WETS table (USDA Natural Resources Conservation Service 1997, Sprecher and Warne 2000). The lower and upper limits of the normal range are indicated by the columns labeled "30% chance will have less than" and "30% chance will have more than" in the WETS table. The USDA Natural Resources Conservation Service (1997, Section 650.1903) also gives a procedure that can be used to weight the information from each month and determine whether the entire period was normal, wet, or dry.

When precipitation has been below normal, wetlands may not flood, pond, or develop shallow water tables even during the typical wet portion of the growing season and may not exhibit other indicators of wetland hydrology. Therefore, if precipitation was below normal prior to the site visit, and the site contains hydric soils and hydrophytic vegetation and no significant hydrologic manipulation (e.g., no dams, levees, water diversions, land grading, etc., and the site is not within the zone of influence of any ditches or subsurface drains), it should be identified as a wetland. If necessary, the site can be revisited during a period of normal rainfall and checked again for hydrology indicators.

c. *Drought years*. Determine whether the area has been subject to drought. Drought periods can be identified by comparing annual rainfall totals with the normal range of annual rainfall given in WETS tables or by examining trends in drought indices, such as the Palmer Drought Severity Index (PDSI) (Sprecher and Warne 2000). PDSI takes into account not only precipitation but also temperature, which affects evapotranspiration, and soil moisture conditions. The index is usually calculated on a monthly basis for major climatic divisions within each state. Therefore, the information is not site-specific. PDSI ranges potentially between –6 and +6 with negative values indicating dry periods and positive values indicating wet periods. An index of –1.0 indicates mild drought, –2.0 indicates moderate drought, –3.0 indicates severe drought, and –4.0 indicates extreme drought. Time-series plots of PDSI values by month or year are available from the National Climatic Data Center at (http://www.ncdc.noaa.gov/oa/climate/onlineprod/drought/xmgr.html#ds). If wetland hydrology indicators appear to be absent on a site that has hydrophytic vegetation and hydric soils, no significant hydrologic manipulation (e.g., no dams, levees, water diversions, land grading, etc., and the site is not within the zone of influence of any ditches or subsurface drains), and the region has been affected by drought, then the area should be identified as a wetland.

d. *Reference sites*. If indicators of hydric soil and hydrophytic vegetation are present on a site that lacks wetland hydrology indicators, the site may be considered to be a wetland if the landscape setting, topography, soils, and vegetation are substantially the same as those on nearby wetland reference areas. Hydrology of wetland reference areas should be documented through long-term monitoring (see item *g* below) or by application of the procedure described in item *5a* on page 107 (Direct Hydrologic Observations) of the procedure for Problematic Hydrophytic Vegetation in this chapter. Reference sites should be minimally disturbed and provide long-term access. Soils, vegetation, and hydrologic conditions should be thoroughly documented and the data kept on file in the District or field office.

e. *Hydrology tools*. The "Hydrology Tools" (USDA Natural Resources Conservation Service 1997) is a collection of methods that can be used to determine whether wetland hydrology is present on a potential wetland site that lacks indicators due to disturbance or other reasons, particularly on lands used for agriculture. Generally they require additional information, such as aerial photographs or stream-gauge data, or involve hydrologic modeling and approximation techniques. They should be used only when an indicator-based wetland hydrology determination is not possible or would give misleading results. A hydrologist may be needed to help select and carry out the proper analysis. The seven hydrology tools are used to:

(1) Analyze stream and lake gauge data
(2) Estimate runoff volumes and determine duration and frequency of ponding in depressional areas, based on precipitation and temperature data, soil characteristics, land cover, and other inputs
(3) Evaluate the frequency of wetness signatures on repeated aerial photography (see item *f* below for additional information)
(4) Model water-table fluctuations in fields with parallel drainage systems using the DRAINMOD model
(5) Estimate the "scope and effect" of ditches or subsurface drain lines
(6) Use NRCS state drainage guides to estimate the effectiveness of agricultural drainage systems

(7) Analyze data from groundwater monitoring wells (see item *g* below for additional information)

f. *Evaluating multiple years of aerial photography*. Each year, the Farm Service Agency (FSA) takes low-level aerial photographs in agricultural areas to monitor the acreages planted in various crops for USDA programs. NRCS has developed an off-site procedure that uses these photos, or repeated aerial photography from other sources, to make wetland hydrology determinations (USDA Natural Resources Conservation Service 1997, Section 650.1903). The method is intended for use on agricultural lands where human activity has altered or destroyed other wetland indicators. However, the same approach may be useful in other environments.

The procedure uses five or more years of growing-season photography and evaluates each photo for wetness signatures that are listed in "wetland mapping conventions" developed by NRCS state offices. Wetland mapping conventions can be found in the electronic Field Office Technical Guide (eFOTG) for each state (http://www.nrcs.usda.gov/technical/efotg/). From the national web site, choose the appropriate state, then select any county (the state's wetland mapping conventions are the same in every county). Wetland mapping conventions are listed among the references in Section I of the eFOTG. However, not all states have wetland mapping conventions.

Wetness signatures for a particular state may include surface water, saturated soils, flooded or drowned-out crops, stressed crops due to wetness, differences in vegetation patterns due to different planting dates, inclusion of wet areas into set-aside programs, unharvested crops, isolated areas that are not farmed with the rest of the field, patches of greener vegetation during dry periods, and other evidence of wet conditions (see Part 513.30 of USDA Natural Resources Conservation Service 1994). For each photo, the procedure described in item *b* above is used to determine whether the amount of rainfall in the 2-3 months prior to the date of the photo was normal, below normal, or above normal. Only photos taken in normal rainfall years, or an equal number of wetter-than-normal and drier-than-normal years, are used in the analysis. If wetness signatures are observed on photos in more than half of the years included in the analysis, then wetland hydrology is present. Data forms that may be used to document the wetland hydrology determination are given in section 650.1903 of USDA Natural Resources Conservation Service (1997).

g. *Long-term hydrologic monitoring.* On sites where the hydrology has been manipulated by man (e.g., with ditches, subsurface drains, dams, levees, water diversions, land grading) or where natural events (e.g., downcutting of streams) have altered conditions such that hydrology indicators may be missing or misleading, direct monitoring of surface and groundwater may be needed to determine the presence or absence of wetland hydrology. The U. S. Army Corps of Engineers (2005) provides minimum standards for the design, construction, and installation of water-table monitoring wells, and for the collection and interpretation of groundwater monitoring data, in cases where direct hydrologic measurements are needed to determine whether wetlands are present on highly disturbed or problematic sites. This standard calls for 14 or more consecutive days of flooding, ponding, or a water table 12 in. (30 cm) or less below the soil surface during the growing season at a minimum frequency of 5 years in 10 (50 percent or higher probability), unless a different standard has been established for a particular geographic area or wetland type. A disturbed or problematic site that meets this standard has wetland hydrology. This standard is not intended (1) to overrule an indicator-based wetland determination on a site that is not disturbed or problematic, or (2) to test or validate existing or proposed wetland indicators.

Wetland/non-wetland mosaics

Description of the problem

In this supplement, “mosaic” refers to a landscape where wetland and non-wetland components are too closely associated to be easily delineated or mapped separately. These areas often have complex microtopography, with repeated small changes in elevation occurring over short distances. Tops of ridges and hummocks are often non-wetland but are interspersed throughout a wetland matrix having clearly hydrophytic vegetation, hydric soils, and wetland hydrology. Examples of wetland/non-wetland mosaics in the Midwest Region include ridge-and-swale topography in floodplains, dune-and-swale systems near Lake Michigan, areas containing numerous ephemeral pools, flatwoods, and areas where wind-thrown trees have created mound-and-pit topography.

Wetland components of a mosaic are often not difficult to identify. The problem for the wetland delineator is that microtopographic features are too small and intermingled, and there are too many such features per acre, to delineate and map them accurately. Instead, the following sampling approach can be used to estimate the percentage of wetland in the mosaic. From this, the number of acres of wetland on the site can be calculated, if needed.

Procedure

First, identify and flag all contiguous areas of either wetland or non-wetland on the site that are large enough to be delineated and mapped separately. The remaining area should be mapped as "wetland/non-wetland mosaic" and the approximate percentage of wetland within the area should be determined by the following procedure:

1. Establish one or more continuous line transects across the mosaic area, as needed. Measure the total length of each transect. A convenient method is to stretch a measuring tape along the transect and leave it in place while sampling. If the site is shaped appropriately and multiple transects are used, they should be arranged in parallel with each transect starting from a random point along one edge of the site. However, other arrangements of transects may be needed for oddly shaped sites.

2. Use separate data forms for the swale or trough and for the ridges or hummocks. Sampling of vegetation, soil, and hydrology should follow the general procedures described in the Corps Manual and this supplement. Plot sizes and shapes for vegetation sampling must be adjusted to fit the microtopographic features on the site. Plots intended to sample the troughs should not overlap adjacent hummocks, and vice versa. Only one or two data forms are required for each microtopographic position; they do not need to be repeated for similar features or plant communities.

3. Identify every wetland boundary in every trough or swale encountered along each transect. Each boundary location may be marked with a pin flag or simply recorded as a distance along the stretched tape.

4. Determine the total distance along each transect that is occupied by wetlands and non-wetlands until the entire length of the line has been accounted for. Sum these distances across transects, if needed. Determine

the percentage of wetland in the wetland/non-wetland mosaic by the following formula.

$$\%\ wetland = \frac{Total\ wetland\ distance\ along\ all\ transects}{Total\ length\ of\ all\ transects} \times 100$$

An alternative approach involves point-intercept sampling at fixed intervals along transects across the area designated as wetland/non-wetland mosaic. This method avoids the need to identify wetland boundaries in each swale, and can be carried out by pacing rather than stretching a measuring tape across the site. The investigator uses a compass or other means to follow the selected transect line. At a fixed number of paces (e.g., every two steps) the wetland status of that point is determined by observing indicators of hydrophytic vegetation, hydric soil, and wetland hydrology. Again, a completed data form is not required at every point but at least one representative swale and hummock should be documented with completed forms. After all transects have been sampled, the result is a number of wetland sampling points and a number of non-wetland points. Estimate the percentage of wetland in the wetland/non-wetland mosaic by the following formula:

$$\%\ wetland = \frac{Number\ of\ wetland\ points\ along\ all\ transects}{Total\ number\ of\ points\ sampled\ along\ all\ transects} \times 100$$

If high-quality aerial photography is available for the site, a third approach to estimating the percentage of wetland in a wetland/non-wetland mosaic is to use a dot grid, planimeter, or geographic information system (GIS) to determine the percentage of ridges (non-wetlands) and swales (wetlands) through photo interpretation of topography and vegetation patterns. This technique requires onsite verification that most ridges qualify as non-wetlands and most swales qualify as wetlands.

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Appendix A: Glossary

This glossary is intended to supplement those given in the Corps Manual and other available sources. See the following publications for terms not listed here:

- Corps Manual (Environmental Laboratory 1987) (http://el.erdc.usace.army.mil/wetlands/pdfs/wlman87.pdf).
- Field Indicators of Hydric Soils in the United States (USDA Natural Resources Conservation Service 2006b) (http://soils.usda.gov/use/hydric/).
- National Soil Survey Handbook, Part 629 (USDA Natural Resources Conservation Service 2005) (ftp://ftp-fc.sc.egov.usda.gov/NSSC/Soil_Survey_Handbook/629_glossary.pdf).

Absolute cover. In vegetation sampling, the percentage of the ground surface that is covered by the aerial portions (leaves and stems) of a plant species when viewed from above. Due to overlapping plant canopies, the sum of absolute cover values for all species in a community or stratum may exceed 100 percent. In contrast, "relative cover" is the absolute cover of a species divided by the total coverage of all species in that stratum, expressed as a percent. Relative cover cannot be used to calculate the prevalence index.

Aquitard. A layer of soil or rock that retards the downward flow of water and is capable of perching water above it. For the purposes of this supplement, the term aquitard also includes the term aquiclude, which is a soil or rock layer that is incapable of transmitting significant quantities of water under ordinary hydraulic gradients.

Contrast. The color difference between a redox concentration and the dominant matrix color. Differences are classified as faint, distinct, or prominent and are defined in the glossary of USDA Natural Resources Conservation Service (2006b) and illustrated in Table A1.

Depleted matrix. The volume of a soil horizon or subhorizon from which iron has been removed or transformed by processes of reduction and translocation to create colors of low chroma and high value. A, E, and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix. However, they are excluded from the concept of a depleted matrix unless common or many, distinct or prominent redox concentrations as soft masses or pore linings are present. In some places the depleted matrix may change color upon exposure to air (reduced matrix); this phenomenon is included in the concept of a depleted matrix. The following combinations of value and chroma identify a depleted matrix:

- Matrix value of 5 or more and chroma of 1, with or without redox concentrations occurring as soft masses and/or pore linings, or
- Matrix value of 6 or more and chroma of 2 or 1, with or without redox concentrations occurring as soft masses and/or pore linings, or
- Matrix value of 4 or 5 and chroma of 2, with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings, or
- Matrix value of 4 and chroma of 1, with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings (USDA Natural Resources Conservation Service 2006b).

Common (2 to less than 20 percent) to many (20 percent or more) redox concentrations (USDA Natural Resources Conservation Service 2002) are required in soils with matrix colors of 4/1, 4/2, and 5/2 (Figure A1). Redox concentrations include iron and manganese masses and pore linings (Vepraskas 1992). See "contrast" in this glossary for the definitions of "distinct" and "prominent."

Table A1. Tabular key for contrast determinations using Munsell notation.

Hues are the same (Δ h = 0)			Hues differ by 2 (Δ h = 2)		
Δ Value	Δ Chroma	Contrast	Δ Value	Δ Chroma	Contrast
0	≤1	Faint	0	0	Faint
0	2	Distinct	0	1	Distinct
0	3	Distinct	0	≥2	Prominent
0	≥4	Prominent	1	≤1	Distinct
1	≤1	Faint	1	≥2	Prominent
1	2	Distinct	≥2	---	Prominent
1	3	Distinct			
1	≥4	Prominent			
≤2	≤1	Faint			
≤2	2	Distinct			
≤2	3	Distinct			
≤2	≥4	Prominent			
3	≤1	Distinct			
3	2	Distinct			
3	3	Distinct			
3	≥4	Prominent			
≥4	---	Prominent			
Hues differ by 1 (Δ h = 1)			**Hues differ by 3 or more (Δ h ≥ 3)**		
Δ Value	Δ Chroma	Contrast	Δ Value	Δ Chroma	Contrast
0	≤1	Faint	Color contrast is prominent, except for low chroma and value.		Prominent
0	2	Distinct			
0	≥3	Prominent			
1	≤1	Faint			
1	2	Distinct			
1	≥3	Prominent			
2	≤1	Distinct			
2	2	Distinct			
2	≥3	Prominent			
≥3	---	Prominent			

Note: If both colors have values of ≤3 and chromas of ≤2, the color contrast is faint (regardless of the difference in hue).

Adapted from USDA Natural Resources Conservation Service (2002)

Figure A1. Illustration of values and chromas that require 2 percent or more distinct or prominent redox concentrations and those that do not, for hue 10YR, to meet the definition of a depleted matrix. *Due to inaccurate color reproduction, do not use this page to determine soil colors in the field.* Background image from the Munsell Soil Color Charts reprinted courtesy of Munsell Color Services Lab, a part of X-Rite, Inc.

Diapause. A period during which growth or development is suspended and physiological activity is diminished, as in certain aquatic invertebrates in response to drying of temporary wetlands.

Distinct. See Contrast.

Episaturation. Condition in which the soil is saturated with water at or near the surface, but also has one or more unsaturated layers below the saturated zone. The zone of saturation is perched on top of a relatively impermeable layer.

Fragmental soil material. Soil material that consists of 90 percent or more rock fragments; less than 10 percent of the soil consists of particles 2 mm or smaller (USDA Natural Resources Conservation Service 2006b).

Gleyed matrix. A gleyed matrix has one of the following combinations of hue, value, and chroma and the soil is not glauconitic (Figure A2):

- 10Y, 5GY, 10GY, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value of 4 or more and chroma of 1; or
- 5G with value of 4 or more and chroma of 1 or 2; or
- N with value of 4 or more (USDA Natural Resources Conservation Service 2006b).

Growing season. In the Midwest Region, growing season dates are determined through onsite observations of the following indicators of biological activity in a given year: (1) above-ground growth and development of vascular plants, and/or (2) soil temperature (see Chapter 4 for details). If onsite data gathering is not practical, growing season dates may be approximated by using WETS tables available from the NRCS National Water and Climate Center to determine the median dates of 28 °F (−2.2 °C) air temperatures in spring and fall based on long-term records gathered at the nearest appropriate National Weather Service meteorological station.

Figure A2. For hydric soil determinations, a gleyed matrix has the hues and chroma identified in this illustration with a value of 4 or more. *Due to inaccurate color reproduction, do not use this page to determine soil colors in the field.* Background image from the Munsell Soil Color Charts reprinted courtesy of Munsell Color Services Lab, a part of X-Rite, Inc.

High pH. pH of 7.9 or higher. Includes moderately alkaline, strongly alkaline, and very strongly alkaline (USDA Natural Resources Conservation Service 2002).

Nodules and concretions. Irregularly shaped, firm to extremely firm accumulations of iron and manganese oxides. When broken open, nodules have uniform internal structure whereas concretions have concentric layers (Vepraskas 1992).

Prominent. See Contrast.

Reduced matrix. Soil matrix that has a low chroma in situ due to the presence of reduced iron, but whose color changes in hue or chroma when exposed to air as Fe^{2+} is oxidized to Fe^{3+} (Vepraskas 1992).

Saturation. For wetland delineation purposes, a soil layer is saturated if virtually all pores between soil particles are filled with water (National Research Council 1995, Vepraskas and Sprecher 1997). This definition includes part of the capillary fringe above the water table (i.e., the tension-saturated zone) in which soil water content is approximately equal to that below the water table (Freeze and Cherry 1979).

Appendix B: Point-Intercept Sampling Procedure for Determining Hydrophytic Vegetation

The following procedure for point-intercept sampling is an alternative to plot-based sampling methods to estimate the abundance of plant species in a community. The approach may be used with the approval of the appropriate Corps of Engineers District to evaluate vegetation as part of a wetland delineation. Advantages of point-intercept sampling include better quantification of plant species abundance and reduced bias compared with visual estimates of cover. The method is useful in communities with high species diversity, and in areas where vegetation is patchy or heterogeneous, making it difficult to identify representative locations for plot sampling. Disadvantages include the increased time required for sampling and the need for vegetation units large enough to permit the establishment of one or more transect lines within them. The approach also assumes that soil and hydrologic conditions are uniform across the area where transects are located. In particular, transects should not cross the wetland boundary. Point-intercept sampling is generally used with a transect-based prevalence index (see below) to determine whether vegetation is hydrophytic.

In point-intercept sampling, plant occurrence is determined at points located at fixed intervals along one or more transects established in random locations within the plant community or vegetation unit. If a transect is being used to sample the vegetation near a wetland boundary, the transect should be placed parallel to the boundary and should not cross the wetland boundary or extend into other communities. Usually a measuring tape is laid on the ground and used for the transect line. Transect length depends upon the size and complexity of the plant community and may range from 100 to 300 ft (30 to 90 m) or more. Plant occurrence data are collected at fixed intervals along the line, for example every 2 ft (0.6 m). At each interval, a “hit” on a species is recorded if a vertical line at that point would intercept the stem or foliage of that species. Only one “hit” is recorded for a species at a point even if the same species would be intercepted more than once at that point. Vertical intercepts can be determined using a long pin or rod protruding into and through the various vegetation layers, a sighting device (e.g., for the canopy), or an imaginary vertical line. The total number of "hits" for each species along the transect is then determined. The result is a list of species and their frequencies of occurrence along the line (Mueller-Dombois and Ellenberg 1974, Tiner 1999). Species are then categorized by wetland indicator status (i.e., OBL, FACW, FAC, FACU, or UPL), the total number of hits is determined within each category, and the data are used to calculate a transect-based prevalence index. The formula is similar to that given in Chapter 2 for the plot-based prevalence index (see Indicator 2), except that frequencies are used in place of cover estimates. The community is hydrophytic if the prevalence index is 3.0 or less. To be valid, more than 80 percent of "hits" on the transect must be of species that have been identified correctly and placed in an indicator category.

The transect-based prevalence index is calculated using the following formula:

$$PI = \frac{F_{OBL} + 2F_{FACW} + 3F_{FAC} + 4F_{FACU} + 5F_{UPL}}{F_{OBL} + F_{FACW} + F_{FAC} + F_{FACU} + F_{UPL}}$$

where:

PI = Prevalence index
F_{OBL} = Frequency of obligate (OBL) plant species
F_{FACW} = Frequency of facultative wetland (FACW) plant species
F_{FAC} = Frequency of facultative (FAC) plant species
F_{FACU} = Frequency of facultative upland (FACU) plant species
F_{UPL} = Frequency of upland (UPL) plant species.

Appendix C: Data Form

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: ______________________ City/County: ______________ Sampling Date: ________

Applicant/Owner: ______________________________ State: ______ Sampling Point: ________

Investigator(s): ______________________ Section, Township, Range: ____________________

Landform (hillslope, terrace, etc.): ____________________ Local relief (concave, convex, none): ______________

Slope (%): ______ Lat: ________________ Long: ________________ Datum: ________

Soil Map Unit Name: ______________________________ NWI classification: ____________

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ______	No ______	**Is the Sampled Area within a Wetland? Yes ______ No ______**
Hydric Soil Present?	Yes ______	No ______	
Wetland Hydrology Present?	Yes ______	No ______	
Remarks:			

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ________)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	______ = Total Cover		
Sapling/Shrub Stratum (Plot size: ________)			
1.			
2.			
3.			
4.			
5.			
	______ = Total Cover		
Herb Stratum (Plot size: ________)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	______ = Total Cover		
Woody Vine Stratum (Plot size: ________)			
1.			
2.			
	______ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ________ (A)

Total Number of Dominant Species Across All Strata: ________ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ________ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	________	x 1 =	________
FACW species	________	x 2 =	________
FAC species	________	x 3 =	________
FACU species	________	x 4 =	________
UPL species	________	x 5 =	________
Column Totals:	________ (A)		________ (B)

Prevalence Index = B/A = ________

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No ______

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: ___________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ 2 cm Muck (A10)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ 5 cm Mucky Peat or Peat (S3)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ Coast Prairie Redox (A16)
___ Iron-Manganese Masses (F12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______________________

Depth (inches): ______________________

Hydric Soil Present? Yes ______ No ______

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9)
___ Aquatic Fauna (B13)
___ True Aquatic Plants (B14)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres on Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Gauge or Well Data (D9)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Stunted or Stressed Plants (D1)
___ Geomorphic Position (D2)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No _____ Depth (inches): ____________
Water Table Present? Yes _____ No _____ Depth (inches): ____________
Saturation Present? (includes capillary fringe) Yes _____ No _____ Depth (inches): ____________

Wetland Hydrology Present? Yes ______ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual, which provides technical guidance and procedures for identifying and delineating wetlands that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act. The development of Regional Supplements is part of a nationwide effort to address regional wetland characteristics and improve the accuracy and efficiency of wetland-delineation procedures. This supplement is applicable to the Midwest Region, which consists of all or portions of 14 states: Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, and Wisconsin.

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