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Developing a "Regionalized" Version of the Corps of Engineers Wetlands Delineation Manual: Issues and Recommendations

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Contents

Preface

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1 Introduction

Wetland delineation is fundamental to Corps of Engineers (Corps) and Environmental Protection Agency (EPA) regulatory responsibilities under Section 404 of the Clean Water Act (CWA). Wetland delineation consists of standardized procedures that are used to determine if a wetland is present on a site and, if so, to establish its boundaries in the field. In combination with current regulations and policies, delineation methods help to define the area of Federal responsibility under the Act, within which the agencies attempt to minimize the impacts of proposed projects to the physical, chemical, and biological integrity of the Nation's waters.

In determining jurisdiction under the Clean Water Act, the Corps is governed by Federal regulations (33 CFR 320-330) that define wetlands but do not provide a method to determine their boundaries. Instead, at various times both the Corps and EPA have issued guidance on the delineation of wetlands to their regulatory personnel. Today, the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory (1987), hereafter called the Corps manual) is the accepted standard for delineating wetlands pursuant to the Section 404 regulatory program.

In 1993, at the request of Congress, the National Research Council (NRC), the research arm of the National Academy of Sciences, formed a committee to review the scientific basis for wetland delineation and the technical validity of current wetland delineation manuals. The NRC report (National Research Council 1995) supported the basic logic and structure of the Corps manual. However, it also concluded that regional variation among wetlands across the United States can affect the validity and usefulness of any national delineation manual, and strongly recommended that delineation procedures be revised to increase their regional specificity.

The purpose of this report is to identify and discuss technical issues relevant to the "regionalization" of the Corps manual. The report is based on published literature and the author's personal experience, and includes recommendations for the development of regional wetland delineation guidance and research to fill information gaps. The general approach is to review the definitions, criteria, and field indicators used to identify wetlands under the Corps manual and to suggest ways that current methods could be made more sensitive to regional variations in wetland conditions.

A Brief History of Federal Wetland Delineation Methods

Methods used to identify and delineate wetlands have evolved considerably since the beginnings of the CWA regulatory program in the 1970s (National Research Council 1995, Tiner 1999). Until 1987, neither the Corps nor EPA had an official technical manual for delineating wetlands. Instead, Corps Districts developed their own delineation guidance or used drafts of manuals then under development. Early methods often relied heavily upon characteristics of vegetation and were not necessarily consistent from District to District.

The first national manual for the delineation of wetlands was published by the Corps (Environmental Laboratory 1987) after several years of development and testing (National Research Council 1995). The Corps manual established a single approach to the identification and delineation of wetlands throughout the United States. It required that an area possess three essential characteristics to be identified as a wetland – hydrophytic vegetation, hydric soils, and wetland hydrology – and described sampling protocols that could be used to delineate wetlands on both relatively natural and highly disturbed sites. The 1987 manual was originally offered as guidance to Corps Districts but its use was not mandatory. As a result, regional differences in delineation methods and jurisdictional limits persisted.

Soon after the Corps manual was published, EPA published its own delineation manual (Sipple 1988a, 1988b), which also incorporated a three-factor test and was intended for use in the Section 404 regulatory program. The two methods had many similarities. However, the EPA manual allowed areas to be designated as wetlands by vegetation alone, if obligate (OBL) wetland plants were present as dominants and there was no evidence of hydrologic alteration. Additional information on soils and hydrology was needed when the vegetation was dominated only by facultative plant species. The two manuals also differed in the field methods used to sample vegetation and select dominant species. Thus, there were instances when the two manuals would produce different wetland boundaries.

During the same period, the Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service), in cooperation with the U.S. Fish and Wildlife Service (FWS), developed the first versions of its *National Food Security Act Manual* (NFSAM). Among other goals, the NFSAM was developed to implement the Swampbuster provisions of the Food Security Act of 1985, which sought to reduce wetland losses by providing penalties for farmers who convert wetlands into croplands. The second edition of the NFSAM was published in 1988 and presented generic procedures that, when combined with wetland mapping conventions developed at the state level, were designed to perform large-scale inventories of wetlands on agricultural lands. These inventories utilized readily available office data, such as soil survey reports, hydric soil lists, National Wetlands Inventory maps, and low-altitude aerial photographs taken annually by the Consolidated Farm Services Agency (formerly the Agricultural Stabilization and Conservation Service) to monitor compliance with crop subsidy programs.

Inconsistencies among the three manuals written by the Federal regulatory agencies to identify and delineate wetlands soon prompted calls for the development of a unified Federal manual (General Accounting Office 1988, The Conservation Foundation 1988). Thus, in late 1988 representatives of the Corps, EPA, FWS, and NRCS convened to write a compromise manual. The resulting *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (Federal Interagency Committee for Wetland Delineation 1989) was signed by all four agencies and was made mandatory within the Section 404 program. However, the 1989 Federal manual generated almost immediate opposition from groups that believed that the manual expanded the Federal government's regulatory authority into lands previously considered to be non-jurisdictional (Strand 1993).

Early in 1991, the Administration proposed a revision to the 1989 Federal manual (final version published in the Federal Register 56(157): 40446-40480, August 14, 1991) that would have eliminated existing protections for groundwater-dominated wetlands that do not normally have water tables at or above the ground surface. This and other features of the 1991 proposed revisions were widely criticized on scientific grounds (e.g., Bedford et al. 1992) and were never adopted.

In August of 1991, the President signed the 1992 Energy and Water Development Appropriations Act in which Congress directed the Corps to stop using the 1989 Federal manual to delineate wetlands subject to Section 404. Since then, use of the 1987 Corps manual has been mandatory in the Section 404 permitting program.

Despite the abandonment of the 1989 Federal manual, mandatory use of the 1987 manual by Corps Districts nationwide brought a measure of consistency to wetland determinations that was not the case before 1989. Today, Clean Water Act jurisdiction extends to environments with similar degrees of growing-season wetness throughout the country, without regard to regional differences in climate, physiography, abundance of wetlands, or other factors.

Interagency differences in wetland criteria and delineation methods arose again in 1994 with the signing of a Memorandum of Agreement (MOA) among the Corps, EPA, FWS, and NRCS concerning wetland delineations on agricultural lands. Under the MOA, NRCS was designated the lead agency for wetland identification on agricultural lands for both Clean Water Act and Food Security Act purposes. To delineate wetlands on agricultural lands, NRCS uses the third edition of its NFSAM (Soil Conservation Service 1994, amended in 1996). Differences between the NFSAM and the Corps manual include:

- Different wetland hydrology criteria.
- Use by NRCS of newly developed hydric soil indicators, which have not yet been approved for general use by the Corps and EPA.

- Emphasis by NRCS on quantitative methods of hydrology analysis called "hydrology tools" (Natural Resources Conservation Service 1997).

Extent of Regional Specificity in Current Wetland Delineation Manuals

Despite their differences, both the Corps manual and the NFSAM provide nationwide rules for the identification of wetlands potentially subject to regulation under the Clean Water Act. Each manual presents a set of wetland criteria, field indicators, and sampling methods intended for use in delineating wetlands throughout the United States. At the present time, regional specificity is limited to the following supplemental materials, which are referenced either in the original manuals or in subsequent guidance memoranda from the appropriate agency headquarters:

a. Both manuals require that regional versions of the *National List of Plant Species that Occur in Wetlands* (Reed 1988) be used to make hydrophytic vegetation decisions, when vegetation is present.

b. The NFSAM relies on field indicators of hydric soils (Natural Resources Conservation Service 1998) that were developed for use in specific USDA Land Resource Regions (Soil Conservation Service 1981). For Corps wetland regulators, the NTCHS field indicators do not supersede those given in the Corps manual, but may be used as supplemental information, particularly in certain problem soil situations (e.g., soils formed in red parent materials, some Mollisols, Entisols, etc.).

c. NRCS has developed, and the Corps has adopted, county lists of hydric soil map units. These lists provide valuable background information about the likely presence or absence of hydric soils on a field site before an onsite delineation is performed. The county lists supersede the older national hydric soils list (Soil Conservation Service 1991) for delineation purposes. The national list is no longer being updated or maintained.

d. Local determinations of growing season dates are now based on data from National Weather Service cooperative weather stations located within each county, in place of the previous guidance that assigned arbitrary growing season dates to broad regions based on presumed soil temperature regimes (e.g., thermic and mesic regions) (Mausbach and Parker 2001).

Regionalizing Wetland Delineation Methods: Science Versus Policy

In an effort to resolve some of the public and administrative confusion that existed in the early 1990s over the technical validity and credibility of wetland delineation methods, Congress directed EPA to fund a study by the NRC of the scientific basis for wetland characterization. The NRC report (National Research Council 1995) validated the basic structure and scientific foundations of the delineation methods that were in use at the time, including the 1987 Corps manual. However, it also listed a number of recommendations for improvement, including a call for improved sensitivity to regional differences in climate, hydrologic and geologic conditions, and other wetland characteristics.

In the broad sense, "regionalization" of wetland delineation methods can involve both technical and policy considerations. Technical issues include whether wetland criteria are appropriate in a particular region, and whether indicators used to identify wetlands in the field are sensitive to regional variations in environmental conditions (National Research Council 1995). These are mainly scientific issues that can be addressed with appropriate research. This report discusses some of the scientific issues involved in the regionalization of wetland delineation methods.

Policy issues include whether to extend regulatory jurisdiction to all areas encompassed by a strictly technical definition of wetlands or to exclude some wetlands from regulation based on political, social, or economic considerations. Furthermore, policy considerations may dictate that some areas that fail to meet wetland criteria (e.g., contiguous upland habitats or "buffers") should also be regulated. Regional factors that may affect wetland protection policy include the abundance or scarcity of wetlands in the region, historical rates of wetland loss, local development pressure, and public perceptions of wetland values.

At the most basic level, policy judgments must be made in deciding where to draw the line between regulated and unregulated portions of the wetness gradient. The issue is not strictly technical. For example, it is largely a policy decision that extends jurisdiction to areas with water tables 12 in. from the surface but not 14 in., and inundation frequencies of 1 year in 2 but not 1 year in 3. The 1991 proposed revisions to the 1989 Federal delineation manual represented a policy shift that would have rescinded the Federal government's regulatory authority over groundwater-dominated wetlands, those which do not pond or flood in an average year. State programs, by policy, may also limit protection to only a portion of the overall wetland resource. For example, the wetland delineation method used in Florida for the administration of State wetland programs (Gilbert et al. 1995) is intended to identify wetlands that are a subset of the "surface waters" defined by statute, thus leaving groundwater wetlands unprotected at the State level. Policy judgments are pervasive in the world of wetland regulation, particularly in the wetland definitions that have been developed to describe the limits of government jurisdiction. Policy issues cannot be avoided in a discussion of regionalization of wetland delineation methods. However, to the extent possible, this report emphasizes scientific issues.

2 Many Definitions of Wetland

The term "wetland" has been defined in many different ways depending upon the purposes of the author or organization involved (National Research Council 1995, Tiner 1999). A purely scientific definition of wetlands has been difficult to achieve, and most definitions are too general to be of much use in determining wetland boundaries. Wetlands are characterized by extreme levels of spatial and temporal variability, which makes them difficult to describe and differentiate from other ecosystems. Rather than independent entities, wetlands are often described as transition zones or ecotones, part of a continuous hydrologic gradient between uplands and open water (Mitsch and Gosselink 1993).

Under the Ramsar Convention on Wetlands, adopted in Ramsar, Iran, in 1971, wetlands are defined as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Article 1.1). Furthermore, wetlands "may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands" (Article 2.1).

Wetland definitions in the United States tend to be more specific than the Ramsar definition, highlighting important wetland attributes rather than descriptive terms. In their precedent-setting textbook *Wetlands*, Mitsch and Gosselink (1993: 22) provide no comprehensive definition of wetlands, instead focusing on three "main components" of most wetland definitions:

1. *Wetlands are distinguished by the presence of water, either at the surface or within the root zone.*

2. *Wetlands often have unique soil conditions that differ from adjacent uplands.*

3. *Wetlands support vegetation adapted to the wet conditions (hydrophytes) and conversely are characterized by an absence of flooding-intolerant vegetation.*

A Technical Definition of Wetland

Most wetland definitions in use today were developed by government agencies and are colored by agency missions, the intent of legislators, and administration policy. The National Research Council (1995: 59) attempted a strictly technical definition, which they used to compare with current regulatory definitions and to evaluate methods for delineating wetland boundaries. Therefore, this technical definition was developed with regulatory issues in mind, but was proposed by a committee of academics, members of private firms, and personnel of non-regulatory agencies and organizations. The NRC defined wetland as:

> *. . . an ecosystem that depends on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics of a wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical, and biological features reflective of recurrent, sustained inundation or saturation. Common diagnostic features of wetlands are hydric soils and hydrophytic vegetation. These features will be present except where specific physicochemical, biotic, or anthropogenic factors have removed them or prevented their development.*

Important parts of this definition include the concept that wetlands are ecosystems and, therefore, like all ecosystems, consist of integrated biotic and abiotic components, linked by energy and materials pathways (Odum 1971, Whittaker 1975). In addition, wetlands depend on the constant or recurrent presence of water, which produces characteristic physical, chemical, and biological features. The definition is vague about what those features might be. For example, wetlands generally have hydric soils and hydrophytic vegetation, but may lack one or both if specific factors "have removed them or prevented their development." Therefore, the definition includes wet areas that do not support vascular plants but do support algae or invertebrate animals that depend on recurrent inundation or saturation. It also says nothing about the timing, frequency, or duration of inundation or saturation that is required to develop or support the physical, chemical, or biological features of wetlands.

The NRC definition of wetland mentions hydric soils as a common feature of many wetlands. Hydric soils, by definition, developed under anaerobic conditions brought about by waterlogging (see the "Hydric Soils" section later in this report). The NRC considered hydric soils to be "a common and sufficient characteristic of wetlands, but not a necessary condition, . . . because some lack anaerobic soils" (National Research Council 1995:118). They give the examples of springs, seeps, some vernal pools, and coarse-textured riverine deposits that support willows (*Salix* spp.) and other wetland plants but remain oxygenated. Therefore, the NRC gives a somewhat broader definition of wetlands than some regulatory definitions (see the following sections) by recognizing that not all wetlands go anaerobic. The NRC stressed the importance of "confirming wetlands status hydrologically where hydric soils are absent" (National Research Council 1995:118).

Although stated in fairly general terms, the NRC definition of wetlands is based on ecosystem-level concepts that are applicable anywhere in the world (although some terms and concepts used in the definition, such as "hydric soils," were developed in the United States and may not be universally accepted). One of the advantages of a strictly technical definition of wetlands is that it should not depend upon the user's location or affiliation, and should not be biased by regional considerations of wetland value, abundance, or other factors. NRC's definition explicitly encompasses a great deal of potential variation in wetland characteristics due to different climatic regimes, hydrologic conditions, substrates, chemical characteristics, and biotic communities. This definition should serve adequately as a frame of reference within which to consider the potential for regionalization of regulatory definitions, criteria, and field indicators.

The National Wetlands Inventory Wetland Definition

Although not used for regulatory purposes, one wetland definition that is widely known in the United States was presented in the U.S. Fish and Wildlife Service's *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979) and is the basis for the National Wetlands Inventory (NWI):

> *Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.*

The NWI definition is broader than either of the regulatory definitions used by the Corps and EPA or the NRCS (see the following section) in that it only requires a one-factor test (i.e., an area must satisfy either clause (*1*) or (*2*) or (*3*) to be considered a wetland for inventory purposes). The third clause also specifically includes wet areas that do not support vascular macrophytes (e.g., sand beaches, rocky streambeds, shallow pond bottoms, mud flats). These unvegetated wet habitats may be regulated as other "waters of the U.S." under Section 404 but do not meet either of the regulatory definitions of wetlands.

Regulatory Definitions of Wetlands

Special-purpose definitions of wetland, such as those used for inventory, management, or regulatory jurisdiction, may or may not encompass all areas included under a strictly technical definition. In addition, wetland delineation criteria and indicators developed under the umbrella of a regulatory definition constitute a further level of refinement and may or may not include all environments potentially covered by the jurisdictional definition. A discussion of regionalization of wetland delineation methods logically must start by considering whether regulatory definitions should differ by regions.

Regulatory definitions of wetlands necessarily reflect both technical issues and regulatory policy. It is a policy decision whether to extend regulatory authority to the same areas encompassed by a strictly technical definition of wetlands, or to make the regulatory definition either more or less inclusive. A regulatory definition of wetlands could include *more* environments than are encompassed by the technical definition, if that were the will of Congress or the policy of the agencies involved, or it could be designed to reduce the reach of government regulatory authority relative to the technical definition.

Two wetland definitions are currently used in regulatory programs at the Federal level. They incorporate both technical and policy considerations. For CWA regulatory purposes, the Corps (33 CFR 328.3) and EPA (40 CFR 230.3) jointly define wetlands as:

> *. . . those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.*

In the Food Security Act (16 USC §3801), wetlands are defined as:

> *. . . land that (A) has a predominance of hydric soils; (B) is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions; and (C) under normal circumstances does support a prevalence of such vegetation. For purposes of this Act, and any other Act, this term shall not include lands in Alaska identified as having high potential for agricultural development which have a predominance of permafrost soils.*

Although they incorporate similar wording, the Corps/EPA definition is more broadly worded and inclusive than the Food Security Act (FSA) definition. First, the Corps/EPA definition does not explicitly require the presence of hydric soils, which are defined fairly narrowly by the National Technical Committee for Hydric Soils (Federal Register 59(133):35680-35681, July 13, 1994) as "soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part." This issue is examined more closely later in the section on "Hydric Soils." Second, the FSA definition contains a policy clause intended to exclude certain wetlands in Alaska from regulation under the FSA.

The two regulatory wetland definitions also have important characteristics in common. First, the definitions specifically include both inundated and saturated systems, although requirements for seasonal timing, frequency, depth, and duration are not given. Second, they both require that wetlands be vegetated.

This requirement is further narrowed in the delineation manuals to mean the presence of vascular macrophytes. Therefore, the regulatory definitions exclude wet environments that are unvegetated or dominated by algae or invertebrate animals, unlike NRC's more general technical definition (National Research Council 1995). Such areas may fall into other categories of regulated "waters of the United States" (33 CFR 328.3(a)) but are not recognized as wetlands. Third, both regulatory definitions mention the presence of soils. Depending upon one's definition of soils, this requirement can potentially exclude areas in which the substrate is rock, cobbles, gravel, recently deposited materials in which soil-forming processes have not yet occurred, or areas that do not support plants.

The regulatory definition of wetland is the first level where regional considerations might be inserted into wetland delineation methods. Both of the current definitions, although they differ in important respects, were intended to be applied throughout the United States. The only part that is specific to a particular region, and represents a policy consideration rather than a technical one, is the statement in the FSA definition exempting certain Alaskan wetlands. These regulatory definitions could be revised to address regional differences in the scientific understanding of wetlands or additional policy considerations about what areas should or should not be subject to regulation.

As *technical* descriptions of areas subject to regulation under the CWA or FSA, the regulatory definitions of wetlands were intended to be simple and universal. This is clear from the fact that they provide few technical details that would be needed to differentiate among regions. For the most part, the details are left to the delineation manuals. Attempting to regionalize these definitions on technical grounds would increase their complexity and reduce their clarity. Increasing their technical content could also reduce flexibility in the future as more is learned about the characteristics, functions, and societal values of wetland systems, perhaps necessitating changes in the regulatory definitions. In the case of the FSA definition, which is written into law, a change would require further legislation. Therefore, it is probably better to have simple, universal regulatory definitions of wetlands and to leave technical matters to the delineation manuals that, ideally, would be updated every few years.

As *policy* statements, however, the regulatory definitions of wetlands could be crafted, if desired, to reflect the wetland-protection priorities of each region. The FSA wetland definition is an obvious example of mixed technical and political considerations. Similar exemptions or more encompassing clauses could be added to the wetland definition to address other regional issues. In the arid Southwest, for example, where wetlands and deepwater habitats make up less than 1 percent of the landscape (Dahl 1990) and where riparian systems provide valuable functions usually attributed to wetlands (e.g., flood storage and conveyance, wildlife habitat) (Brinson et al. 1981), protection of riparian zones may be a high societal priority. Corps regulations currently define the limits of jurisdiction in non-tidal waters, in the absence of adjacent wetlands, as the "ordinary high water mark" (33 CFR 328.4), a limit roughly equivalent to the 1.5-year flood return interval (Dunne and Leopold 1978, Rosgen 1996). Thus if additional protection was desired, an additional clause, such as the following, could be added to the regulatory definition of wetland:

In the southwestern region, the definition of wetland shall include riparian systems up to the limits of the 2-year (or 5-year or 10-year) flood return interval, regardless of flood duration or time of year.

On the other hand, in the southeastern coastal plain, where wetlands currently comprise 12-30 percent of the land area, despite historic losses of up to 60 percent in some southeastern states (Dahl 1990), wetland protection might focus on certain wetland types that are less abundant or thought to be more fully functional. Thus, an exemption for certain low-priority wetland types could be written into the regulatory definition, such as the following:

*In the southeastern region, wetlands shall not include flatwoods dominated by pines and saw palmetto (*Serenoa repens*) unless there is evidence of surface inundation in most years.*

Both of these examples must be recognized as policy statements, not strictly technical considerations. The first clause would extend government jurisdiction beyond the areas of *sustained* inundation or saturation described by NRC's technical definition. The second clause excludes one kind of wetland (i.e., groundwater wetland dominated by pines and saw palmetto) that would be encompassed by the technical definition. A similar exclusion is embodied in the wetland definition used for State programs in Florida (Gilbert et al. 1995).

3 Wetland Delineation Manuals

Delineation manuals are used in the field to draw jurisdictional boundaries around areas that meet the regulatory definitions of wetlands. Delineation methods are designed to draw an artificial line dividing the wetness gradient into wetland and nonwetland zones. Although the methods are based in science, the decision rules are necessarily somewhat arbitrary. They are based in large measure on logic and precedent in the absence of complete scientific understanding.

As mentioned previously, there currently are two delineation manuals in use at the Federal level. The Corps manual (Environmental Laboratory 1987) was designed for use under Section 404 of the CWA. It emphasizes wetland boundary determinations in relatively undisturbed environments and in areas recently disturbed by man's activities, called "atypical situations" in the manual. Delineation procedures under the Corps manual have been updated since 1987 in two ways: (a) through adoption of supplementary information published by other agencies, such as wetland plant lists developed by the FWS (Reed 1988) and hydric soil criteria and lists developed by NRCS, and (b) through guidance memos issued by Corps Headquarters. The NFSAM (Soil Conservation Service 1994, amended in 1996) was designed primarily for FSA applications but, since the 1994 MOA, also has a role in CWA regulation of wetlands on agricultural lands. It describes methods for both offsite and onsite wetland determinations on agricultural lands.

The Corps manual and the NFSAM differ in their wetland hydrology criteria, approved lists of hydric soil field indicators, and the emphasis given to quantitative methods of hydrologic analysis on lands managed for agriculture. Despite these differences, however, the two manuals describe very similar wetness conditions. Both manuals were intended to be applicable nationwide, and both offer some degree of regionalization, such as the use of regionalized plant lists.

Because the two manuals are so similar in their goals and approach, the remainder of this report will focus mainly on the Corps manual and issues related to the regionalization of its wetland delineation procedures. To that end, the discussion will consider wetland criteria and field indicators of each of the three required factors – hydric soils, wetland hydrology, and hydrophytic vegetation.

4 Wetland Delineation Criteria and Field Indicators

Wetland delineation practitioners have been accustomed to thinking in terms of a hierarchy of decision rules consisting of “criteria” and “field indicators” for each of the three wetland factors. Wetland criteria are technical definitions of each factor. They may or may not be directly observable in the field and may require long-term study or specialized training and equipment to evaluate at a particular site. Field indicators, on the other hand, are evidence observable to an investigator in the field that one or more criteria probably are met. Wetland delineation in most routine cases is based on field indicators.

The Corps manual makes no clear distinction between criteria and field indicators except for soils, and that was based on prior work by NRCS to develop a list of hydric soils for use by the FWS National Wetlands Inventory (Mausbach and Parker 2001). In addition to the criteria, there is also a technical definition of hydric soil developed by the National Technical Committee for Hydric Soils (NTCHS), an NRCS-led committee of academic and government scientists. Therefore, for hydric soils there are three levels of description – definition, criteria, and field indicators. The hydric soil definition and criteria that were current at the time were incorporated word-for-word into the 1987 Corps manual. Subsequent revisions to the hydric soil definition and criteria approved by the NTCHS have also been adopted by the Corps. In contrast, unregionalized hydric soil indicators given in the Corps manual have not been officially updated or revised since 1987.

For hydrophytic vegetation, the first indicator listed in the Corps manual has been called either the “basic rule” or the hydrophytic vegetation criterion. However, it is also the main indicator used in the field to make hydrophytic vegetation decisions. For wetland hydrology, no criterion is stated explicitly in the Corps manual. Rather, hydrology thresholds discussed in various parts of the manual have led to the “5-percent rule” given in Corps guidance (e.g., U.S. Army Corps of Engineers (1992)) and often called the Corps’ wetland hydrology criterion. The following sections summarize current wetland delineation criteria and field indicators, and identify issues to consider in regionalizing criteria and indicators for each factor.

A more general issue concerns the system of regions and subregions used to develop regional wetland guidance. Currently, at least two different systems of regions have been used by different agencies that provide supplemental information for wetland delineators. Regional lists of wetland plants developed by FWS (Reed 1988) are based on groupings of states rather than natural or ecological boundaries (see the section on "Regionalizing Hydrophytic Vegetation Criteria and Field Indicators"). In contrast, lists of hydric soil field indicators recently developed by NRCS and the NTCHS are grouped by USDA Land Resource Regions and Major Land Resource Areas (Soil Conservation Service 1981). Other potential regionalization options include at least two different ecoregion schemes (Bailey 1980, Omernik 1995), and a unified system of regions being considered by the Federal Geographic Data Committee. Therefore, an essential first step in regionalizing the Corps manual is to identify the most appropriate system of regions and to apply the same system to plants, soils, and all aspects of delineation guidance.

Hydric Soils

Definition

The NTCHS (Federal Register 59(133):35680-35681, July 13, 1994) defines hydric soils as "soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part." The definition makes it clear that NTCHS considers the development of anaerobic conditions, and not the presence of water per se, to be the critical factor in hydric soil development.

As was mentioned previously, the Corps/EPA wetland definition does not explicitly require the presence of hydric soils or anaerobic conditions, only that the area be "inundated or saturated by surface or ground water at a frequency and duration sufficient to support . . . a prevalence of vegetation typically adapted for life in saturated soil conditions." The Corps/EPA wetland definition could be interpreted to include areas that, despite being wet for extended periods, may not develop anaerobic conditions, such as areas where oxygenated groundwater discharges at the surface or where soils are in contact with flowing and oxygenated surface water. These environments might support hydrophytic vegetation but not develop hydric soil morphology. Regulatory practice in the Corps differs somewhat from District to District. However, current practice in most Districts is to follow the guidance given by the NTCHS and accept as hydric any soil that is inundated for at least 7 consecutive days during the growing season in most years (in accordance with hydric soil criteria 3 and 4 below) even if they lack hydric soil indicators, but not to accept soils that may be saturated by groundwater for long periods unless there is additional evidence of anaerobic conditions in the form of chemical tests or hydric soil morphology. This represents a change from previous practice, which also accepted as hydric any soil that conformed with hydric soil criterion 2 (i.e., soils with high water tables) even in the absence of indicators.

Criteria

Hydric soil criteria were originally devised as selection criteria to generate a national list of hydric soils from the NRCS database of Soil Interpretations Records (SIR) (Mausbach 1994, Mausbach and Parker 2001). Current hydric soil criteria are as follows (http://www.statlab.iastate.edu/soils/hydric/intro.html#DEF):

1. All Histels except Folistels and Histosols except Folists, or

2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, Pachic subgroups, or Cumulic subgroups that are:

    a. Somewhat poorly drained with a water table equal to 0.0 foot (ft) from the surface during the growing season, or

    b. Poorly drained or very poorly drained and have either:

        (1) Water table equal to 0.0 ft during the growing season if textures are coarse sand, sand, or fine sand in all layers within 20 in. (in), or for other soils

        (2) Water table at less than or equal to 0.5 ft from the surface during the growing season if permeability is equal to or greater than 6.0 in/hour (h) in all layers within 20 in, or

        (3) Water table at less than or equal to 1.0 ft from the surface during the growing season if permeability is less than 6.0 in/h in any layer within 20 in, or

3. Soils that are frequently ponded for long duration or very long duration during the growing season, or

4. Soils that are frequently flooded for long duration or very long duration during the growing season.

Hydric soil criteria were not originally intended to be used in identifying hydric soils in the field (Mausbach 1994, Mausbach and Parker 2001). However, they were often used for that purpose, particularly in problem wetland situations where hydric soil indicators may be absent or in cases of hydrologic alteration where soil morphology may not reflect the current hydrologic regime. Currently, NRCS uses criterion 2 solely as a database selection criterion and not as a field indicator (Federal Register 60(37):10349, February 24, 1995).

Criteria 1, 3, and 4, however, currently serve as both database criteria and hydric soil field indicators. Criterion 1 is repeated as the first indicator of hydric soils in the Corps manual (see below). Criteria 3 and 4, unlike most indicators, cannot be evaluated in a brief field visit without additional quantitative information about the long-term hydrology of the site.

The wording of criteria 3 and 4 is based on frequency and duration classes defined in the Soil Survey Manual (Soil Survey Division Staff 1993) and used in the SIR database. Thus, "frequent" is a class denoting inundation frequency of 50 times or more in 100 years. "Long" is a duration class extending from 7 to 30 days, and "very long" is the class extending 30 days or more. Although frequency and duration classes were used in hydric soil criteria to help generate a list of hydric soil series from the SIR database, quantitative thresholds suitable for field use were not specified. Lacking guidance to the contrary, wetland delineators have looked to the minimum thresholds for frequent and long duration inundation. Therefore, use of criteria 3 and 4 as field indicators has led to the concept that a soil is hydric if it is flooded or ponded for as little as 7 days during the growing season at least every other year.

Field indicators

Hydric soil field indicators are morphological or other evidence that a soil meets the hydric soil definition and criteria. Most hydric soil indicators are the result of chemical reduction of manganese (Mn), iron (Fe), or sulfur (S), or the accumulation of organic carbon (C), under anaerobic conditions (Vepraskas and Sprecher 1997).

Field indicators of hydric soils listed in the Corps manual were intended for nationwide use. No attempt was made to regionalize the indicators, although some soil situations addressed in the manual are more common in particular regions, such as dark soils (e.g., Mollisols) in the prairie region of the upper Midwest and sandy soils on the Atlantic and Gulf coastal plains. Indicators were listed in two groups, for nonsandy and sandy soils, as follows (Environmental Laboratory 1987, para. 44-45):

For nonsandy soils:

a. Organic soils (Histosols).

b. Histic epipedons.

c. Sulfidic material.

d. Aquic or peraquic moisture regime.

e. Reducing soil conditions.

f. Soil colors.

(1) Gleyed soils.

(2) Soils with bright mottles and/or low matrix chroma.

g. Soils appearing on hydric soils list.

h. Iron and manganese concretions.

For sandy soils:

a. High organic matter content in the surface horizon.

b. Streaking of subsurface horizons by organic matter.

c. Organic pans.

Within each group, the indicators were listed in presumed order of decreasing reliability. Hydric soil indicators in the Corps manual have never been officially updated or revised. However, current guidance given in interagency wetland delineation training courses (Regulatory IV) is to use caution in applying certain indicators that field experience has found to be unreliable, particularly *d*, *g*, and *h* for nonsandy soils and indicator *c* for sandy soils.

Building on pioneering work in Florida (Hurt and Brown 1995), NRCS, in cooperation with the NTCHS, has led an interagency effort to develop a regionalized list of hydric soil field indicators (Natural Resources Conservation Service 1998). The NTCHS indicators represent a refinement and expansion of the indicators given in the Corps manual, plus they contain a number of indicators specifically developed for problem soil situations, such as those identified in the manual. The NTCHS indicators are grouped into categories for All Soils, Sandy Soils, and Loamy and Clayey Soils, and are listed for use in specific USDA Land Resource Regions. NRCS uses the NTCHS indicators for wetland determinations done under the NFSAM, and Corps regulators may use them as supplemental information and in recognized problem soil situations. However, the Corps and EPA have not yet officially adopted the NTCHS indicators as replacements for those in the Corps manual.

The NTCHS is a committee of mainly NRCS and university soil scientists who are concerned with the technical issues of soil hydrology, chemistry, and morphology. It does not function as a policy-making body for the CWA regulatory program. Therefore, the Corps has been cautious in accepting NTCHS tools and recommendations without careful evaluation of their effects on the program and their usefulness to regulators. The Corps should maintain the right to accept some or all of NTCHS' recommendations, and to modify NTCHS tools as needed for regulatory use.

Corps regulatory personnel, even those with considerable soils training and experience, are divided about whether the NTCHS indicators should supersede those in the 1987 Corps manual. Criticisms of the NTCHS indicators in one or more Corps Districts include: (a) they are too complicated for use in routine delineations, (b) they are too restrictive and exclude obvious wetlands or portions of wetlands, (c) they reduce the role of vegetation in defining the wetland boundary, making wetland delineation too dependent upon hydric soil delineation, (d) they require increased training and experience to apply accurately, and (e) their quality varies from region to region. On the other hand, some regulators view the hydric soil indicators in the Corps manual as vague, ill- defined, out-of-date, and in some cases, technically wrong. Their continued use promotes inconsistency and the potential for abuse. The many caveats that must accompany the Corps indicators result in a proliferation of "problem" soil situations requiring separate guidance. Furthermore, the hydric soil indicators in the Corps manual are not regionalized.

Regionalizing hydric soil field indicators

To make hydric soil decisions more sensitive to local environmental conditions, regionalization should focus on hydric soil field indicators. There is value in having a consistent hydric soil definition for the entire nation. The current definition's central concept is that a hydric soil develops only under anaerobic conditions and not as a result of inundation or saturation alone. One potential shortcoming of the definition is that it excludes areas that may be inundated or saturated for long periods by oxygenated water. Such areas may otherwise satisfy the Corps/EPA and NRC wetland definitions. In addition, the hydric soil definition could be modified to reflect new information on soil chemistry and seasonal dynamics – for example, by eliminating reference to the growing season (see the section on "Wetland Hydrology").

The hydric soil criteria will continue to play a part in the development of hydric soil lists, but the lists themselves will become less and less relevant to the wetland delineator. Already, national and state hydric soil lists have been superseded by county or field office lists for the delineation practitioner. These provide valuable background information for a wetland determination, indicating where hydric soils and wetlands might exist on a tract, but onsite delineation of hydric soils already depends almost entirely on morphological indicators. Although there continues to be a need for procedures to identify hydric soils in the absence of indicators, or in the presence of misleading ones, it is time to sever all connection between the hydric soil criteria, which were designed for database manipulation, and field indicators by dropping hydric soil criteria from the Corps manual.

Hydric soil indicators listed in the Corps manual are more than 14 years old and no longer represent the state of the art. In some areas, such as in Florida where sandy soils are widespread, guidance for identification of hydric soils in the Corps manual is totally inadequate for the needs of the regulatory program. The quickest way to update the indicators, and simultaneously provide increased regional sensitivity, is to replace some or all of the hydric soil indicators in the Corps manual with the latest version of the NTCHS *Field Indicators of Hydric Soils in the United States* (Natural Resources Conservation Service 1998). If done, this should include many of the indicators designated for testing, if repeated field application since 1998 has demonstrated their reliability. Possible disadvantages of this action include wetland decisions that may be inconsistent with previous practice, and increased training requirements for regulatory personnel.

At the same time, however, there is a need to develop procedures for making hydric soil decisions in situations where indicators are lacking, or are misleading due to altered hydrology. An important characteristic of the NTCHS indicators is that they are designed to be "test positive." In other words, soils that exhibit one or more indicators are always hydric, but some hydric soils may not exhibit any indicators. For regulatory purposes, there must be alternative ways to accept soils as hydric in situations where other evidence points to the presence of wetlands but hydric soil morphological indicators are absent. This should include environments that meet the NRC and Corps/EPA definitions of wetlands but may not develop the anaerobic and reduced conditions necessary for hydric soil morphology. Decisions should be based on landscape position, hydrology, vegetation and other organisms, or a combination of factors, when hydric soil indicators are absent.

Soils are sometimes touted as the primary factor in the identification and delineation of wetlands (e.g., Hurt and Carlisle (2001)) because in many cases the hydric soil boundary defines the wetland boundary. Soils are particularly useful in identifying wetlands because, unlike vegetation, soils can usually be assessed accurately year-round, they are resistant to short-term change during drought cycles and other climatic variability, and they often are unaltered by human use of the land. Furthermore, when hydric soil indicators are present, they unambiguously reflect anaerobic and reduced soil conditions brought about by periodic waterlogging. However, the "test positive" nature of the NTCHS indicators means that some wetlands or their fringes will lack hydric soil indicators, creating confusion and controversy in jurisdictional decisions.

Even obvious wetlands may sometimes lack easily recognizable hydric soil indicators. For example, in some depressional and riverine backswamp wetlands, hydric soil indicators may be absent from the central portions of the wetland, which may have uniformly dark soils with organic matter masking any redoximorphic features. Hydric soil indicators (e.g., iron and manganese concentrations) are more prevalent at the edges of the wetland. This may be due to edge-focused discharge of groundwater (e.g., Richardson, Arndt, and Montgomery (2001)), more pronounced fluctuations of the water table, and/or less organic accumulation at the wetland edge. In such situations, landscape position dictates that the soil immediately downgradient of a recognizable hydric soil is also hydric even if it lacks obvious indicators. Other hydric soils that may lack indicators include recently deposited sediments, soils derived from strongly colored parent materials, saline and alkaline soils, soils with deep dark surface layers, soils with high shrink/swell capacity, and soils disturbed by human activities.

The NTCHS is developing Technical Standards for hydric soils intended for use in testing proposed hydric soil indicators. The draft standards are highly technical and require the simultaneous measurement of soil saturation (inferred from groundwater well or piezometer data), redox potential, presence of reduced iron, and pH over an extended period of "normal" precipitation. The standards are not designed nor are they appropriate for regulatory purposes, which require more rapid decisions. Therefore, if the NTCHS indicators are adopted for use with the Corps manual, practical procedures for making hydric soil decisions in problem cases must be developed at the same time.

One option that the NTCHS has considered in the past is the development of lists of "facultative" indicators of hydric soils (Mausbach and Parker 2001), which could be developed for each region. Like the facultative designation given to plants (Reed 1988), soils exhibiting one of these indicators are often, but not always, associated with wetlands. The current NTCHS list of hydric soil indicators (Natural Resources Conservation Service 1998) only gives "obligate" indicators. A list of facultative hydric soil indicators would be used in the presence of other strong evidence of wetlands (e.g., based on landscape position, hydrology, vegetation and/or other organisms) to identify wetlands that lack one of the obligate or test positive hydric soil indicators. However, even this step would not identify hydric soils that are completely lacking in hydromorphic features.

Although the NTCHS indicators represent the new state-of-the-art in identification of hydric soils, they are based mainly on field experience of soil scientists and are still largely untested. For example, sandy soil indicators for the Southeast have had a longer history of development and application than indicators developed for other regions, but research on their accuracy is still very limited. There is evidence that some of the new carbon-based sandy soil indicators may not correlate as well as expected with water-table data (Segal, Sprecher, and Watts 1995; Davis et al. 1996), and some indicators for sands may require longer periods of reduction than reflected in current hydric soil or wetland hydrology criteria (Kuehl, Comerford, and Brown 1997).

Long-term soils research can be expensive and time-consuming, but the financial implications of wetland regulatory decisions demand that soil indicators be tested for reliability. Therefore, simultaneous with the adoption of the NTCHS indicators, more research is needed to examine relationships between hydric soil indicators and water-table or redox measurements in all regions of the country, for both sandy and nonsandy soils, in all hydrogeomorphic wetland classes. This work should follow the model of the NRCS-led Wet Soils Monitoring Project that involves university researchers in more than eight states (Wakeley, Sprecher, and Lynn 1996). Some additional research and development topics dealing with soils are listed in Table 1.

Recommendations

The following are recommended steps to improve the regional sensitivity of hydric soil determinations using the Corps manual:

- Regionalization of hydric soil decisions should focus on *field indicators*, rather than the hydric soil definition and/or criteria. There is value in having a single hydric soil definition nationwide and the NTCHS is the appropriate body to develop and maintain that definition. However, one potential shortcoming of the current definition is its exclusion of oxygenated wet soils, which may exclude some areas that otherwise satisfy the Corps/EPA and NRC wetland definitions.

Table 1
Suggested Research Topics Aimed at Improving the Accuracy and Regional Specificity of Hydric Soil Determinations and Developing Tools and Guidance for Wetland Delineators

1. Determine relationships between the regional hydrogeomorphic (HGM) classification of a wetland and the kinds of hydric soil indicators present.

2. Develop and test lists of "facultative" hydric soil indicators that can be used to help identify wetlands in the absence of "test positive" hydric soil indicators.

3. Initiate additional regional studies to test the accuracy of NRCS hydric soil indicators in relation to soil hydrology and redox status.

4. Identify additional indicators that can be used to identify problematic hydric soils (e.g., those formed from recently deposited sediments, derived from strongly colored parent materials, saline and alkaline soils, soils with deep dark surface layers, soils with high shrink / swell capacities, and soils disturbed by human activities).

5. Identify features that can be used to distinguish contemporary from relict hydric soil indicators.

6. Develop methods to identify certain regional hydric soils that change color seasonally as they wet and dry, particularly when the color change overlaps hydric/nonhydric thresholds (e.g., from chroma 2 to chroma 3).

7. Identify indicators that can be used to recognize soils that are saturated for long periods but do not become chemically reduced (e.g., Griffin et al. (1996), Kuehl, Comerford, and Brown (1997)).

8. Determine the distribution and kinds of redoximorphic features in a soil profile associated with the presence and depth of the capillary fringe.

- Hydric soil criteria should be used only for their intended purpose: database manipulation and development of hydric soils lists by NRCS. Hydric soil criteria are no longer relevant to the identification of hydric soils in the field and could be dropped from the Corps manual. Ponding and flooding criteria should be retained as indicators of hydric soils.

- In accordance with the Corps/EPA regulatory definition of wetlands and NRC's technical definition, Corps regulators should be advised to accept as wetlands those areas that meet hydrophytic vegetation and wetland hydrology criteria but lack hydric (anaerobic) soils due to the input of oxygenated surface water or groundwater. This guidance would particularly clarify wetland delineation practice in arid regions (e.g., riverine systems with sand and gravel substrates) and improve the Corps manual's regional sensitivity.

- National hydric soil indicators given in the Corps manual no longer represent the state-of-the-art and should be replaced, at least in part, with the latest version of the NTCHS *Field Indicators of Hydric Soils in the United States*, which are keyed to particular Land Resource Regions. Guidance to Corps regulators should stress that the NTCHS field indicators are "test positive" and that some hydric soils may lack indicators. Indicators "e" (reducing conditions) and "f" (soil colors) in the Corps manual (para. 44) should be retained as guidance for identification of hydric soils that may lack an NTCHS indicator.

- Simultaneous with the adoption of the NTCHS field indicators, the Corps and EPA should develop practical procedures at the regional level for making wetland decisions in situations where hydric soil indicators are lacking, or are misleading due to altered hydrology. These procedures should emphasize landscape position and strong evidence of wetland hydrology, hydrophytic vegetation, and/or use by other water-dependent organisms.

- As part of the previous item, the Corps should support the development of regional lists of "facultative" hydric soil indicators that can be used, with additional information, to identify some wetlands in the absence of a "test positive" hydric soil indicator.

Wetland Hydrology

The Corps manual defines wetland hydrology as "the sum total of wetness characteristics in areas that are inundated or have saturated soils for a sufficient duration to support hydrophytic vegetation" (Environmental Laboratory (1987): Appendix A). Thus, wetland hydrology does not necessarily imply anaerobic conditions or hydric soils, although anaerobic and reducing conditions are recognized as a common consequence of prolonged inundation or saturation (Environmental Laboratory (1987): para. 46). The development of anaerobic conditions depends not only on soil wetness but also on temperature, availability of soil organic matter, and an active microbial community (e.g., Turner and Patrick 1968).

Criteria

As mentioned previously, the Corps manual does not explicitly state a wetland hydrology criterion. Instead, the manual relies mainly on field indicators that, when combined with evidence of hydric soils and hydrophytic vegetation, are used to identify wetlands and delineate their boundaries. The manual mentions that hydrologic records such as stream, lake, and tide gauge data may be used to help evaluate the hydrology of a site, but does not clearly provide the standards needed for a decision about the presence or absence of wetland hydrology based on the analysis of hydrologic measurements.

Current interpretations of the Corps' wetland hydrology "criteria" (e.g., U.S. Army Corps of Engineers (1991, 1992)) are based on information given in Table 5 of the Corps manual along with paragraphs 48, 49, and 55. Table 5 in the manual indicates that inland areas inundated or saturated for more than 12.5 percent of the growing season are always wetlands, whereas areas inundated or saturated for less than 5 percent of the growing season are not wetlands. Areas having intermediate conditions (i.e., inundated or saturated for 5 to 12.5 percent of the growing season) are sometimes wetlands and sometimes not, depending upon additional evidence of hydric soils and hydrophytic vegetation. Therefore, the 5-percent threshold has become the minimum standard for wetland hydrology under the Corps manual's three-factor approach. Simply stated, *an area has* *wetland hydrology if it is inundated or saturated to the surface continuously for at least 5 percent of the growing season in most years.* This criterion has several important components, some of which are particularly relevant to the regionalization of wetland delineation methods:

- Wetland hydrology can be due to inundation, saturation, or a combination of both.
- Saturation must be "to the surface," but includes the capillary fringe. The critical depth of soil saturation is within the major portion of the rooting zone of plants or within 12 in. of the surface.
- Inundation or saturation must occur during the growing season.
- The critical duration of continuous inundation or saturation is 5 percent of the growing season.
- The threshold frequency is at least every other year (i.e., 50 percent or greater probability in any particular year).

Growing season

The idea that inundation or saturation must occur during the "growing season" is incorporated not only into the Corps' wetland hydrology criterion but also into the hydric soil definition and hydric soil criteria. In addition, the different wetland hydrology criteria given in the NFSAM also refer to a growing season. For wetland delineation, the growing season is not based on the phenology of plants. Instead, it is based on the presumed activity period of soil microbes and might better be called the "microbial activity season" (Megonigal, Faulkner, and Patrick 1996). Microbial activity is the engine that causes waterlogged soils to become anaerobic and chemically reduced (Ponnamperuma 1972, Turner and Patrick 1968), resulting in the development of distinctive hydric soil morphology (Pickering and Veneman 1984, Vepraskas 1992) and putting stress on nonadapted plants (Whitlow and Harris 1979, Tiner 1991). The growing season has been defined as the period of year when soil temperature measured at 20 in. depth is above "biological zero" or 5 °C (Soil Conservation Service 1991). In the absence of soil temperature data, Corps guidance is to estimate growing season dates and durations based on the average occurrence of 28 °F air temperatures in spring and fall (U.S. Army Corps of Engineers 1992). The requirement that inundation or saturation occur during the growing season reflects the assumption that soil microbial activity becomes negligible below this temperature threshold. Therefore, saturation during the nongrowing season is not expected to result in soil anaerobiosis or reduction.

In the southeastern United States, the concept of the growing season has become less relevant to wetland scientists and delineators due to recent findings that soil temperatures in large portions of the Southeast rarely, if ever, drop below 5 °C (Griffin et al. 1996; Megonigal, Faulkner, and Patrick 1996). Thus, the microbial activity season and potential for soil chemical reduction in some regions occur year-round.

Elsewhere in the country, recent studies have shown that microbial populations are active, and unfrozen soils may become reduced at temperatures below 5 °C, although the duration of saturation required to produce anaerobic conditions may be longer and rates of anaerobic activity may be slower than in soils at higher temperatures (Dorland and Beauchamp 1991; Bell, Butler, and Thompson 1996; Ping, Clark, and Michaelson 1996). Microbial activity and soil chemical reduction do vary seasonally, apparently due to seasonal changes in both soil temperature and availability of water (Groffman and Tiedje 1989, Huddleston and Austin 1996).

Results of these studies and others suggest that it is inappropriate to think that anaerobic conditions and significant chemical reduction can only occur if soils become saturated during a specified growing season. Rather, it is more accurate to think of wet soils as having the potential to become anaerobic year-round, with the duration of saturation required to initiate anaerobic conditions varying seasonally in response to soil temperature and other factors (National Research Council 1995). Therefore, an important step in updating and regionalizing the wetland hydrology criteria in the Corps manual should be to drop the current requirement that inundation or saturation must occur during an arbitrarily defined growing season. Tiner (1999) pointed out that public perceptions of regulatory policy may also benefit from this change. In most of the northern portions of the United States, seasonal wetlands are wet for extended periods during winter and early spring, but the wet period may extend into the growing season by only a few weeks. Thus, most wetlands are actually inundated or saturated far longer each year than is implied by a regulatory policy that requires only 1-2 weeks of wetness "during the growing season."

Duration of inundation or saturation

Wetland hydrology criteria based on the Corps manual require continuous inundation or saturation for at least 5 percent of the growing season, based in part on the findings of a workshop of experts on southeastern floodplain forests (Clark and Benforado 1981) and generalized for the entire nation. Therefore, local thresholds for duration of inundation or saturation vary with latitude, altitude, and other factors that affect growing season length. In Florida, where the growing season is year-round, the required duration is slightly more than 18 days. In Fargo, North Dakota, with a 152-day growing season based on 28 °F air temperatures, the required duration is only 7.6 days. The required duration of waterlogged conditions in Alaska can be even shorter, and vanishes completely in areas where the growing season is undefined because soil temperature at 20 in. never exceeds 5 °C even when surface soils are thawed and plants are physiologically active. Thus, latitudinal differences in hydrology thresholds can be substantial and problematic under the Corps manual's criteria. Furthermore, if wetland hydrology criteria are supposed to be related to the initiation of anaerobic conditions in the soil, it is counterintuitive for the required duration of waterlogging to be longer in a warm climate than in a colder one.

In contrast to the Corps manual, the NFSAM uses wetland hydrology criteria based on fixed periods of inundation or saturation during the growing season (Soil Conservation Service 1994: §527.4), as follows:

1. *Inundation (flooding or ponding) occurs for 7 consecutive days or longer during the growing season in most years (50 percent chance or more); or*

2. *Saturation at or near the surface occurs for 14 consecutive days or longer during the growing season in most years (50 percent chance or more). Soils may be considered to be saturated to the surface when the water table is within:*

    a. *0.5 ft of the surface for coarse sand, sand or fine sandy soils; or*

    b. *1.0 ft of the surface for all other soils.*

Hydrology criteria given in the NFSAM have some advantages over those presented in the Corps manual. First, they avoid the pitfalls that result from a duration threshold based on a percentage of the growing season. Second, they provide more guidance on identifying groundwater-dominated wetlands. Third, they are more explicit and quantitative, making them more suitable for use with actual hydrologic data, such as those from groundwater wells and stream gauges. Disadvantages include their use of the growing season concept, and their lack of regional sensitivity. Despite their drawbacks, however, the Corps should consider adopting the NFSAM hydrology criteria as an interim step in the development of regionalized wetland hydrology criteria.

Regionalizing wetland hydrology criteria

Wetland hydrology criteria are used in wetland delineation only in the rare event that detailed hydrologic data, such as surface-water gauging records or water-table monitoring data, are available for a particular site. In the majority of cases, wetland hydrology determinations are based on indicators. However, hydrology criteria are particularly useful in disturbed or problem situations when only direct hydrologic measurements can resolve questions brought about by missing or misleading indicators (Warne and Wakeley 2000). Because the conditions required for wetland formation and maintenance vary regionally due to differences in climate, physiography, and plant distributions (National Research Council 1995), it is appropriate and necessary that wetland hydrology criteria be regionalized.

Therefore, after eliminating the growing season requirement, the next step needed to update wetland hydrology criteria in the Corps manual is to replace the current minimum duration of inundation or saturation (the 5-percent rule) with a varying requirement based on normal seasonal temperature changes within particular regions or locales. The new criteria should be based, at least in part, on the amount of time required for waterlogged soils to become anaerobic and significantly reduced under particular thermal conditions, but they should also consider saturation thresholds required to stress susceptible plants. Although many factors other than temperature also affect how quickly anaerobic conditions develop in waterlogged soils (National Research Council 1995), a simple system based on normal air temperatures should be adequate in the relatively rare event that direct hydrologic data must be used to evaluate wetland hydrology on a site for regulatory purposes.

In warm regions, such as the southern Pacific coast, Pacific islands, the Caribbean, and the southeastern states, regionalized wetland hydrology criteria based on the time lag between soil waterlogging and onset of anaerobic or reduced conditions at normal temperatures could result in relatively short periods of inundation or saturation being sufficient to satisfy hydrology criteria during the hot summer period. For example, Hudnall and Szogi (1996) found that some natural Louisiana soils became reduced almost immediately after heavy June or July rainfall, and laboratory studies using soil samples kept at elevated temperatures (e.g., Turner and Patrick (1968); Larson, Graetz, and Schaffer (1991)) indicate that waterlogged soils with high organic matter content can become significantly reduced only 2-3 days after flooding. It is not clear whether such brief exposure to anoxic and reduced soil conditions has any significant effect on vegetation, although 3-4 days of flooding reduces the rate of photosynthesis in seedlings of certain hardwood species (Gravatt and Kirby 1998). Thus, there is a need to consider the tolerances of plant species to flooding and soil saturation when developing duration criteria for wetland hydrology. Botanical studies at the individual and species levels also need to be supplemented with research at the community level, to determine hydrologic thresholds that produce significant changes in plant-community composition.

Field indicators

Even though hydrology is the driving force behind the development and maintenance of wetlands, hydrologic observations have a limited role in wetland delineation. This is because hydrology cannot be evaluated effectively in a brief site visit. Instead, wetland delineators focus on soil characteristics and vegetation composition to identify areas subject to prolonged inundation or soil saturation.

Soils and vegetation, however, are relatively stable and do not change quickly after a site is drained. The herbaceous layer may shift toward more upland species within a few years, but it may be many more years before the drained wetland fails to meet hydrophytic vegetation criteria. Furthermore, hydric soil features may persist for decades or more in drained wetlands. Therefore, the presence of hydric soils and hydrophytic vegetation alone provides little assurance that the site has not been drained. For the most part, wetland hydrology field indicators help to ensure that the site has been inundated or saturated *recently* and, therefore, provide some assurance that hydric soils and hydrophytic vegetation are not relict features.

The following field indicators of wetland hydrology are recognized in the Corps manual in the absence of recorded hydrologic data (para. 49):

1. *Visual observation of inundation.*

2. *Visual observation of soil saturation.*

3. *Watermarks.*

4. *Drift lines.*

5. *Sediment deposits.*

6. *Drainage patterns in wetlands.*

Field personnel must be careful in applying these indicators because some of them (e.g., water marks, drift lines) can be created during unusual or low-frequency flood events.

The following indicators were added in 1992 to the official field data form for routine wetland determinations (U.S. Army Corps of Engineers 1992):

7. *Oxidized root channels in the upper 12 in.*

8. *Water-stained leaves.*

9. *Local soil survey data.*

10. *FAC-neutral test.*

Current policy requires that at least one indicator from the first list or two indicators from the second list must be present to conclude that wetland hydrology is present. However, the site is a wetland only if hydric soils and hydrophytic vegetation are also present.

Five out of six of the hydrology indicators given in the Corps manual (first list) are formed only when surface waters inundate a site. Only indicator *2* (visual observation of soil saturation) is useful for identifying groundwater-dominated wetland systems. However, use of indicator *2* requires that the investigator be present during the period of the year when the water table is high. In seasonal wetlands, falling water tables during drier periods mean that the indicator may be absent for much of the year, making wetland determinations problematic. The problem is compounded in drought years when water tables may never penetrate the root zone during the growing season. One reason for the development of the second list (indicators *7 – 10*) was to provide regulators with additional tools with which to evaluate groundwater-dominated systems. Oxidized root channels, in particular, are a well-documented response of certain plant species to anaerobic soil conditions (Mendelssohn, Kleiss, and Wakeley 1995) and would be appropriate as a stand-alone indicator of wetland hydrology.

Regionalizing wetland hydrology field indicators

Hydrology indicators listed in the Corps manual and subsequent guidance were intended to be applicable nationwide. However, regionalization of the indicators is essential due to the tremendous variability in climate, landforms, geology, hydrology, soils, vegetation, and animal communities across the country (National Research Council 1995). Recommendations for regionalizing the wetland hydrology indicators need to come from local wetland scientists and agency representatives. Corps Headquarters should facilitate this process by establishing a procedure similar to that used by the FWS to propose changes to the plant lists. Regional panels, consisting of Corps District, other Federal and state agency, and university scientists, would develop proposed lists of regional hydrology indicators. These lists would then be reviewed and approved by a national panel. The regional panels would meet every few years to review and update the lists.

A number of potential wetland hydrology indicators, in addition to those given in the Corps manual and subsequent guidance, should be reviewed by the regional panels for applicability in each region or subregion. Hydrology indicators should reflect, to the extent possible, *current or very recent past* inundation or soil saturation and, thus, should indicate a continuing wetland hydrologic regime. Soils and vegetation are reliable indicators of long-term hydrology (National Research Council 1995). Therefore, hydrology indicators are only needed to provide evidence that an area is continuing to function as a wetland and has not been drained. The following list of potential wetland hydrology indicators was derived from previous Federal delineation manuals, various state manuals (Tiner 1999), and personal experience, and should be considered by the regional teams:

1. *Algal mats and crusts.*

2. *Remains of aquatic plants.*

3. *Moss and lichen lines.*

4. *Aquatic fauna such as aquatic snail and clam shells.*

5. *Presence of muck or mucky mineral material at the soil surface.*

6. *Sulfidic odor in the upper 12 in. of soil.*

7. *Positive reaction to the ferrous iron test in the upper 12 in.*

8. *Soil that changes color upon exposure to air.*

9. *Regional dimensionless rating curves.*

10. *Surface morphology (e.g., cracking, polygons).*

11. Certain landforms, such as depressions in a flat landscape.

12. Absence of hydrologic modifications in the wetland's immediate watershed or to the wetland's primary water source(s).

The first four potential indicators listed above are biotic evidence of recent and/or continuing inundation or soil saturation. These indicators are independent of vegetation composition, which is considered in the hydrophytic vegetation decision, and do not include plant morphological adaptations that may persist long after drainage. Algae require surface water; thus, their presence as crusts or stranded detritus indicate recent inundation. Algal crusts have also proved useful in delineating the edges of playas in the Southwest when coupled with certain types of mudcrack polygons (Brostoff, Lichvar, and Sprecher 2001). Aquatic plants include submersed and floating-leaf species that only live in standing water; their presence, as dead plants or detritus, indicates recent prior inundation. Aquatic mosses and lichens on tree trunks or other objects may indicate recent or typical high water levels. Remains of aquatic fauna have also proven useful in identifying some wetlands during dry periods (e.g., Euliss, Mushet, and Johnson 2001) although such remains can also be transported with fill or dredged material to upland sites.

In warm climates, thin organic layers or films (indicator *5*) can persist only if oxidation of organic matter is retarded by frequent and prolonged saturation. Therefore, thin muck layers, particularly in the Southeast or south Pacific regions, indicate ongoing wetland hydrology. Indicators *6-8* reflect saturated or near-saturated soil conditions at the time of sampling. Sulfidic material (H_2S) and ferrous iron (FeII) are only present in soils while they are saturated and reduced; they are generally absent from oxidized upland soils and from hydric soils during dry periods. Similarly, soils that rapidly change color upon exposure to air (keeping moisture content constant) indicate that ferrous iron was present in the undisturbed horizon; the color change results from the rapid oxidation of FeII to FeIII in the presence of atmospheric oxygen. Indicators *6-8* are often associated with a high water table and, thus, may not provide any additional information. However, they may also be associated with the tension-saturated zone above the water table and reflect current near-surface reducing conditions.

Regional dimensionless rating curves (Dunne and Leopold 1978) have been used to estimate flood frequencies on surfaces adjacent to stream channels and, thus, may be useful wetland hydrology indicators in floodplains of ungauged streams (indicator *9*). The curves express the relationship between the ratio of channel-full discharge to bank-full discharge and the ratio of channel-full depth to bank-full depth, and are developed in advance for all streams in a region. Their use at a particular site requires knowledge of the drainage area above the site and the average cross-sectional depth of the stream.[1]

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[1] Personal Communication, 20 August 1999, Bruce A. Pruitt, U.S. Environmental Protection Agency, Atlanta, GA.

Various surface phenomena, such as cracking and polygons (indicator *10*), reflect recent inundation in some systems (e.g., in playas; Brostoff, Lichvar, and Sprecher (2001)) and may be useful regional hydrology indicators. Indicator *11* acknowledges that certain landforms accumulate surface runoff or are focal points for groundwater discharge. In some regions, the landform itself may be sufficient evidence of wetland hydrology. Finally, in relatively unaltered landscapes, the absence of recent hydrologic modifications (e.g., dams, levees, ditches, surface contouring, significant vegetation modification, extensive soil disturbance) (indicator *12*) may be sufficient evidence for the continuation of the historic wetland hydrologic regime, as reflected in the soils and vegetation. However, this last indicator would not be useful in most urban, suburban, or agricultural areas where hydrologic modification is often subtle and pervasive (Richardson, Arndt, and Montgomery 2001).

Correct interpretation of hydrologic data or field indicators for a particular site often requires information about antecedent rainfall in relation to "normal" precipitation levels (Natural Resources Conservation Service 1997). To determine whether precipitation has been normal, recent precipitation inputs are compared with the frequency distribution of precipitation amounts based on long-term records at National Weather Service stations near a site (Sprecher and Warne 2000). Current regulatory practice is to use the 30th and 70th percentiles of monthly precipitation totals to determine whether actual measured rainfall was below normal, normal, or above normal for the site, and tables for this purpose are available over the Internet from the NRCS National Water and Climate Center (www.wcc.nrcs.usda.gov/water/wetlands.html). Sprecher and Warne (2000) discuss the advantages and disadvantages of various existing methods for evaluating precipitation data. Most methods include assumptions or arbitrary decision thresholds that may or may not be appropriate for a particular location or application. Analytical procedures appropriate in the humid eastern part of the United States may be unreliable when applied to regions having much less frequent and more variable rainfall. Therefore, there is a need for research into the best methods to use for evaluating antecedent precipitation in each region. Table 2 is a complete list of suggested research topics related to wetland hydrology.

Recommendations

The following are recommended steps to improve the regional sensitivity of wetland hydrology criteria and indicators in the Corps manual:

- Due to the increasing use of direct hydrologic measurements (e.g., groundwater well data) to evaluate the presence of wetlands in disturbed or problematic situations, there is a need to develop unambiguous technical standards for wetland hydrology based on water-table depth, duration, and timing during the monitoring period. The standards should take into account the normality of precipitation and temperatures before and during monitoring. Technical standards should be developed regionally, and could be in addition to the general wetland hydrology criteria given in the manual.

Table 2
Suggested Research Topics Aimed at Improving the Accuracy and Regional Specificity of Wetland Hydrology Criteria and Indicators

- Determine the duration of saturation that is needed to produce (1) anaerobic and (2) chemically reduced conditions in soils of different regions, taking into consideration seasonal climatic variations, hydrogeomorphic wetland types, soil types, and other factors.
- Determine regional and seasonal variations in duration of saturation required to stress non-adapted plants and affect the composition of plant communities.
- In each region, identify plant species or associations that are always associated with the presence of wetland hydrology, and those that are never associated with wetlands.
- Identify new indicators of wetland hydrology that are useful in groundwater-dominated systems and in drier-end wetlands of transition zones.
- Identify reliable indicators of effectively drained wetlands.
- Identify the most reliable techniques for evaluating antecedent precipitation in different regions with different climates and rainfall patterns, to evaluate whether wetland hydrologic observations at a site were made during periods of "normal" precipitation.

- Hydrology criteria in the Corps manual should be revised by dropping the requirement that inundation or saturation occur during an arbitrary growing season. This action should be accompanied by a change (generally an increase) in the required duration of inundation or saturation, taking into account regional climatic variation.

- Due to their practical advantages over those given in the Corps manual, the Corps of Engineers should consider adopting the NFSAM hydrology criteria as an interim step in the development of regionalized wetland hydrology criteria.

- The minimum required duration of inundation or saturation should vary seasonally, with longer duration required during colder portions of the year and shorter duration required during warmer periods. Regionalization of wetland hydrology criteria should be based on typical time lags between soil saturation, anaerobiosis, and chemical reduction in relation to normal seasonal temperatures, and the effects of prolonged inundation or saturation on vegetation. There is an immediate need for research to aid in the development of appropriate hydrologic standards for each region.

- The Corps should develop regionalized lists of wetland hydrology field indicators. Corps Headquarters should facilitate this process by establishing regional panels, consisting of technical experts from Corps Districts, other Federal and state agencies, and universities who would be tasked with developing proposed lists of indicators. Proposed indicators would be reviewed by a national panel and recommended to Headquarters for adoption. The regional panels would meet every few years to review and update the lists.

Hydrophytic Vegetation

The Corps manual defines hydrophytic vegetation as "the sum total of macrophytic plant life growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content" (Environmental Laboratory 1987: Appendix A) and further states that inundation or soil saturation must "exert a controlling influence on the plant species present" (para. 29). Thus, a hydrophytic vegetation determination is made by evaluating the species composition of the plant community present on a site.

A critical component of the procedure for making hydrophytic vegetation decisions is the system for assigning each plant species a wetland indicator status (Reed 1988). The wetland indicator status is an estimate of a plant species' frequency of occurrence in wetlands, and is assigned by a regional plant list panel comprised of botanists and wetland scientists from the cooperating Federal agencies. The assignment is based on habitat information given in local floras and handbooks, other technical data (e.g., scientific journals), and the personal experience of panel members. Based on the weight of technical evidence, each plant species is assigned one of five indicator status categories: obligate (OBL) if the estimated frequency of occurrence in wetlands under natural conditions is more than 99 percent, facultative wetland (FACW) if the frequency of occurrence is between 67 and 99 percent, facultative (FAC) if between 34 and 66 percent, facultative upland (FACU) if between 1 and 33 percent, and upland (UPL) if less than 1 percent.

Criteria

As mentioned previously, the Corps manual lists several indicators of hydrophytic vegetation without stating a hydrophytic vegetation criterion. However, the first indicator is the one most commonly used and is sometimes called the "basic rule" or the Corps' hydrophytic vegetation criterion. It states that more than 50 percent of the dominant species in the community must be OBL, FACW, or FAC (Environmental Laboratory 1987, para. 35a). FAC-minus (FAC−) species do not count in this tally; instead they are counted among the FACU and UPL plants. The rule is designed to be used by investigators who may not be able to identify every plant species that occurs on a site. Therefore, the determination is based on *dominant* species that are selected from each of the vegetation layers or strata that are present (i.e., tree, sapling/shrub, herb, and woody vine strata).

The procedure for selecting dominant species from each stratum has evolved over time. The Corps manual specifies that the three most abundant plant species in each stratum, or the five most abundant species in each stratum if only one or two strata are present, be considered dominants. (In routine cases, relative abundance of species is estimated visually based on standard measures, such as basal area of trees and percent cover of herbs.) However, since 1992 (U.S. Army Corps of Engineers 1992) Corps regulators have been allowed to select dominant species based on the "50/20 rule":

. . . dominant species are the most abundant plant species (when ranked in descending order of abundance and cumulatively totaled) that immediately exceed 50 percent of the total dominance measure for the stratum, plus any additional species comprising 20 percent or more of the total dominance measure for the stratum.

Despite its apparent complexity, the 50/20 rule is actually very easy to apply in practice, and provides a more flexible and ecologically justifiable selection of dominants than the rigid quotas specified in the Corps manual.

After combining the lists of dominant species across all strata, the final step in evaluating whether a plant community is hydrophytic is to look up the wetland indicator status of each species in Reed (1988) and determine whether or not more than 50 percent of dominant species are rated OBL, FACW, or FAC.

There are other ways to evaluate whether a plant community is hydrophytic that are more quantitative and have stronger theoretical foundations than the basic rule given in the Corps manual. One option is the "weighted average" method (Wentworth, Johnson, and Kologiski 1988), also called the "prevalence index." The prevalence index is a weighted average wetland indicator status for *all* species in a sample from the plant community, not just a subset of dominants. To calculate the prevalence index, indicator status categories are assigned numerical ratings (i.e., OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5) and weights are relative abundances of each species in the community. Generally, a plant community is considered to be hydrophytic if the prevalence index is less than 3.0.

The Corps manual's basic rule and the prevalence index are different approaches to the identification of hydrophytic vegetation and their results do not necessarily agree. In one study, hydrophytic vegetation decisions based on the Corps manual and the prevalence index disagreed in about 20 percent of actual and simulated cases (Wakeley and Lichvar 1997). There is some evidence that hydrophytic vegetation decisions based on the prevalence index agree more closely with hydric soil determinations done at the same locations than do vegetation decisions based on the Corps manual's basic rule (e.g., Davis et al. [1996] in Florida, and Wakeley, Sprecher, and Lichvar [1996] in Hawaiian rain forest), but the issue requires further study in other regions and wetland types.

A hydrophytic vegetation criterion based on the prevalence index may be superior both theoretically and practically to one based on dominant species. First, it would take into account the entire plant community, not just a few dominants. Second, its stronger correlation with hydric soils, which should be verified in each region, would make it particularly useful in problematic soil situations as the main indicator of the wetland boundary. Any new hydrophytic vegetation criterion based on the prevalence index would have to specify a seasonal window corresponding to the wet portion of the growing season in a normal rainfall year, and sampling guidance should specify that it be calculated from coverage estimates for each species made on sample plots such as those described in the Corps manual (e.g., Wakeley and Lichvar 1997). Despite its apparent technical advantages, determining the prevalence index can be complicated and seasonally restrictive, and would require greater botanical expertise than is typical among Corps regulators. Therefore, the "basic rule" should remain the primary field indicator of hydrophytic vegetation for routine wetland determinations (as it is presented in the Corps manual) rather than a "criterion" for hydrophytic vegetation.

Other field indicators

The manual lists five "other indicators" of hydrophytic vegetation that are much less often used than the basic rule. Mostly they are designed to provide additional information to "strengthen a case for the presence of hydrophytic vegetation" (Environmental Laboratory 1987, para. 35(b)). The five indicators are:

1. *Visual observation of plant species growing in areas of prolonged inundation and/or soil saturation.*

2. *Morphological adaptations.*

3. *Technical literature.*

4. *Physiological adaptations.*

5. *Reproductive adaptations.*

The first indicator is intended to be used only when there is well-documented evidence that certain plant species in the local area commonly grow in areas with frequent, prolonged inundation or soil saturation. This indicator could be used to accept a community dominated by FACU species as hydrophytic if there were sufficient documentation that the species commonly occur in very wet situations in that region. Morphological adaptations (e.g., buttressed tree bases, pneumatophores, adventitious roots, shallow root systems [Tiner 1999]) can be used to make or support the hydrophytic vegetation decision if most individuals of at least two dominant species on the site exhibit such adaptations (Environmental Laboratory 1987: para. 70, Step 13b; U.S. Army Corps of Engineers 1992). Available sources of technical literature are used by the plant list panels in assigning a wetland indicator status to a plant species. However, more recent literature might be used to support a hydrophytic vegetation decision. Finally, physiological and reproductive adaptations for life in wetlands generally are not observable in the field, but recent technical literature may provide evidence of such adaptations.

Regionalizing hydrophytic vegetation criteria and indicators

There seems to be little need to develop regionalized hydrophytic vegetation criteria, whether based on the prevalence index or on dominant species. Both approaches are logical ways to evaluate whether a site has "a prevalence of vegetation typically adapted for life in saturated soil conditions."

Instead, to provide regional sensitivity to hydrophytic vegetation decisions, effort should focus on (1) developing a new system of plant list regions based on natural boundaries rather than political ones, and (2) assigning the correct wetland indicator status to each plant species in a region or subregion based purely on technical considerations. Current regulatory practice is based on Reed's (1988) plant list, which recognizes 13 regions including 10 regions within the contiguous states, plus Alaska, Hawaii, and the Caribbean. Plant list regions are derived by grouping states and, thus, are based on political boundaries rather than ecological ones. Current plant list regions are also very large and incorporate a great deal of internal variability in climate, geology, landforms, and responses of plants to wetness conditions. A more technically sound system of plant regions would be based on natural boundaries, such as ecoregions (Bailey 1980, Omernik 1995) or land resource regions (Soil Conservation Service 1981). To be efficient for wetland delineation practitioners, plant lists and lists of hydric soil and wetland hydrology field indicators must use the same system of regions and subregions.

Recently, some of the regional plant list panels have proposed to subdivide their regions based on natural internal boundaries and to assign indicator statuses by subregion. However, these proposals have not yet been accepted by the Corps or EPA for Section 404 purposes. A better approach may be to do away with the 13 existing plant list regions altogether and develop a new national system of smaller regions delineated on the basis of ecological boundaries.

In the past, assignment of the wetland indicator status to a plant species has often been based on the experience and best professional judgment of plant list panelists working with limited technical data. In the future, regional plant lists should be revised based on quantitative analyses of plant distributions across landscapes and/or laboratory studies of the physiological responses of plants to inundation or shallow water tables (e.g., Spencer 1994). Additional research is needed in each region to identify and verify the assigned indicator status of problematic plant species (Table 3).

Table 3
Suggested Research Topics Aimed at Improving the Accuracy and Regional Specificity of Hydrophytic Vegetation Determinations

- Develop sampling guidance and a quantitative approach for testing and refining the wetland indicator status of plant species based on plant distributions across landscapes.
- Develop objective procedures for assigning wetland indicator status based on physiological responses to soil waterlogging (e.g., Spencer (1994)).
- Compare and contrast hydrophytic vegetation determinations based on plot-based prevalence indices and dominant species in typical wetland situations in each region, focusing on each procedure's ability to identify the wetland edge.
- Particularly in problematic areas, initiate detailed studies of vegetation changes along wetland-to-upland gradients to help refine wetland indicator status of plant species and to improve the agreement among indicators of hydrophytic vegetation, hydric soils, and wetland hydrology (e.g., Davis et al. (1996)).
- Explore the potential of using individual plant species as indicators of the wetland boundary in each region.

In the West, the presence of halophytes (i.e., plants tolerant of saline conditions) and phreatophytes (i.e., plants whose roots extend downward to a deep water table or to the capillary fringe above it), often with FACW indicator status, can make wetland delineation in arid areas more difficult and controversial. For example, iodine bush (*Allenrolfea occidentalis*) is a dominant species on playas at Dugway Proving Ground, Utah. On hard playas, it is associated with intermittently ponded areas and its FACW indicator status seems appropriate. But on soft playas and mounds it is a phreatophyte occupying areas with water tables apparently well below wetland jurisdictional depth (Lichvar, Sprecher, and Wakeley 1995; Brostoff, Lichvar, and Sprecher 2001). Near the Salton Sea in California, iodine bush is also widespread in areas with seasonal high water tables more than 2 ft deep (personal observation). Where iodine bush occurs as a phreatophyte, its FACW indicator status is misleading. A potential solution to this problem, and others like it, may be to assign the indicator status of certain plant species in the West based in part on the type of landform they occupy.

Recommendations

The following are recommended steps to improve the regional sensitivity of hydrophytic vegetation decisions under the Corps manual:

- The Corps should consider adopting a hydrophytic vegetation criterion based on a wet-season, plot-based prevalence index, rather than on dominant species. Advantages of the prevalence index include its consideration of all species in a community, rather than just a few dominants, and its apparent better correlation with hydric soils. However, the "basic rule" should remain the primary field indicator of hydrophytic vegetation in routine situations. Before adopting a particular criterion, additional research is needed to test appropriate decision thresholds for the prevalence index, taking into account its relationship with hydric soils in each region.

- Regionalization of hydrophytic vegetation determinations should focus on assigning a technically correct wetland indicator status to each plant species in a region or subregion, independent of social and political considerations. To that end, the Corps should move to adopt recent proposed revisions to the 1988 wetland plant lists as an interim step in development of new plant list regions.

- Current plant list regions used by FWS, which are based on political boundaries, should be dropped in favor of smaller regions based on ecological boundaries. The same system (e.g., ecoregions, land resource regions) should also be used for regionalization of hydric soil and wetland hydrology indicators.

- In the arid western United States, consideration should be given to assigning the indicator status of certain halophytes and phreatophytes by the landform on which they occur (e.g., hard playa, soft playa, river terrace, etc.).

5 Problem Area Wetlands

Background

The Problem Areas section of the Corps manual (Section G) describes the following four examples of "wetland types in which wetland indicators of one or more parameters may be periodically lacking due to normal seasonal or annual variations in environmental conditions that result from causes other than human activities or catastrophic natural events" (para. 77, emphasis in the original text).

- Wetlands on drumlins.
- Seasonal wetlands.
- Prairie potholes.
- Vegetated flats.

These examples of problem situations include at least three that are aimed at wetland delineators in particular regions. "Wetlands on drumlins" describes slope wetlands on till that occur commonly in the glaciated portions of the northern United States, including Alaska. They are a problem mainly due to the unusual landscape position and seasonal hydrology. "Seasonal wetlands" discusses the difficulties associated with identifying many seasonal wetlands during the dry season, but focuses on depressional wetlands in the western United States. These wetlands are dominated by OBL, FACW, and FAC species during the winter and early spring wet period, but may be invaded by FACU and UPL annuals during drier periods. At those times, they may fail the hydrophytic vegetation basic rule. Accurately identifying the boundaries of "prairie potholes" is a problem for wetland delineators in the glaciated northcentral region, due to plant-community changes during long-term wet/dry cycles and to the deep, dark prairie soils. The final problem wetland situation, "vegetated flats," occurs sporadically nationwide and is not restricted to a particular region. Vegetated flats are wetlands that support annual or non-persistent plant species, and may be mistaken for unvegetated mud flats during the non-growing season.

The Corps manual acknowledges that there are other wetland situations that may be problematic. The manual calls these four cases "Representative examples of potential problem areas" and notes that "Similar situations may sometimes occur in other wetland types" (para. 78).

Other sections of the Corps manual identify a number of problematic soil situations that are appropriately dealt with using Problem Area guidance. These include:

- *Dark (black) mineral hydric soils (para. 44f(2), note).*
- *Soils with significant coloration due to the nature of the parent material (e.g., red soils . . .) (para. 44f(2), caution.)*
- *Recently deposited sandy material (para. 45, caution).*
- *Organic pans (para. 45c).*
- *Man-induced wetlands (para. 76).*

Although some of these problematic soil situations occur nationwide, most are focused in particular regions. For example, soils with deep, dark A-horizons (e.g., Mollisols) are most prevalent in the former prairies of the upper Midwest, but also occur less frequently elsewhere. These soils are problematic because accumulated organic matter can mask any redoximorphic features that may be present. Red soils have a patchy distribution and are often formed of weathered red Triassic and Jurassic sandstones and shales, such as those along the eastern Rockies. Highly weathered soils (e.g., the Ultisols of the Southeast and Oxisols of tropical climates) are also often strongly red colored (Tiner 1999). Soils that are red because of the base color of mineral grains may not, or may very slowly, develop the grayish colors usually associated with hydric soils. Other soils that may have significant coloration due to parent materials include gray soils derived from lacustrine and marine sediments, glacial outwash, and volcanic ash. Such soils in upland positions could be mistaken for hydric soils.

Sandy soils are a particular problem for wetland delineators in Florida and along the Gulf Coast. Sands often lack sufficient iron to form typical redoximorphic features. Spodosols (i.e., soils with "organic pans" or spodic horizons) are also common in that region as well as in evergreen forested areas of the Northeast. Hydric Spodosols are often sandy and may lack iron-based indicators. Furthermore, the leached E-horizons of upland Spodosols can be mistaken for hydric soil features.

Developing more reliable hydric soil indicators for these problem soil situations has been a priority for the NRCS and NTCHS. The latest version of the NTCHS field indicators (Natural Resources Conservation Service 1998) contains 14 new regional indicators for problem soil types, plus an additional 10 designated for testing.

A previous delineation manual (Federal Interagency Committee for Wetland Delineation 1989) gave the following somewhat expanded list of problem area wetlands, including many of those mentioned previously:

- Wetlands dominated by FACU plant species.
- Evergreen forested wetlands.
- Wetlands on glacial till.
- Highly variable seasonal wetlands.
- Interdunal swale wetlands.
- Vegetated river bars and adjacent flats.
- Vegetated flats.
- Caprock limestone wetlands.
- Newly created wetlands.
- Entisols (floodplain and sandy soils).
- Red parent material soils.
- Spodosols (evergreen forest soils).
- Mollisols (prairie and steppe soils).

This list includes at least three regionally significant problems, besides those discussed above. Evergreen forested wetlands are common in the Northeast and Northwest. Some of these wetlands are dominated by FACU species such as eastern hemlock (*Tsuga canadensis*), eastern white pine (*Pinus strobus*), and western hemlock (*T. heterophylla*) despite clearly hydric soils (often Histosols) and prolonged saturation during the growing season (Tiner 1999). Interdunal swales are common along the coasts and are problematic mainly due to sandy soils and often seasonal hydrology. Caprock limestone wetlands are found in south Florida and consist of vegetated limestone outcrops with very little soil development.

Experience of wetland regulators and scientists over more than a decade since the publication of the Corps manual has pointed out additional regionally significant wetland situations that are problematic due to lacking or misleading indicators. Most cases involve hard-to-interpret soils. Examples of potential problem areas not mentioned in previous delineation manuals include:

- Wetlands on clay-rich soils (e.g., Vertisols).
- Wetlands with perched water tables .
- Wetlands on saline or alkaline soils.
- Wetlands in areas dominated by Folists and Folistels.
- Irrigated wetlands.

Vertisols and other soils with high content of montmorillonite clays have high shrink/swell capacities. Vertic soils are particularly common in the Mississippi Alluvial Valley and parts of eastern Texas. They are problematic because of dark colors and soil churning that destroys redoximorphic features. Furthermore, most hydric Vertisols have surface hydrology, which leaves little evidence in the soil profile and makes it difficult to identify hydric units during periods of the year when soils are not ponded (Tiner 1999).

Like Vertisols, other soils may perch water over relatively impermeable layers near the soil surface. These may have hydric soil colors only in a thin surface layer over brownish subsoils that appear to be nonhydric. Examples of perched or "episaturated" systems include vernal pools in California and some slope wetlands in glacial landscapes.

In arid regions, groundwater-discharge wetlands may accumulate salts, such as carbonates and gypsum, that affect vegetation development, microbial activity, and soil pH (Tiner 1999, Boettinger and Richardson 2001). Even soils that are saturated for long periods may not develop typical redoximorphic features due to limited inputs of organic matter to serve as an electron donor, reduced microbial activity due to limited organic matter and high salt content, and very low redox potentials required to reduce iron and manganese under high-pH conditions.

Folists and Folistels are nonhydric Histosols that are relatively uncommon in the 48 contiguous United States but are widespread in Hawaii and Alaska. In Hawaii, Folists exist as thin organic layers over lava rock. Wakeley, Sprecher, and Lichvar (1996) described the problems involved in delineating depressional wetlands on undulating lava surfaces due, in part, to difficulties in distinguishing hydric and nonhydric Histosols without chemical tests or redox electrodes.

Some areas in the arid and semiarid West have been subject to intensive, long-term irrigation or irrigation overflow that has created wetlands in areas where they did not exist previously. Near Reno and Carson City, NV, for example, obvious hydrophytic vegetation and hydric soil morphology now exist in areas formerly dominated by sagebrush (*Artemisia tridentata*) and other upland communities. These areas are wetlands in every technical sense, but they revert to uplands when the irrigation is stopped. Intensively irrigated areas are problematic because of the difficulties in distinguishing natural from irrigation-induced wetlands, which may be exempt from regulation under the Clean Water Act.

An additional jurisdictional problem in the West is the identification and delineation of non-wetland "waters of the United States" in areas such as playas, streams, and ephemeral washes. Corps regulations (33 CFR 328.4) define the limits of Clean Water Act jurisdiction in non-tidal waters, in the absence of adjacent wetlands, as the ordinary high water mark (OHWM), defined as "that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means . . . ." In the past, different interpretations of this definition have led to inconsistent jurisdictional determinations, particularly across District boundaries. There is an effort underway in the western Corps Districts to develop unified guidance on identification of the OHWM with the potential for developing ecoregion-based OHWM criteria. This effort deserves continued Headquarters support with the goal of developing a regionalized manual for the identification of non-wetland waters of the United States.

Recommendations

Any effort to regionalize the Corps manual should include revisions to the "Problem Areas" section to provide additional examples and more detailed guidance for delineating problematic wetland types in each region, and to drop examples that are no longer significant problems due to the development of new tools (e.g., hydric soil indicators) to deal with them. The following recommendations are aimed at making the Corps manual a more comprehensive source of regional guidance for dealing with problematic wetland types:

- Updated lists of problematic wetland types in each region should be developed by local teams of agency scientists and other wetland delineation experts, perhaps by the same panels recommended previously for development of regionalized wetland hydrology indicators.

- Problem area guidance should be reviewed and updated regularly so that new technology can be disseminated rapidly and important information gaps can be identified for further research.

- The Corps should continue current efforts by western Districts to develop consistent guidance for identification of the ordinary high water mark, with the eventual goal of developing a regionalized manual for delineating non-wetland "waters of the United States," such as playas and riparian systems.

6 Conclusions

This report identifies a number of ways that the regional sensitivity of the Corps manual could be improved, and more reliable and regionally focused wetland delineation guidance provided to Regulatory staff. Some of the recommendations made herein could be implemented quickly through supplemental guidance without altering the basic concepts or criteria given in the Corps manual (e.g., developing regionalized lists of wetland hydrology field indicators, and expanding the list of examples given in the “Problem Areas” section). Other recommendations would involve more fundamental changes, including a reevaluation of the manual’s wetland hydrology criteria. Still others would require additional research before specific changes in wetland delineation practice are proposed.

Development of the Corps’ wetland delineation manual needs to be a continuing process, one that is separate, to the extent possible, from the social and political issues of regulatory jurisdiction. Wetlands are ecosystems and their basic definition and recognition are technical issues. Socioeconomic considerations should enter into decisions about what kinds of wetlands should be regulated and in what ways. But these decisions, too, should be reevaluated periodically with changes in our technical understanding of wetlands and changes in society’s priorities for wetland protection and use.

Continuing development of the Corps manual, including improved regional specificity, has been hampered by the lack of an authoritative national technical panel charged with directing and overseeing the effort. Formation of a National Technical Committee for Wetland Delineation (NTCWD) should be initiated immediately by the Corps. The committee should be co-chaired by the Corps and EPA as primary users of the Corps manual, and include NRCS and FWS as important contributors of wetland delineation expertise and cooperating MOA agencies. The NTCWD should consider issues that are national in scope, such as what system of regions to use in developing improved wetland delineation guidance, and what refinements are needed in basic wetland definitions and criteria. Additional responsibilities of the national committee would be to coordinate with existing Federal panels dealing with wetland plants and hydric soils, and to designate and oversee the efforts of regional workgroups composed of wetland experts from government, academia, and the private sector.

Important initial tasks for the regional workgroups include developing draft lists of regionalized wetland hydrology indicators and problematic wetland situations. Later, the regional workgroups could develop draft guidance for delineating problematic wetland types. Products of the regional workgroups could be submitted to the NTCWD for review and testing before being forwarded to decision makers in the Corps and EPA Headquarters.

Given the emphasis at the Federal level on the development of new methods for assessing the functions of wetlands (Federal Register, Vol. 62, No. 119, pp. 33607-33620, 20 June 1997), regionalization of wetland delineation methods should be tied as closely as possible to wetland functions as a way to expedite the overall Section 404 wetland assessment and permitting process. Therefore, regional workgroups should consider stratifying wetland indicators at the sub-region level based on hydrogeomorphic (HGM) wetland classes (i.e., depression, riverine, fringe, slope, and flat) (Brinson 1993) and developing indicators that are useful both for delineating wetland boundaries and assessing wetland functions. In the future, the science and art of wetland delineation will likely move away from methods that recognize wetlands solely on the basis of physical characteristics (e.g., vegetation, soils, hydrology) and toward a system that recognizes and protects areas that provide valuable wetland functions (e.g., storing flood water, retaining sediment and toxic substances, trapping and transforming excess nutrients, and providing unique and valuable habitats).

7 Summary and Recommendations

This report identifies and discusses technical issues important to the "regionalization" of the 1987 *Corps of Engineers Wetlands Delineation Manual*. The report reviews current technical and regulatory definitions of wetlands, gives a brief history of wetland delineation methods developed by the Federal regulatory agencies, and compares existing Federal delineation manuals. Current criteria and field indicators for hydric soils, wetland hydrology, and hydrophytic vegetation are then reviewed and recommendations made for increasing the manual's regional sensitivity and filling important information gaps.

The following list summarizes the major conclusions of this study and gives recommendations for further action. Recommendations given in previous sections of the report are repeated here for convenience. Those that could be implemented without reconsidering the Corps manual's basic structure or wetland criteria are denoted in italics. However, recommendations that involve more fundamental changes in the manual (e.g., rethinking its wetland hydrology criteria) are also necessary if wetland delineation procedures are to be regionalized effectively. Major conclusions and recommendations are as follows:

Wetland Definitions

- A general technical definition (National Research Council 1995) recognizes wetlands as ecosystems that depend upon recurrent, sustained, shallow inundation or saturation. The technical definition is intended to be universal and serves as a frame of reference within which to consider the potential for regionalizing regulatory definitions, criteria, and field indicators.

- Regulatory definitions of wetlands (i.e., the Corps/EPA wetland definition and the Food Security Act wetland definition) reflect both technical issues and regulatory policy. Current regulatory definitions exclude some environments that would be included under the technical definition, such as wet areas that do not support macrophytes.

- As technical descriptions of areas potentially subject to regulation, the regulatory definitions were intended to be simple and universal. Details were left to the delineation manuals. Therefore, efforts to regionalize wetland delineation methods should focus on the delineation manuals rather than the wetland definitions.

- As policy statements, the regulatory definitions of wetlands could be modified, as was the FSA wetland definition, by adding clauses reflecting wetland-protection priorities in each region.

Delineation Manuals

- Delineation manuals are designed to draw an artificial line dividing the wetness gradient into wetland and non-wetland zones. Decision rules are necessarily somewhat arbitrary, based in large measure on common sense and historical precedent in the absence of complete scientific understanding.

- Two wetland delineation manuals are currently used at the Federal level – the 1987 Corps manual and the third edition of the NFSAM. Although they differ in important ways, both manuals describe very similar growing-season wetness conditions and were intended to be applicable nationwide.

- Both manuals incorporate some degree of regionalization. Both require the use of regional lists of wetland plants, and the NFSAM uses regionalized lists of hydric soil field indicators not yet fully adopted by the Corps and EPA. NRCS has developed county lists of hydric soil map units that provide useful background information for an onsite delineation. In addition, current practice under both manuals requires that growing season dates be determined from local climatic data.

- *A new and consistent system of wetland delineation regions is needed, one based on natural boundaries such as ecoregions or land resource regions, rather than political boundaries. For consistency, wetland plant lists and lists of hydric soil indicators should be revised as needed to conform to the selected system of regions.*

Hydric Soils

- Regionalization of hydric soil decisions should focus on field indicators, rather than the hydric soil definition and/or criteria. There is value in having a single hydric soil definition nationwide and the NTCHS is the appropriate body to develop and maintain that definition. However, one potential shortcoming of the current definition is its exclusion of oxygenated wet soils, which may exclude some areas that otherwise satisfy the Corps/EPA and NRC wetland definitions.

- Hydric soil criteria should be used only for their intended purpose of database manipulation and development of hydric soils lists by NRCS. Hydric soil criteria are no longer relevant to the identification of hydric soils in the field and could be dropped from the Corps manual. Ponding and flooding criteria should be retained as indicators of hydric soils.

- In accordance with the Corps/EPA regulatory definition of wetlands and NRC's technical definition, guidance should be given to Corps regulators to accept as wetlands those areas that meet hydrophytic vegetation and wetland hydrology criteria but lack hydric (anaerobic) soils due to the input of oxygenated surface water or groundwater. This guidance would particularly clarify wetland delineation practice in arid regions (e.g., riverine systems with sand and gravel substrates) and improve the Corps manual's regional sensitivity.

- *National hydric soil indicators given in the Corps manual no longer represent the state of the art and should be replaced, at least in part, with the latest version of the NTCHS* Field Indicators of Hydric Soils in the United States*, which are keyed to particular Land Resource Regions. Guidance to Corps regulators should stress that the NTCHS field indicators are "test positive" and that some hydric soils may lack indicators. Indicators "e" (reducing conditions) and "f" (soil colors) in the Corps manual (para. 44) should be retained as guidance for identification of hydric soils that may lack an NTCHS indicator.*

- *Simultaneous with the adoption of the NTCHS field indicators, the Corps and EPA should develop practical procedures at the regional level for making wetland decisions in situations where hydric soil indicators are lacking, or are misleading due to altered hydrology. These procedures should emphasize landscape position and strong evidence of wetland hydrology, hydrophytic vegetation, and/or use by other water-dependent organisms.*

- *As part of the previous item, the Corps should support the development of regional lists of "facultative" hydric soil indicators that can be used, with additional information, to identify some wetlands in the absence of a "test positive" hydric soil indicator.*

- *Adoption of the NTCHS indicators should also be accompanied by increased research on the relationships between hydric soil indicators and water-table or redox measurements, for both sandy and nonsandy soils, in various regional wetland types.*

Wetland Hydrology

- *Due to the increasing use of direct hydrologic measurements (e.g., groundwater well data) to evaluate the presence of wetlands in disturbed or problematic situations, there is a need to develop unambiguous* *technical standards for wetland hydrology based on water-table depth, duration, and timing during the monitoring period. The standards should take into account the normality of precipitation and temperatures before and during monitoring. Technical standards should be developed regionally, and could be in addition to the general wetland hydrology criteria given in the manual.*

- Hydrology criteria in the Corps manual should be revised by dropping the requirement that inundation or saturation occur during an arbitrary growing season. This action should be accompanied by a change (generally an increase) in the required duration of inundation or saturation, taking into account regional climatic variation.

- Due to their practical advantages over those given in the Corps manual, the Corps of Engineers should consider adopting the NFSAM wetland hydrology criteria as an interim step in the development of regionalized wetland hydrology criteria.

- The minimum required duration of inundation or saturation should vary seasonally, with longer duration required during colder portions of the year and shorter duration required during warmer periods. Regionalization of wetland hydrology criteria should be based on typical time lags between soil saturation, anaerobiosis, and chemical reduction in relation to normal seasonal temperatures, and the effects of prolonged inundation or saturation on vegetation. There is an immediate need for research to aid in the development of appropriate hydrologic standards for each region.

- *The Corps should develop regionalized lists of wetland hydrology field indicators. Corps Headquarters should facilitate this process by establishing regional panels, consisting of Corps District, other Federal and state agency, and university scientists, who would be tasked with developing proposed lists of indicators. Proposed indicators would be reviewed by a national panel and recommended to Headquarters for adoption. The regional panels should meet every few years to review and update the lists.*

Hydrophytic Vegetation

- The Corps should consider adopting a hydrophytic vegetation criterion based on a wet-season, plot-based prevalence index, rather than on dominant species. Advantages of the prevalence index include its consideration of all species in a community, rather than just a few dominants, and its apparent better correlation with hydric soils. However, the “basic rule” should remain the primary field indicator of hydrophytic vegetation in routine situations. Before adopting a particular criterion, additional research is needed to test appropriate decision thresholds for the prevalence index, taking into account its relationship with hydric soils in each region.

- *Regionalization of hydrophytic vegetation determinations should focus on assigning a technically correct wetland indicator status to each plant species in a region or subregion, independent of social and political considerations. To that end, the Corps should move to adopt recent proposed revisions to the 1988 wetland plant lists as an interim step in development of new plant list regions.*

- *Current plant list regions used by FWS, which are based on political boundaries, should be dropped in favor of smaller regions based on ecological boundaries. The same system (e.g., ecoregions, land resource regions) should also be used for regionalization of hydric soil and wetland hydrology indicators.*

- *In the arid western United States, consideration should be given to assigning the indicator status of certain halophytes and phreatophytes by landform on which they occur (e.g., hard playa, soft playa, river terrace, etc.).*

Problem Areas

- *Updated lists of problematic wetland types in each region should be developed by local teams of agency scientists and other wetland delineation experts, perhaps by the same panels recommended previously for development of regionalized wetland hydrology indicators.*

- *Problem area guidance should be reviewed and updated regularly so that new technology can be disseminated rapidly and important information gaps can be identified for further research.*

- *The Corps should continue current efforts by western Districts to develop consistent guidance for identification of the ordinary high water mark, with the eventual goal of developing a regionalized manual for delineating non-wetland "waters of the United States," such as playas and riparian systems.*

Processes

- *To accomplish these recommendations, a National Technical Committee for Wetland Delineation (NTCWD) should be established, chaired by the Corps and EPA and including NRCS and FWS members. The NTCWD would consider wetland delineation issues that are national in scope, and would designate and oversee a number of regional workgroups.*

- *Further refinement and regionalization of wetland delineation methods should be tied as closely as possible to wetland functions as a way to expedite the overall wetland assessment and permitting process. Therefore, regional workgroups should consider stratifying wetland indicators based on hydrogeomorphic wetland classes (i.e., depression, riverine, fringe, slope, and flat) and developing indicators that are useful both for delineating wetland boundaries and assessing wetland functions.*

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14. ABSTRACT

Wetland delineation is fundamental to Corps of Engineers and Environmental Protection Agency regulatory responsibilities under Section 404 of the Clean Water Act. The Corps' *Wetlands Delineation Manual* is the accepted standard for delineating wetlands pursuant to the Section 404 regulatory program. This report identifies and discusses technical issues relevant to the "regionalization" of the Corps manual. The report reviews current technical and regulatory definitions of wetlands, gives a brief history of wetland delineation methods developed by the Federal regulatory agencies, and compares existing Federal delineation manuals. Current criteria and field indicators for hydric soils, wetland hydrology, and hydrophytic vegetation are then reviewed and recommendations made for increasing the manual's regional sensitivity and filling important information gaps.

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UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		61	

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