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EVALUATION OF PROPOSED REVISIONS TO THE 1989 "FEDERAL MANUAL FOR IDENTIFYING AND DELINEATING JURISDICTIONAL WETLANDS."

(Report of the Ecological Society of America's Ad Hoc Committee on Wetlands Delineation)

Note: The following report of the Ad Hoc Wetlands Committee is being published in its entirety because of the current interest in the subject and the increasing responsibility of ecologists to comment on the scientific dimensions of major environmental issues such as wetlands.—Ed.

The Ecological Society of America (ESA) is a scientific organization founded in 1915 for several purposes, among them the responsible application of ecological data and principles to the solution of environmental problems. In keeping with this purpose, the President of the Society, Dr. H. Ronald Pulliam, charged this committee on 3 September 1991 with the task of conducting a scientific review of proposed revisions to the 1989 "*Federal Manual for Identifying and Delineating Jurisdictional Wetlands*" as presented in the 14 August 1991 Federal Register. This report contains the committee's findings and recommendations.

We do not find the proposed revisions as presented in the 14 August 1991 Federal Register (hereafter 1991 revisions) to be a responsible application of ecological data or principles to the problem of wetland identification and delineation. In fact, no data or scientific documentation are presented for the 1991 revisions. No citations to relevant recent studies or results of various tests of previous versions of the *Manual* are provided. Well-established scientific understanding of wetlands appears to have been ignored. The 1991 revisions lack the scientific justification that ought to be required for what is considered "a technical guidance document" (p. 40446).

There are several general problems and numerous specific problems with the 1991 revisions. Most of these problems derive from fundamental scientific flaws in the conceptual basis for the revisions. Therefore, our comments are arranged as follows: (a) a discussion of major conceptual problems with the 1991 revisions; this discussion addresses several of the "areas of major revision" for which comment is being sought (p. 40446); (b) comments on some of the eight additional issues identified for comment (pp. 40447–40448); (c) other specific problems not addressed under the eight identified issues; and (d) our recommendations.

Major Conceptual Problems with the 1991 Revisions

The Clean Water Act regulates wetlands in order to maintain wetland functions (e.g., flood protection and water quality improvement). Wetland areas that carry out these functions are what should be delineated for regulatory jurisdiction. Ideally, the boundary would be drawn at the point where critical functions diminish rapidly as one moves from the wetter to the drier parts of the ecosystem. Because scientific data on functional capacity are difficult to obtain, structural attributes, which can be examined over shorter periods of time, often are used as surrogate measures. Species composition, soil type, and hydrologic indicators all have proved to be useful indicators of wetland functioning. Thus, in delineating wetlands for regulatory jurisdiction, it must be remembered that wetland functions are a product of all components of the wetland ecosystem (not just vascular plants), that the wetland functions year round (not just when vascular plants are actively growing), and that critical functions (such as flood protection) will occur only at irregular intervals (not necessarily 6 years out of 10).

The entire conceptual basis of the proposed revisions is fundamentally flawed in terms of well-established scientific understanding of the development and functioning of wetland ecosystems. The revised *Manual*, as did its predecessors, identifies three criteria that can be used to identify and delimit a wetland: the presence of standing water or saturated soil (referred to as "wetland hydrology," in the *Manual*), hydrophytic vegetation, and hydric soils. Unlike its predecessors, however, the 1991 revisions strictly require independent indicators of all three criteria in the short term, i.e., over the short time frames within which delineations are done. Under the 1991 revisions, the presence of hydrophytic vegetation and/or hydric soils at the time of field inspection cannot be used as evidence of longer term patterns of continuous or intermittent flooding or saturation of a site. By requiring that the specified criterion of wetland hydrology be demonstrated regardless of the clear presence of hydrophytic vegetation and/or hydric soils, the 1991 revisions implicitly deny established scientific understanding of the interdependence of wetland soils, wetland vegetation, and long-term patterns of periodic or continuous flooding or soil saturation.

Wetlands are formed and are maintained by periodic or continuous flooding or soil saturation over many years. They are indicators of where in the landscape water regularly accumulates or flows. Flooding or saturation by groundwater of soils produces anoxic (without oxygen) conditions that initiate a series of chemical and physical changes in the soil. Long-term patterns of continuous or intermittent flooding or soil saturation cause the development of distinctive soils and vegetation. That is, the development of hydric soils and the presence of hydrophytic vegetation are the direct result or manifestation of periodic or continuous flooding or soil saturation over many years. Thus, in the absence of significant hydrologic alteration (i.e., drainage) of a site, these distinctive soil or vegetative characteristics constitute sufficient scientific evidence to document the occurrence of a wetland. Requiring independent verification of all three criteria is conceptually in error, a short-term mismatch with long-term realities.

The practical difficulties inherent in this flawed conceptual approach are evident throughout the 1991 *Manual*. The *Manual* is inconsistent (e.g., tidal and nontidal wetlands appear to require the use of different criteria, the lack of hydrologic records is admitted and then required), and difficult to read and follow. For lack of a coherent, scientifically based framework, it imposes needlessly complicated sampling techniques and erects a cumbersome structure of "exceptions," "special wetlands that fail the hydrophytic vegetation criterion," and "problem areas." One is led to conclude that if so many wetlands have to be treated as exceptions because they meet only two of the three mandatory criteria, either the criteria are too restrictive or they are inadequate in other ways.

We call attention to the following specific aspects of the 1991 revisions as being particularly lacking in scientific justification:

a) *Requirement for independent verification of flooding/saturation frequency and duration.*

The strict requirement that flooding or soil saturation be proven independent of vegetation and soil criteria is not scientifically defensible. It fails to recognize the inherent interdependence in wetlands of soils, vegetation, and flooding or saturation of the soil, described above, and the ephemeral nature of water in wetlands. Though the presence of water in wetlands is predictable over the long term, it is the most difficult attribute to assess in the short term. Water levels in most wetlands are dynamic, not stable (Mitsch and Gosselink 1986). They fluctuate seasonally, annually, and over longer term climatic cycles. For example, in prairie potholes water levels can vary over a normal wet–dry cycle from 2 m above the soil surface during wet years to 0.5 metres below the soil surface during droughts (van der Valk and Davis 1978, Kantrud et al. 1989).

Because of this variability in wetland water levels, it is unrealistic and impractical to require verification of its presence independent of the enduring changes in soil or vegetative characteristics produced by the presence of water over longer time periods. Groping for additional primary and secondary indicators of "hydrology" does not elevate this approach to the same level of reliability and persistence exhibited by soils and vegetation. In fact, it is possible to use soils and vegetation as primary indicators of hydrology (in contrast to their use as criteria). Provided the site has not been effectively drained, hydrophytic vegetation and hydric soils are extremely reliable indicators that flooding or soil saturation exists over a duration long enough to allow their development.

Most wetland sites are not likely to have the required long-term photographic records or data from wells and gauging stations. Furthermore, such well data or gauging station data would seldom, if ever, be available along the upper limits of wetlands and therefore would not be suitable for delineating wetland boundaries.

b) *Specified frequency and duration of inundation or saturation.* The frequency and duration of inundation (15 consecutive days) or soil saturation (21 consecutive days) specified in the 1991 revisions appear to be arbitrary. To our knowledge there is no statistical or factual basis for adopting these numbers. Previous definitions of wetlands have avoided such specificity regarding frequency and duration, recognizing that our knowledge of wetland hydrology is insufficient to establish such limits. As Tiner (1991*b*) has noted:

> *Hydrologic assessments require long-term studies to document the fluctuations in surface water levels and in the position of the water table. Scientific research has not focused on examining these long-term relationships in wetlands, especially along their upper limits, for several reasons: (1) the interest in this topic is only recent; (2) wetland identification by plants and/or soils was widely accepted as a practical approach to determine wetland limits; and (3) the long-term commitment of resources (dollars and time) required to undertake such a task was unavailable.*

For these reasons, the adoption of specific numbers as hydrologic criteria, neither those numbers in the 1991 revisions nor those in the 1989 manual, can be justified on the basis of strong scientific evidence.

The choice of a minimum of 3 years of hydrologic records as one of the indicators that can be used to document that the hydrology criterion has been met also seems arbitrary, as does another indicator that requires "inundation and/or saturation in most years (e.g., 3 of 5 years or 6 of 10 years)" (p. 40452). Hydrologists have developed methods for predicting the probability of flooding based on past records of flooding to different levels. Expressions of "return time" or "frequency of flooding" are normally used, not "most of the time." If specificity is desired, then the techniques and methods developed over decades of hydrologic study of other aquatic systems, including methods from the extensive studies of the U.S. Geological Survey, should be considered. Ad hoc procedures should not form the basis for a technical document.

c) *Requirement for inundation or soil saturation to the soil surface.* Requiring that soils be saturated to the surface rather than within the rooting zone of plants runs counter to all accepted knowledge of plant growth. Flooding a soil severely restricts the exchange of oxygen between the atmosphere and the soil. As the supply of oxygen in the soil is depleted by soil microbes, the soil becomes anaerobic (without oxygen) and a series of chemical and physical changes occur that strongly influence the growth of plants (Ponnamperuma 1972, Gambrell and Patrick 1978, Kozlowski 1984). Flooding above the soil surface adds additional stress for plants, especially seedlings (Keddy and Constabel 1986). Upland plants cannot grow in anaerobic soils. Wetland plants have evolved various means by which they can grow in such soils (Jackson and Drew 1984, Hook 1984). Hence, the only technically sound requirement for defining wetlands is inundation or soil saturation within the rooting zone of plants. Typically this zone will be within 30 centimetres (about 12 inches) of the surface, though roots of some perennial wetland species may penetrate deeper (Brinson et al. 1981, Kozlowski 1984, Lugo et al. 1984).

d) *Restriction of the requirement for inundation or soil saturation to the growing season.* There are two scientific problems with the proposal to require that inundation or soil saturation occur during the growing season in order for the hydrology criterion to be met: (a) the use of the growing season is not appropriate for defining wetlands, and (b) if growing seasons are adopted, the criteria proposed to define them fail to pass scientific scrutiny. We discuss the first of these problems below. See our discussion of the definition of growing season under Issue 8 below for an elaboration of the second problem.

The use of the growing season concept, which was developed to predict crop growing regions, is not scientifically justified for wetland delineation purposes. It would be more appropriate to consider inundation and flooding patterns over the course of the entire year for several reasons: (a) native plants are not restricted to growing between the frost-free periods of concern for annual crop plants; some wetland plants are evergreen and continue some growth year round; (b) flooding during periods prior to the frost-free period influences soil conditions and plant growth in the early spring; and (c) wetland functions of concern to society that contribute to the goals of the Clean Water Act (e.g., flood storage, sediment retention, nutrient adsorption, provision of food and cover for wildlife) are not restricted to the frost-free period. For example, in a study of 213 small prairie pothole wetlands, Hubbard and Linder (1986) found that these wetlands stored immense quantities of water in the early spring, a function important for both flood control and groundwater recharge in the region. Most prairie potholes, as well as numerous other wetlands, collect snowmelt and spring runoff long before plant growth begins.

e) *Use of absolute criteria for determination of hydrophytic vegetation.* A problem with all tests that require use of absolute criteria, such as the number of obligate wetland vs. upland species, is that they will not work in wetlands with prolonged drawdowns. During drawdowns these wetlands can be dominated by upland species that become established temporarily. For example, when a prairie pothole is flooded, a cattail stand may dominate and contain only two or three species, all obligate wetland species. When it is in a drawdown phase (because of climatic variability), these same obligate wetland species still may be present, but perhaps 5 to more than 20 upland species may also be present (van der Valk and Davis 1978, van der Valk 1986). The same problem is true for Carolina Bay wetlands of the Southeast. The water levels in these bays naturally fluctuate in a pattern of consecutive wet years followed by a series of dry years (Sharitz and Gibbons 1982). During the wet periods, wetland hydrology and hydrophytic vegetation are present. During dry years, the hydrology may not meet the wetland hydrology criterion and facultative and upland plant species may become established. These upland species typically disappear in wet years.

The vegetation criterion needs to address the issue of the potential flora of a wetland, not just its actual flora on the day that the delineation is made. Just as the 1991 revisions recognize that it can take many years to establish the hydrology of a wetland, they also should recognize that it may take several years to establish the complete composition of the flora of a wetland.

Eight Issues Identified for Comment

The eight issues identified for comment in the 14 August 1991 *Federal Register* largely assume that one accepts the conceptual basis for the 1991 revisions. Based on our scientific assessment explained above, we do not accept that conceptual basis. Nevertheless, we offer the following comments on five of those issues in hopes of highlighting some of the problems inherent in the proposed revisions.

Issue 1. Alternatives to specifying seasonally harder to identify wetlands. The problems identified under this issue arise because of *flua*, and *Pinus taeda* (loblolly pine). Areas with these species may be excellent examples of wetlands. In addition, small stream floodplains in the Southeast, that clearly have important flood storage and nutrient retention functions, may not be classified as wetlands by the FAC Neutral test.

Issue 6. Requirements for use of hydrologic records to meet hydrology criterion. The proposed 1991 revisions to the *Manual* allow the use of at least 3 years of hydrologic records to meet the hydrology criterion. The records must be collected "during years of normal rainfall (amount and monthly distribution) which is correlated with long-term hydrologic records for specific geographical areas." Comments are sought on whether a specific definition of "years of normal rainfall" is appropriate, i.e., "annual observations periods with at least 90% of average yearly precipitation and at least 90% of normal monthly distribution."

This requirement is not clearly stated and we question whether it is scientifically justified. What is meant by normal monthly distribution? Does it mean that each month of the three years during which hydrologic records are evaluated must be within 10% of the long-term mean for that month? Have the analyses been done to indicate how long this assessment takes and how many years qualify within a long-term record?

We also question if the proposed requirement can ever be met in regions of highly variable rainfall. For example, analysis of the rainfall data for San Diego, California's Lindbergh Field by one of our members raises several issues concerning the proposed criteria for using hydrologic records. The data base included 140.5 years, from 1850 to mid-1990. The first issue is that of what period to consider as a year—the calendar year, the rainfall year (July through June), or the hydrologic year (October through September). There was an approximately 50% difference in the number of years that qualified as being within 10% of the mean annual rainfall using calendar vs. rainfall years. The second issue is whether a year would qualify if it was ±10% of the mean, or whether it had to have at least 90% of the annual rainfall. Few years had 90–110% of the annual rainfall in this long-term record; using the calendar-year total, only 21 years, or 15% of the historic record, qualified as being within 10% of the mean. The third issue is what is meant by "normal monthly distribution?" Monthly rainfall had even higher variability (Coefficient of Variation (CV) as high as 405% for July) than annual rainfall (CV closer to 40%). Only 11 years (8% of the record) had January rainfall that fell within 10% of the 141-year average. Of these 11 years, only 5 had February rainfall that was within 10% of the 141-year average. Thus, not one of the 141 years qualifies as having "normal monthly distribution," defined as each month within 10% of the long-term mean.

This cursory review of rainfall data suggests that little consideration was given to regions with high interannual variability. Obtaining and interpreting the required records will pose a problem, especially for the arid and semi-arid regions that dominate the western half of the United States.

The lack of definition of terms indicates that the criteria have not been explored at all; hence, the scientific validity of the entire approach is called into question. The basic question remains, what is the rationale for requiring 90% of rainfall (annual and monthly distribution)? One is left with the impression that the standard is arbitrary.

Issue 8. Definition of the growing season. The 1991 revisions to the *Manual* define the growing season as "the interval between 3 weeks before the average date of the last killing frost in the Spring to 3 weeks after the average date of the first killing frost in the Fall, with exceptions for areas experiencing freezing temperatures throughout the year . . . that nevertheless support hydrophytic vegetation." (p. 40452). As discussed above, we do not view the use of the growing season to be appropriate for identifying and delineating wetlands. However, if the use of growing seasons is adopted, several questions must be raised about its definition.

The growing season concept has been useful in agriculture, because it is a simple means of predicting where various crops will grow. However, agricultural scientists recognize that growing seasons are difficult to define, and various approaches have been taken. The average period between frosts is a simple definition, but is imprecise. "At Iowa Falls, Iowa, for example, the average frost-free season is 150 days, but it has varied from a low of 111 days to a high of 188 days" (Reed 1941 in Wilsie 1962:186). A 77-day differential certainly indicates high interannual variability.

The concept of growing season as defined for crops is not readily transferrable to natural ecological communities. Most plants native to temperate climates can continue activity at air temperatures below 0°C (32°F). They accumulate organic solutes of low molecular mass that depress the freezing point and confer frost resistance. A study of a common wetland sedge in New York showed that new shoots emerge and grow in late October and November, several weeks after the average date of the first killing frost for that region (Bedford et al. 1988). Arctic and alpine plants are well adapted to photosynthesize under low air temperatures. Fitter and Hay (1987) list minimum temperatures for net photosynthesis of −3° to −6°C (approximately 26° to 18°F). Photosynthesis can occur at even lower temperatures, but respiration rates increase so that there is no net gain of carbon. However, species distributional limits may well be determined not by the direct effects of cold temperatures, but by indirect effects of cold temperature on water and nutrient supplies (Chapin 1983 in Fitter and Hay 1987). Scientific literature does not support the concept of a growing season for native vegetation that is defined by the period of air temperatures above 0°C (32°F).

Since many plants are active before and after frost, an extension of the growing season is proposed; however, no rationale is given for a 3-week period before and after the average date of the last spring and first fall frost. Such an extension would not be constant for all regions of the country. The relationship between the growing season and frosts would no doubt differ by region. Areas of highly variable frost-free periods would be expected to have a longer extension beyond the spring and fall frosts than would areas where the frosts are highly dependable and preceded or followed by very cold weather. Both the extension period and the protocols for selecting and using weather station data need to be considered more thoroughly. Even within a single state, switching to criteria that vary according to local weather station records not only will reduce the scientific validity but also will create different growing seasons for each weather station. For example, the State of Washington would have over 200 growing seasons (C. Simenstad, University of Washington, *personal communication*).

Furthermore, there is no inherent scientific reason why the definition of growing season and extension period should be based on plant growth alone rather than on all biological activities influencing wetland functions. Microbial populations that influence the capacity of wetlands to retain or transform nutrients and other pollutants are active longer than the proposed plant growing season. Nutrient retention in wetlands is determined by both biological processes as well as hydrological and physical aspects of the soils. Nutrient accumulation or release can occur in any season depending on local conditions (Verry and Timmons 1982, Herbert 1986, Devito et al. 1989.) Waterfowl begin to feed on invertebrates in prairie potholes beginning in March and April (Bellrose 1976, Duebbert and Frank 1984, Swanson and Duebbert 1989).

Other Comments

Comments on Standard Methods, Appendix 2, 3, and 4. The assumption that any plant species not included on the National List of Wetland Plant Species is an upland species is not valid. In a study of the correspondence between vegetation and soils in wetlands and nearby uplands in six states (Scott et al. 1989), of the 664 species encountered, 56 unlisted species were assigned a category other than obligate upland. Of these, 26 were assigned to FACU, 8 were assigned FAC, 10 were assigned FACW, and 12 were classified as OBL.

There may be many cases when it is not clear when to use the routine method or the intermediate or comprehensive method of wetland determination. The decision depends in part on how homogeneous the soils, vegetation, and hydrology are; this can be a subjective judgment. Unless the physical boundary of a wetland is sharp, the area of the boundary is likely to be a gradient in vegetation. Does this imply that intermediate or comprehensive methods must always be used for boundary delineation if the boundaries are gradual or indistinct?

The procedures for determining the dominant species, based upon estimation of the cover classes of all species in all strata, calculating a 50% dominance threshold, and using those species that contribute to this threshold are exceedingly cumbersome. Procedures that require cover class estimates of all species should be field tested along with standard ecological sampling techniques, and contradictions inherent in the proposed revisions. As stated, "the proposed *Manual* explicitly requires that for an area to be delineated as a vegetated wetland it must have three components: wetlands hydrology, hydric soil, and hydrophytic vegetation" (p. 40447). Nonetheless, it is also stated that "the revised Manual clearly must provide the necessary flexibility to perform wetland determinations throughout the year regardless of normal variations in conditions such as seasonal wetness," and that it is "essential that the revisions to the Manual not exclude obvious, long-recognized wetland types that clearly satisfy the regulatory definition" (p. 40447). Comments are then solicited on three "alternatives to specifying seasonally harder to identify wetlands types."

This issue thus recognizes seasonal variability in wetness and the fact that obvious, long-recognized wetland types may fail to meet the strict requirement for independent evidence of all three criteria. What is implicit in asking for alternatives to the three-criteria approach for these wetlands is the assumption that variability in wetness (seasonal, annual, or longer term) is the exception for wetlands. On the contrary, it is the norm. Most types of wetlands undergo water level fluctuations above and below the soil surface. The recognized need to develop alternatives only underscores the basic limitation of the proposed approach.

The list of alternatives omits a simpler option than those presented. Allowing seasonally wet wetlands to be identified by the presence of at least one of the criteria (hydrophytes, hydric soils, or hydrology) is consistent with all federal definitions of wetlands and would greatly streamline the delineation process.

Issue 3. Exceptions and special wetlands. As stated, the "proposed Manual recognizes that there are examples of wetlands which meet the regulatory definition, but which sometimes may meet only two of the three wetland criteria" (p. 40447). These wetlands are identified as "exceptions" but included "by specific reference as jurisdictional wetlands." Comments are sought on the technical validity of this approach and on whether wetland types additional to those named should be included as exceptions. The named "exceptions to the three criteria" are pocosins, playas, prairie potholes, and vernal pools; the named "special wetlands that fail the hydrophytic vegetation criterion" (because they are dominated by facultative species) are white pine bogs of the Northeast and Northern Midwest, eastern hemlock swamps and bogs in the Northeast, and tamarack bogs (p. 40460). Potential exceptions on which comments are sought include pitch pine lowlands in the Northeast, jack pine and white spruce in evergreen forested swamps in the Northern Midwest, lodgepole pine bogs and muskegs in the Northwest and Alaska coasts, sugar maple and paper birch swamps and bogs in the Upper Midwest, and longleaf pine wet savannas of the Southeast.

The fact that so many widely recognized wetland types need to be listed as exceptions and special cases calls into question the validity of the proposed three-criteria approach and suggests that this approach is too restrictive. It underscores the points we raised with regard to the lack of conceptual underpinnings for the 1991 revisions. In the absence of clearer scientific justification, the three-criteria approach should be replaced with the one-criterion approach, with exceptions listed for circumstances or "special wetlands" where the one-criterion approach would be subject to misinterpretation.

Issue 5. Facultative Neutral Test. A Facultative Neutral Test is proposed under which the hydrophytic vegetation criterion would be met if after discounting all facultative (FAC) plants, the number of dominant obligate wetland (OBL) and facultative wetland (FACW) species exceeds the number of dominant facultative upland (FACU) and obligate upland (UPL) species. Such an approach is not scientifically valid. Facultative species *should not* be discounted in the determination of hydrophytic vegetation for the following reasons:

a) Facultative species are those that have a broad ecological amplitude and occur across moisture gradients from wetland to upland. Many areas that meet the criteria of hydric soils and hydroperiod may be dominated by FAC species, such as *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum) and *Nyssa sylvatica* (black gum). Use of FAC species along with hydric soils and wetland hydrology recognizes the transitional nature of plant composition along the soil moisture gradient (Tiner 1991*a*).

b) Gradual transition zones between wetlands and uplands will often be dominated by FAC plants. Thus, without the use of FAC species, wetland boundary determinations will become extremely difficult, detailed and time-consuming. Again, this reflects the transitional nature of plant composition along moisture gradients.

c) Use of the FAC Neutral test will require the determination of a Prevalence Index (PI) for a large number of wetlands that are characterized by FAC species. As scientists, we recognize that carrying out the PI analysis properly will require carefully trained individuals with considerable expertise in plant identification and vegetation analysis.

d) It is known from the scientific literature that there are wetland ecotypes of some facultative species. Thus, the species level is not always the appropriate level for evaluating adaptation to wet or dry conditions. Some species have within them distinct populations of plants that have adapted genetically to local conditions (ecotypes). These populations may be able to tolerate conditions of flooding or soil saturation different from those tolerated by other populations of the same species. These ecotypes may be sufficiently distinct in their morphology or physiology to be given subspecific names. Tiner (1991*a*) gives examples of species with recognized varieties occurring in different habitats and with different wetland indicator status. These include:

Acer rubrum var. *rubrum*: FAC (red maple)
var. *drummondii*: OBL to FACW
var. *trilobum*: OBL to FACW+
Celtis laevigata: FACW to UPL (sugarberry)
Nyssa sylvatica var. *sylvatica*: FAC (black gum)
var. *biflora*: OBL to FACW+
Panicum virgatum: FACW to OBL (switch-grass)
Quercus falcata var. *pagodaefolia*: FACW to FAC+ (cherrybark oak)

In a more detailed study of *Nyssa sylvatica,* Keeley (1979) reported differentiation into unique floodplain and swamp ecotypes (both presumably var. *biflora*) that had different physiological and morphological responses to short-term flooding. *Acer rubrum* is well known for its ability to thrive on both wet and dry sites (Kramer 1949). This species has an adaptable root system. In wetlands, it develops numerous shallow lateral roots to help avoid anaerobic stress. On dry sites, it forms a deep taproot. Few studies of this type have been done, but existing studies suggest that many facultative species will have obligate wetland ecotypes.

Variants of the FAC Neutral Test. Comments are sought on whether six variants of the FAC Neutral Test improve the test's reliability. Variants (1), (2), and (5) require the use of the prevalence index when there is not more than one species difference between OBL/FACW and FACU/UPL or when the area is dominated by FAC species. The PI is based on a frequency analysis of all species within the community. Data collection for a PI determination is labor intensive and requires extensive field sampling. In the standard procedure (p. 40472, Comprehensive On-site Determination Method), the PI is determined from the frequencies of occurrence of all species at sample intervals along transects established in the area. FAC species are assigned a value of 3 (compared with OBL = 1, FACW = 2, FACU = 4 and UPL = 5). The mean PI for the sampled transects must be less than 3 with a standard error not exceeding 0.20. The requirement that *all species* that occur at the transect intervals be sampled and assigned wetland indicator values, as opposed to visually determined *dominant species,* will increase the need for highly trained plant ecologists to carry out identification and delineation procedures.

Variant (3) increases the scale of values used in the FAC Neutral test and assigns greater weight to OBL than to FACW species. This is an appropriate variant of the test. Variants (4) and (6) lower the cutoff for including a vegetation stratum or for including additional dominant species in the analyses. These variants would increase the number of plant species used in the test. Field evaluations of these two variants are necessary to determine if they would improve the reliability of the test for determining hydrophytic vegetation.

In summary, there is no clear evidence that the FAC Neutral test will be either more efficient or more reliable than the dominance test used in the 1989 *Manual* in which hydrophytic vegetation is considered present when more than 50% of the dominant species have an indicator status of OBL, FACW, and/or FAC. Furthermore, there are many wetlands that are dominated by facultative plants. In the Southeast, these areas are frequently dominated by *Acer rubrum, Liquidambar styraci-*

then subjected to peer review. A wide range of wetland types in each major region of the country should be included in the comparison. Only methods that withstand scientific scrutiny should be adopted.

Recommendations

In light of the above findings and comments, the Ecological Society of America makes the following recommendations:

a) that the current 60-day comment period for the 1991 revisions be extended for at least 18 months to allow adequate time for thorough scientific review, field testing of existing and proposed methods, and development of a new manual based on sound science that is easy to use and understand;

b) that a scientific review of issues pertaining to wetland identification, delineation, and functioning be conducted by an independent panel of wetland scientists under the auspices of the National Academy of Sciences (NAS); if a review by the NAS is undertaken, the comment period should be extended for a period of 18 months from the date the NAS study is funded; and

c) that any future manuals retain the intention of the 1989 *Manual* to provide a descriptive, technically based standard for identifying and delineating the universe of wetlands; federal and state agencies then would have a common reference around which regulatory and administrative policy regarding wetland resources can be structured openly.

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THE SUSTAINABLE BIOSPHERE INITIATIVE: A STUDENT CRITIQUE AND CALL TO ACTION

Introduction

As students planning careers in Ecology, we read about the "Sustainable Biosphere Initiative" (SBI) (Lubchenco et al. 1991) with great interest. SBI represents the collective vision of the "ecological establishment" outlining a possible course for future ecological research. We had mixed reactions. While we support the broad goals presented in SBI, the purpose of this commentary is to address several questions. First, does this document foreshadow future research funding priorities in ecology? Second, does SBI require a fundamental "retooling" for ecological research? Third, how will educational reforms necessary for SBI be realized? And fourth, as aspiring ecologists, how can we participate in the future implementation of SBI?

Three central themes were selected as the foci of future research efforts: global change, biodiversity, and sustainable ecological systems. SBI charges us as ecologists to (1) further our understanding of the ways ecological complexity controls global processes, (2) discover linkages between biological diversity and ecological processes, and (3) elucidate underlying ecological processes in natural and human-dominated ecosystems (Holland et al. 1991).

As we interpret SBI, its main assumption is that advances in understanding ecological