WETLAND POLICY ISSUES

CAST COUNCIL FOR AGRICULTURAL SCIENCE AND TECHNOLOGY FEBRUARY 1994

Council for Agricultural Science and Technology

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Foreword

Following a recommendation by the CAST National Concerns Committee, the CAST Board of Directors authorized preparation of a report addressing wetland policy issues.

Dr. Jay A. Leitch, professor, Department of Agricultural Economics, North Dakota State University, Fargo, served as chair of the task force. A highly qualified group of scientists was chosen to serve as authors and reviewers and includes persons with expertise in agricultural economics, agricultural engineering, biology, natural resources, public policy analysis, sociology and anthropology, soil science, plant sciences, and wetlands.

The authors met and prepared an initial draft of the report. All authors and reviewers assisted in revising all subsequent drafts and reviewing the proofs. The CAST Executive and Editorial Review committees reviewed the final draft. The CAST staff provided editorial and structural suggestions and published the report. The chair, authors, and reviewers are responsible for all scientific content in the report.

On behalf of CAST, we thank the authors and reviewers who gave of their time and expertise to prepare this report as a contribution of the scientific community to public understanding of the the issues. Also, we thank the employers of the authors and reviewers who made the time of these individuals available at no cost to CAST. The members of CAST deserve special recognition because the unrestricted contributions they have made in support of the work of CAST have financed the preparation and publication of this report.

This report is being distributed to members of Congress, the U.S. Department of Agriculture, the Environmental Protection Agency, the Food and Drug Administration, the Agency for International Development, Office of Technology Assessment, Office of Management and Budget, media personnel, and to institutional members of CAST. Individual members of CAST may receive a copy upon request. The report may be republished or reproduced in its entirety without permission. If copied in any manner, credit to the authors and CAST would be appreciated.

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Preface

Wetlands in rural America currently are being fought over by those who would use them for alternative purposes and those who would preserve them. This land-use controversy, which began at least three decades ago, often is fought in settings far removed from the natural landscape. This report primarily addresses wetland issues as they relate to rural America. The principles and the concepts involved, however, are applicable generally to all wetlands.

The wetland issue persists primarily because it involves a clash between quantitative and ethical values, between ecocentrists and technocentrists. Although scientists have labored to respond to technical concerns, the deepest issues are not technical but social and philosophical. However, the public is largely oblivious of wetlands and the wetland debate. The combination of distance from the public's everyday focus and technical nature of wetland issues contributes to confusion about the real problems that exist.

This report is an attempt to present an objective assessment of the importance of wetlands to society and to offer suggestions for resolving ongoing disputes. Just as the physical and biological aspects of wetland science are complex, so too are the social, economic, legal, and political aspects. None can be addressed completely in a single summary document.

Without exception, each of the issues surrounding wetlands can be made to look complex. If the intent is to totally understand all social and scientific issues, it is indeed complex, but complexity is universal. Wetlands are not an exception. This report attempts to lay out the issues in a straightforward manner from a neutral position.

Finally, we use the word wetland as if it were commonly understood—it isn't. One of the principal constraints to resolving wetland debates is agreeing on what constitutes a wetland. We address this issue in Chapter 1.

Jay A. Leitch
Chair

Abbreviations

CRP	Conservation Reserve Program, U.S. Department of Agriculture
EPA	Environmental Protection Agency
FWS	U.S. Fish and Wildlife Service
NAWMP	North American Waterfowl Management Plan
NED	National economic development
NNL	No-net-loss
NTCHS	National Technical Committee for Hydric Soil
NWI	National Wetlands Inventory
OSE	Other social effects
OTA	Office of Technology Assessment
SCS	Soil Conservation Service
SWAP	Small Wetlands Acquisition Program
USACE	U.S. Army Corps of Engineers

Interpretive Summary

This new CAST report discusses the basis for the ongoing controversy surrounding wetland regulation. The task force synthesized, sifted, and summarized the voluminous data, divergent perspectives, and existing philosophies into this single manuscript. Several suggestions, conclusions, and implications for the various entities in the wetland issues are offered.

Suggestions

- Wetland scientists should
  - recognize the legitimate bounds of their disciplines and the proper role of science in policy-making,
  - interact with agricultural and ecological interests and the public to support the development of public policy, and
  - devote more attention to the relative values of nonwetland landscapes.

- Wetland policymakers/regulators should
  - recognize that not all wetlands are equal,
  - resolve the property rights issue,
  - define wetland more clearly,
  - recognize that nonwetland landscapes have value too, and
  - recognize that wetland can be valuable for more than its natural functions.

- The agricultural community should
  - know that the world is changing, especially with respect to the assignment of "rights,"
  - appreciate the other side(s) of the wetland issue, and
  - recognize that trade-offs are necessary in a world of increasing scarcity.

- The environmental community should
  - recognize that government is anthropocentric (like it or not),
  - acknowledge that money is the common denominator for exchange,
  - recognize that trade-offs are necessary in a world of increasing scarcity,
  - appreciate the other side(s) of the wetland issue, and
  - encourage efforts to identify values of nonwetland landscapes to the degree of effort expended on wetlands.

- The public should
  - not rely on science or public officials to determine what they want protected; they should become informed and get involved.

Conclusions/Implications

- Debates over the use and allocation of wetlands continue.
- Although approximately half of the lower-48's wetlands have been converted to other uses, that alone is not justification for preserving all of the remaining half.
- There is scarce middle ground in the discussion of wetlands—or at least few are willing to occupy it. Those informed and interested enough in the subject to take a position usually end up at one or the other extreme in the debate.
- While wetlands perform numerous useful functions, quantification, elaboration, and enumeration of wetland values in the absolute are of little use; what is needed are estimates of the relative values of wetlands and all other landscapes or alternative uses, which may have to be given up to protect wetland. Unless similar evaluations of forest land, agricultural land, grassland, and urban land are available, no meaningful relative basis exists on which to suggest land management or allocation policies.
- The public is largely oblivious to wetlands and the wetland debate. The combination of distance from the public's everyday focus and the technical na-

ture of wetland issues contributes to confusion about the real problems that exist.
- One of the principal constraints to resolving wetland debates is agreeing on what constitutes a wetland. Science alone cannot decide for society what is and is not wetland. Wetland is as much a social construct as a topographic feature, therefore the public policy arena rather than the academic laboratory is the proper locus for defining wetland.
- Existing wetland legislation leads to confusion because many of the terms (e.g., mitigation, restoration, creation, or no-net-loss) are not defined clearly.
- Wetlands are dynamic components of the landscape and dynamic in the way society perceives them.
- Social value, an appropriate common denominator for social decisionmaking, frequently is confused with ecologic value and function of wetlands. For there to be social value, wetland function must lead to some potential perceptible change in human well-being.
- There are many well informed, rational people who place higher values on alternative uses of wetland than on "natural" wetland.
- All wetland regulations affect the economic decisions of individuals, firms, and the public. Regulation also affects the distribution of income among present generations and between the present and future generations.
- Science will not, and should not, be the last word on wetland issues.
- Science has made contributions toward resolving the issues, but, despite decades of excellent wetland science, the issue remains largely

  - an issue of philosophical and ethical value differences,
  - a political-legal issue of explicitly assigning property rights,
  - a social-technical issue of defining exactly what a *wetland* is,
  - a largely regional-local issue most often discussed at the national level, and
  - a matter of having to make decisions today in spite of not resolving the above four points.

Executive Summary

That wetland issues are complex is an understatement because of the diversity of scientific issues and perspectives involved. Additionally, emotion, economics, and law play major roles in assessments of the importance of wetlands to individuals and to society.

Understanding wetland issues requires first a definition of wetland. Wetland is as much a social concept as a topographic feature; its definition is dynamic and eludes rigorous technical description. Definition of wetland is political and not technical and will remain so until indicators that are useable *in situ* for each region of the United States are agreed upon and these indicators have been thoroughly field tested. Criteria and definitions lack field existence of direct evidence.

Through the outputs that their functions make available, wetlands contribute to the well-being of society. Most decisions are made by humans and for humans; the value of wetland lies in its contribution to human satisfaction. Human satisfaction, it is believed, could be enhanced by direct use of a wetland, by conversion of a wetland to an alternative use, by improvement of health indirectly aided by a wetland, or by knowledge that a wetland ecosystem will be available for future generations. Conversion may contribute more or less to human satisfaction than preservation of wetland. Balancing of currently recognized and as yet unrevealed wetland values requires careful attention during the drafting of wetland regulations. The main issue concerns the functions and resulting social benefits of wetland, as compared to nonwetlands in terms of benefits provided. Because the wetland issue quickly becomes a land use issue, attention must be directed to the values of all land uses, not only those of wetland but also the values of nonwetland.

Conflicts with respect to the use and management of wetland arise primarily from a lack of understanding of the resource and the role of a wetland in natural and social systems. The fact that alternative users of wetland must compete and that effective market or political mechanisms to allocate wetlands among competing uses are lacking lead to conflict. Additionally, incomplete specification of wetland property rights and socially induced changes in rights have resulted in numerous legal conflicts over the use of this resource. The presence of litigation indicates that wetlands and wetland conversion affect the economic and social well-being of individuals and society.

The multiplicity of wetland scientific perspectives and wetland regulations has created an ambiguous and ill-defined metalanguage. *Mitigation*, for instance, has many meanings. *Restoration* is thought possible by many and impossible by many others. *Replacement* means "to put back exactly what was taken" to some and "to put back to a former level of well-being" to others. Confusion such as this, together with no-net-loss policies, has opened a regulatory can of worms. Until each of these and many other wetland concepts are defined clearly and concisely, there is little hope for consensus, much less for understanding or rational wetland policymaking.

Wetland science has come a long way in the last 25 years, and it still has a long way to go. Decisions must and will continue to be made despite incomplete knowledge of wetlands' role. The challenge to policymakers is to avoid ecologically irreversible choices while maintaining economic development and improving income distribution. Neither myopic case-by-case decisions nor blanket regulations can be used alone to allocate wetland resources in a way that maximizes society's well-being. Choices need to be made in a comprehensive context or under a regulatory rubric that considers the full range of societal values.

Introduction

Wetland issues have been researched and discussed extensively within a variety of disciplines such as ecology, biology, agriculture, soil science, and hydrology. This publication adds to the few attempting to facilitate federal and state wetland policymaking by reviewing wetland issues from a multidisciplinary perspective. In 1984, the Office of Technology Assessment (OTA) summarized the state of our knowledge of wetlands and concluded that although wetlands were a valuable resource, there still was much to learn about their contributions to social welfare. Ten years later OTA's assessment still is accurate.

Mitsch and Gosselink (1993) summarize the current state of our understanding of wetlands as far advanced from 1984 but still confined largely to the natural sciences. Much work is needed to integrate science into the policymaking arena so that the full range of societal needs and constraints are considered.

Humans have used wetlands since the beginning of recorded history. Only recently have we also become concerned with their loss (Williams, 1991). Until very recently, drainage of land too wet to farm was uncontroversial, whereas drainage of marshes has been controversial for well over half a century (Leitch, 1981). Some believe that it is time to halt the conversion (drainage) of wetlands and have begun to restore them.

The crux of many of today's hotly debated wetlands issues lies in the subtle distinction between land too wet to farm and wetland (i.e., wetLAND or WETland). This distinction became important in the late 1970s, when wetland management responsibilities of both the U.S. Army Corps of Engineers (USACE) and the Environmental Protection Agency (EPA) compelled them to develop a procedure drawing lines (delineations) between wetlands and upland. Much has been written about the subtleties of such delineation (e.g., Environmental Defense Fund and World Wildlife Fund, 1992; Kusler, 1992), yet little has been resolved. For instance, the 1989 Federal Delineation Manual (Federal Interagency Committee for Wetland Delineation, 1989) includes much wet land (wetLAND) within wetlands (WETland) and therefore constitutes a major source of ongoing scientific and political controversy. However, there is little or no controversy about drawing the line between wetland and water (i.e., between wetland and lakes, between wetland and oceans). But there are other unresolved issues.

> "Once we free ourselves from the illusion that science or technology (if lavishly funded) can provide a solution to resource or conservation problems, appropriate action becomes possible." (Ludwig et al., 1993, 36)

Many claim and attempt to persuade the public that science and only science should be used to define and subsequently to delineate wetlands (Environmental Defense Fund and World Wildlife Fund, 1992). Headlines such as "Bush wetlands plan worries scientists" (*The Forum*, 1991), lead the public to conclude that scientists both agree and are omniscient. Although most of the public is oblivious to the delineation issue, some have become intensely aware of it although they generally are unable to fully understand scientists' arguments. These two groups have vastly different perceptions of wetlands. Many scientists see wetland properties and functions at the "drier-end" of the wetland continuum. Scientists attempt to differentiate wetlands from drylands and from ponds and other water systems. Scientists perceive wetlands as ephemeral features subject to seasonal changes with upper and lower boundaries. The public, largely from the portrayal of wetlands by special interests, perceives of wetlands as something with standing shallow water. Their ideas conform more to the wetter boundary.

Wetland policymakers react both to interest group outcries to protect wetlands and to scientists who promote policymaking through science. The recipe for effective wetland policy includes much more than just science. Yet some policy goals already have been proposed, e.g., no-net-loss of the nation's wetlands, that make the impact of additional policy directly dependent on the definition of wetlands.

A basic constraint to effective wetland policymaking has been that the bulk of scientific literature espouses the value of these areas. Granted, much good science has been accomplished, but good science available to advocate only one side of an issue usually is inadequate. There has been virtually no natural science research directed toward socially balancing wetland management because there is no assertive constituency for science-based questioning of wetland special interests. Nor is there an equivalent base of scientific work espousing such value in other landscape components, e.g., forest, tundra, or desert (Leitch, 1992b).

The purposes of this report are (1) to identify, to explain, and to discuss the important areas of understanding, misunderstanding, and controversy involving wetlands; (2) to improve understanding; (3) to encourage an appreciation of broad issues; and (4) to facilitate effective policymaking. Definition and delineation are addressed first so that readers share a common perception of the wetland resource. The role of wetlands in contributing to social well-being is clarified next through a discussion of how wetland functions are transformed into wetland values. Several points of conflict among wetland users are examined, as are the impacts of regulations, especially as they affect property rights. Light is shed on several poorly understood issues such as restoration, creation, and mitigation. Finally, conclusions are drawn and implications summarized.

Society wishes to do the right thing with respect to wetlands, but it should do so for the right reasons. The next discussion helps identify what may be socially optimal and clarifies the criteria for allocating society's scarce resources: wetlands, uplands, prairies, rivers, labor, and all other resources.

Ecocentrism is a belief in (1) the intrinsic importance of nature for humanity, (2) ecological laws dictate human morality, (3) biorights (the rights of nonhuman species), and (4) materialism for its own sake is wrong.

Technocentrism is a belief that (1) humans can always find a way out of difficulties, (2) progrowth goals define the rationality of project appraisal and policy formulation, (3) humans can improve the lot of the world's people, (4) scientific and technological expertise provides the basic foundation for advice on matters pertaining to economic growth, and (5) attempts to widen the basis for participation in project appraisal and policy review are without merit (O'Riordan and Turner, 1983).

A Selected Chronology of Key Wetland Events

1776 The United States has approximately 215–221 million acres of "wetlands and wet lands"

1800 Washington, D.C. was built on swampland converted to upland

early 1800s George Washington and others attempt to drain the Dismal Swamp

1849, 1850, 1860 Swamp Lands Acts promoted drainage by giving title to swamplands to states in exchange for reclamation

- about 65 million acres were given to 15 states

1862 Homestead Act; extension of railroad and stage line, road building, and improved river transport brought Europeans to the Upper Midwest

- these hard working settlers "tamed" the landscape for most of the next 100 years; often with the unmitigated moral and financial support of federal, state, and local governments

1899 River and Harbor Act; established USACEs' authority for the nation's navigable waters

1902 Reclamation Act; established a drainage specialist position and USDA staff to investigate methods and problems involved in agricultural drainage

1934 Migratory Bird Hunting Stamp (Duck Stamp) Act; provided money for wetland easements and purchases

1937 Ducks Unlimited founded

1943 USDA program provided cost-sharing for drainage and for creating shallow water areas for wildlife

1944 Flood Control Act (PL 566); federal projects to coordinate private drainage with large federal and state projects

1954 Circular 39 (type I, II, III, . . .); the first documented attempt to classify the nation's wetlands

1956 Conservation Reserve Program (Soil Bank); provisions for water impoundment

1958 Small Wetlands Acquisition Program (SWAP); protected wetlands through permanent easements and purchases administered by the U.S. Department of the Interior

1962 Reuss Amendment; prohibited cost sharing for drainage on types III, IV, and V wetlands. Rachel Carson's *Silent Spring* is published.

mid-1960s through 1970s Environmental Movement

1970 The Water Bank Act; to preserve, restore, and improve wetlands and habitats for wildlife

1971 "Classification of the natural lakes and ponds of the glaciated prairie region": (Stewart and Kantrud, 1971); U.S. Fish and Wildlife Service's (FWS) second attempt to classify wetlands

1972 Section 404 of the Federal Water Pollution Control Act

1974 National Wetland Inventory began

1977 Executive Order 11990; established wetland protection as official U.S. Government policy, ended all direct Federal assistance for wetland conversion

mid-1950s to mid-1970s wetland conversion continues at a rate of 458,000 acres per year

1978 drainage cost-sharing gone

1979 "Classification of wetlands and deepwater habitat of the United States" (Cowardin et al., 1979); the third and most recent Fish and Wildlife Service attempt to classify wetlands

1980s approximately half of the nation's wetlands have been converted to other uses

- wetland conversion slowed to between 100,000 and 290,000 acres/year

1985 Food Security Act (Farm Bill); Swampbuster provision eliminated farm program benefits for farmers planting annual crops on wetland converted after 1985. Violators are denied price support payments, farm storage facility loans, crop insurance, disaster payments, and certain kinds of operating loans. Cropped wetlands also are eligible for enrollment in the Conservation Reserve Program. Conservation easements on FHA foreclosed lands.

1985 Tax Reform Act; abolished preferential capital gains tax rates and removed other incentives to convert wetlands to farmland through drainage

1986 Water Resources Development Act; cost-share

1986 Emergency Wetlands Act; established the National Wetland Priority Conservation Plan aimed at fulfilling U.S. obligations under the 1986 North American Waterfowl Management Plan (NAWMP), whereby the United States, Canada, and Mexico agree to try to restore waterfowl populations to the average of 1970–79

1987 North Dakota, where the wetland wars began in the Starkweather watershed almost 30 years earlier, enacted nation's first no-net-loss legislation

1987 first federal manual for identifying and delineating jurisdictional wetlands using three parameters (vegetation, hydrology, soils)

1988 Presidential candidate Bush's "NO-NET-LOSS" campaign promise

1989 revised federal manual for identifying wetlands; four federal agencies agree to agree (FWS, EPA, USACE, Soil Conservation Service [SCS])

1989 North American Wetlands Conservation Act and Coastal Wetlands Conservation and Restoration Act (PL 101–233); created a wetland trust fund to finance coastal wetland programs and wetland acquisition under NAWMP

1990 White House Domestic Policy Council wetlands task force

1990 Vice President Quayle's Council on Competitiveness wanted to amend wetland delineation manual ("wetland scientists" and special interests claim that the nation would loose 50% of its wetlands)

1990 Food, Agriculture, Conservation, and Trade Act (Farm Bill); retained Swampbuster with some clarifications

1990 wetland reserve program added to Conservation Resource Program (CRP)

1991 National Wetland Inventory 70% completed in the lower 48 states and 18% completed in Alaska

- proposed revision of 1989 manual published in *Federal Register* and field tested by federal interagency teams
- USACE returned to use of 1987 manual based upon 1992 Water Resources Act

1992 Several concerns field tested and found major flaws in 1989 manual

1993 (January) EPA formally agreed to use 1987 manual; (March) The USACE established a Wetland Delineator Certification Program; (Mid-year) The National Academy of Sciences initiated 18-month, $400,000 study of wetland delineation issues, functions, and values; (Summer) Clinton administration issued its wetland policy. Only change was to designate SCS as the lead federal agency. Still no definition. Dixie Lee Ray's *Environmental Overkill* is published.

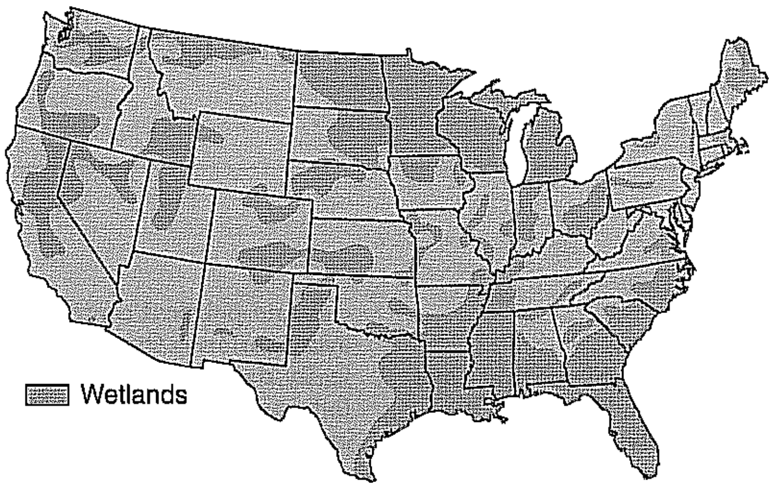


Figure I–1. Distribution of wetlands in conterminous United States (adapted from Mitsch and Gosselink, 1993; U.S. Department of Interior).

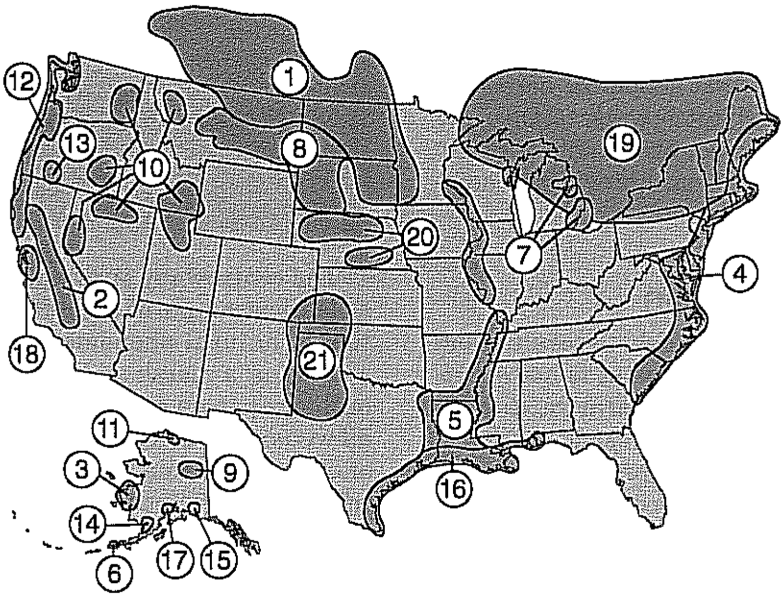


Figure I–2. Major waterfowl habitats (U.S. Department of Agriculture, 1987).
Priority area name

1. Prairie Potholes and Parklands
2. Central Valley of California
3. Yukon-Kuskokwim Delta
4. Middle-Upper Atlantic Coast
5. Lower Mississippi River Delta and Red River Basin
6. Izembek Lagoon
7. Upper Mississippi River and Northern Lakes
8. Northern Great Plains
9. Yukon Flats
10. Intermountain West (Great Basin)
11. Teshelpuk Lake
12. Middle-Upper Pacific Coast
13. Klamath Basin
14. Upper Alaska Peninsula
15. Copper River Delta
16. West-Central Gulf Coast
17. Upper Cook Inlet
18. San Francisco Bay
19. NE United States, SE Canada
20. Sandhills and Rainwater Basin
21. Playa Lakes

1 *Wetland* Definition and Delineation

In Brief

Definition and delineation are problems that have fueled controversy about wetlands. These two problem areas likely never will be resolved completely, for changing social values across space and time affect both. Solutions become possible, however, when the ideas of those in conflict approach each other. Delineation can be resolved only by policymakers, taking into account the efforts of scientists, but not by scientists alone. Definition and delineation likely will remain dynamic concepts, requiring periodic reassessment as science and the needs of society evolve.

Lawmakers need to clearly specify the goals of regulatory programs. Once goals are set, policymakers can identify the resources that should be managed. Once the resources, e.g., habitat or water quality, are identified, scientists can select observable traits to distinguish regulated areas from unregulated adjacent areas.

Introduction

Much of the ongoing wetland debate results from disagreement about what is and what is not a *wetland* (the *definition* problem). Furthermore, there is site-specific disagreement about the exact location of a wetland's edge (the *delineation* problem). As will be argued, wetlands are social constructs, not scientific discoveries; therefore, the role of science is in helping society decide what it wants to define as a wetland and formulating workable definitions.

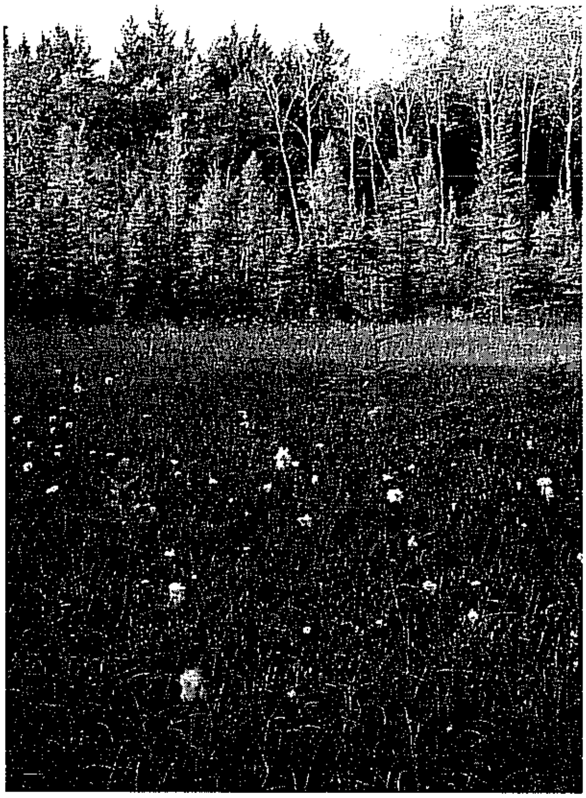
Existence as a Function of Definition

What at first seems easily defined—a wetland—is in fact a complex concept. Because science strives to achieve accuracy, the problem of accurate definition is fundamental (Lastrucci, 1963). Yet a clear, precise, unequivocal, and objective definition sometimes is achieved with difficulty. Once conceived, definitions change with new information or with a changed social and political context (Zuckerman, 1988). Moreover, wetlands themselves are physically and chemically dynamic. Courts have allowed challenges to federal regulatory definitions of wetlands on the grounds that the definitions are difficult to understand and apply (Want, 1990). Some argue that these reversals result from federal regulators' insufficient attention to scientists (e.g., Kusler, 1992).

> "Even the most critical question—What is a wetland?—recently has been assigned to the National Academy of Sciences for an answer." (Shabman et al., 1993, 1)
>
> "There is a need to place a sharp, narrow line on the ground to delineate wetland areas, although nature follows less distinct changes." (Walker and Richardson, 1991, 5)

The controversy surrounding the term *wetland* is a classic example of the difficulties attending definition of natural phenomena. If we point to a bog, a swamp, or a marsh and say that it is a wetland, any ordinary person can understand (Table 1.1). But not all wetlands look, function, or feel alike. Unless a class of objects has an easily perceived set of common attributes, it becomes quite difficult to designate such classes in simple, straightforward terms. If we define *wetlands* implicitly, we encounter problems because some do not understand our benchmarks. Operational definitions are problematic, because the various users have not agreed to define *wetlands* similarly, nor have their mandates required a common definition.

The matter is complicated further by the fact that in scientists' choices of problems for research, they are influenced by cultural values. Scientists thus are products of time and culture and cannot escape the influences of their value systems. Data classified in taxonomic systems are manageable. But such systems are artificial, mental creations not existing naturally apart from the qualities given them by indi-



A bog in the St. Croix NSR, Whispering Pines, Washburn County, Wisconsin. Flora include black spruce (*Picea mariana*), larch (*Larix laricina)*, aspen (*Populus* spp.), cotton grass (*Eriophorum* spp.) and other sedges, pitcher plant (*Sarracenia purpurea*), and others. Photograph courtesy of Tom Rosburg, Colo, Iowa.

viduals (Lastrucci, 1963). In short, we create categories to serve our purposes (Lakoff, 1987).

"The judgment of scientists is often heavily influenced by their training in their respective disciplines, but the most important issues involving resources and the environment involve interactions whose understanding must involve many disciplines." (Ludwig et al., 1993, 36)

When we use the term *natural resource* in reference to wetlands, it conjures up images of cattails and herons far removed from human activity. Baerwald (1991) suggests that placing too much emphasis on the word *natural* obscures the fact that *resource* is a culturally defined term. For something to be a resource, people need to perceive it as valuable and accessible. Resources are functions of human perceptions and capabilities. However, the character of any resource changes as both physical properties and people's perceptions change. This is so with wetlands. Historically, wetlands were defined by society as a nuisance, to be drained, as evidenced by the Swamp Land Acts of the mid-nineteenth century. But as early as the 1930s, certain groups began to recognize the benefits of wetland preservation, and public protection through economic incentives and legal constraints followed (Leitch, 1983).

Table 1.1. Examples of wetland types (U. S. Environmental Protection Agency, 1991)

Bogs typically have a thick layer of floating root masses or peat on the surface and are highly acidic. They may have no regular inlet or outlet of water, thus they are dependent upon precipitation for water. Most floating bogs are found in the northern United States. Pocosins, also a type of bog, are described below.

Bottomland hardwoods are deciduous forested wetlands, found along rivers and streams generally in the broad floodplain of the southeast and south central United States.

Emergent wetlands are characterized by free-standing, nonwoody plants. They can be either freshwater or saltwater. Emergent wetlands are found throughout the United States particularly in coastal areas, adjacent to major lakes, and in the West.

Fens have a defined outlet and are supported by mineral rich ground water that has seeped to the surface. Like bogs, fens have large amounts of peat. They are found in the northern United States.

Mangrove swamps are coastal saltwater shrub or forested wetlands that may be flooded with water all year around or only during high tide. Mangroves are found along the coast of the southern United States.

Marshes are emergent wetlands typically with a regular inlet and outlet of water. They can be either salt or freshwater, inland or coastal. They are dominated primarily by nonwoody vegetation. Marshes are found throughout the United States.

Swamps are dominated primarily by trees or shrubs and are found throughout the United States.

Prairie potholes are depressional wetlands found in the Upper Midwest, especially North Dakota, South Dakota, and Minnesota. They are major waterfowl breeding and migration resting areas.

Playa lakes are periodically flooded wetland basins that are common in parts of the Southwest and plains states.

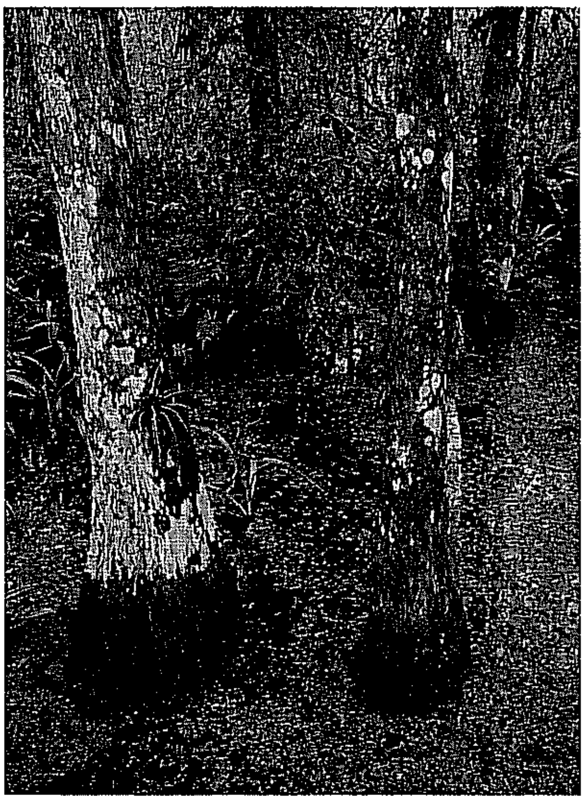
Pocosins are broad-leaved evergreen shrub bogs found in the Southeast. They may not be readily apparent because the thick underlying peaty soils dry out rapidly after the early part of the growing season.

Vernal pools are naturally occurring depressional wetlands that are covered by shallow water for variable periods from winter to spring, but may be completely dry for most of the summer and fall.

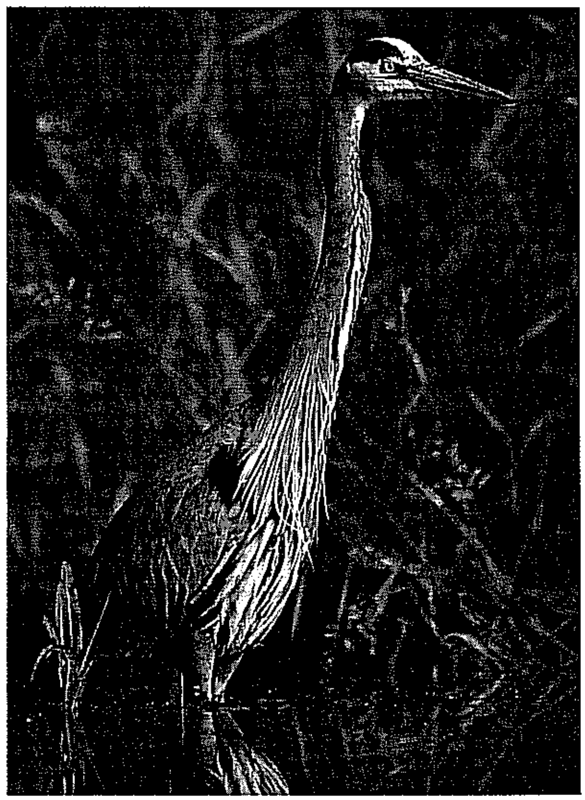
We could define a *wetland* as wet land (Kusler, 1983). Yet this approach raises more questions than it answers. From an ecological perspective, the term *wetland* has no meaning. Water creates "wet" and water varies with meterologic and climatic events. Watershed systems exist on a hydrologic gradient from ocean to desert. Somewhere along this gradient is what society calls wetland (Pierce, 1991). For regulatory purposes, then, a *wetland* is whatever society decides it is.

Terms such as *bog*, *marsh*, and *swamp* have been used throughout the English-speaking world for centuries. The term *wetland* came into broad usage only in the last 20 years, when a few states began to pass laws to protect wet areas from human alteration. Definitions of *wetland* have differed from state to state, and it was not until the mid-1970s that efforts were made to standardize the meaning of wetland (Golet, 1991). The definition of wetland has changed virtually every year for the past decade. Although more than 20 definitions exist (Kusler, 1992), most are scientifically similar and differ most often with regard to the deep water boundary of the system (aquatic) and the drier-end boundary (terrestrial)—the two ends of the continuum or gradient.

Many would define wetlands as lands that contain water long enough to water-log the soils in the root zone in most years. This definition contains the elements of the recent definition. The lack of oxygen in the root zone makes this area uninhabitable by upland plants. Two issues here are (1) saturation drives out vegetation unable to survive in oxygen depleted environments, and (2) this saturation occurs in most years. Cowardin et al. (1979) note that wetland vegetation could be used as specific regional indicators for short-term accommodation of this definition but they note that hydric soils are a long-term indicator of this condition. The use of this definition with both vegetation and hydric soils can be used to identify wetlands during dry periods. Table 1.2 presents three widely used definitions. All are similar in that they use a multiple parameter (criteria) approach and are



The Corkscrew Swamp, an Audubon sanctuary in southwestern Florida, is inhabited by baldcypress (*Taxodium distichum*), arrowhead (*Saggitaria* spp.), duckweed (*Lemna* spp.), and other species. Photograph courtesy of Carl Kurtz, St. Anthony, Iowa.



The great blue heron (*Ardea herodias*) is a common inhabitant of wetlands. Photograph in Dallas County, Iowa courtesy of Ty Smedes, Nature Photography, Urbandale, Iowa.

Table 1.2. Definitions of wetlands

"Those areas that are inundated or saturated by surface or ground water at 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."

U.S. Environmental Protection Agency and Army Corps of Engineers

"Wetlands are defined as areas that have a predominance of hydric soils and that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions. . ."

Soil Conservation Service

"Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following 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."

U. S. Fish and Wildlife Service

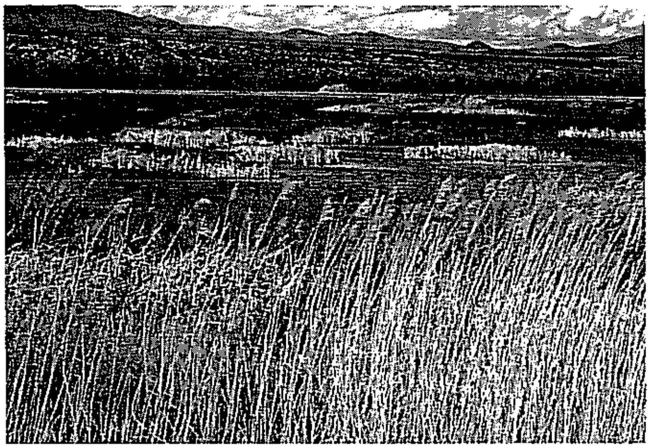
based on scientifically developed measurements and observations. The definition by the FWS is ecological. The definitions developed by the USACE, the EPA, and the SCS are regulatory or jurisdictional.

"Wetlands are jurisdictional; when they come under the authority of one of the federal agencies, and, in some cases, under the authority of state agencies that have assumed responsibility for reviewing permits." (Walker and Richardson, 1991, 5)

Wetland Definition

This section presents a brief history of wetland definitions that have had both scientific and regulatory purposes. Effective law enforcement ultimately depends upon a clear definition of what constitutes a jurisdictional wetland. Perhaps the classification most used historically is contained in the FWS publication *Wetlands of the United States* (U.S. Fish and Wildlife Service, Circular 39, published in 1956, and reissued several times) (Shaw and Fredine, 1956). This classification, created by Martin et al. (1953), uses common terms such as *fresh meadows*, *bogs*, *marshes*, *wooded swamps*, and so on to describe 20 types of U.S. wetlands (Kusler, 1983). Water depth and permanence, water chemistry, vegetation life form, and dominant plant species are used to classify wetland types. One of the problems with this approach is that many different meanings have been attached to the key terms (Kusler, 1983). And because the emphasis is waterfowl habitat, greater attention has been paid to vegetated than nonvegetated areas.

The great egret (*Casmerodius albus*) is common in marshes, mangrove swamps, and mud flats. Photograph at Lakin Slough, Guthrie County, Iowa courtesy of Ty Smedes, Nature Photography, Urbandale, Iowa.



Marshland in a desert environment, the Bosque del Apache National Wildlife Refuge in New Mexico. Photograph courtesty of Tom Rosburg, Colo, Iowa.

The greatest problem has been the inadequate definition of types, which ultimately led to inconsistent application (Cowardin et al., 1979; Leitch, 1966; Stewart and Kantrud, 1971).

Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al., 1979) addresses inherent problems of Circular 39 by providing another set of objective concepts for use (Table 1.3). This classification system is hierarchical, progressing from five systems at the most general level to dominance types based on plant and animal communities at the most specific level. The system also includes modifying terms for water depth, water chemistry, soil, and human influence. The initial classification (Shaw and Fredine, 1956) was developed as part of the FWS's inventory of wetlands. The sole purpose of this inventory was to assess extent and type of waterfowl habitat. Since then, the extent of U.S. wetlands has naturally changed (e.g., in deltas and along coastlines) and has been changed considerably by humans. At the same time, wetland ecology has become better understood.

The social construction of the term *wetland* and its definition have expanded. The scope of the 1974 directive to design and to conduct a new national inventory of wetlands was considerably broader than the scope of earlier classification systems. In addition to providing basic data on the characteristics and the extent of the nation's wetlands and deepwater habitats, the 1974 directive was intended to facilitate management of these areas. The FWS identified four long-range objectives: (1) to describe ecological units with certain homogeneous natural attributes; (2) to arrange these units in a system that would aid decisionmaking about resource management; (3) to furnish units for inventory and mapping; and (4) to provide uniformity in concept and terminology throughout the United States. In sum, the primary objective of the classification was to impose boundaries on natural ecosystems for the purposes of inventory, evaluation, and management (Cowardin et al., 1979). Such boundaries are to a large extent arbitrary, as they are driven by program objectives,

Snow geese (*Chen caerulescens*) and sandhill cranes (*Grus canadensis*) feed near the water in the Bosque del Apache National Wildlife Refuge in New Mexico. Photograph courtesy of Tom Rosburg, Colo, Iowa.

Canvasback ducks (*Aythya valisineria*) at Goose Lake, Green County, Iowa. Photograph courtesy of Ty Smedes, Nature Photography, Urbandale, Iowa.

Table 1.3. Comparison of wetland types described in U.S. Fish and Wildlife Service Circular 39 with some of the major components of the Cowardin et. al. classification system (Cowardin et. al., 1979)

	Classification of wetlands and deepwater habitats		
Circular 39 types and references for examples of typical vegetation	Classes	Water regimes	Water chemistry
Type I Seasonally flooded basins or flats Wet meadow (Dix and Smeins, 1967; Stewart and Kantrud, 1972) Bottomland hardwoods (Braun, 1950) Shallow-freshwater swamps (Penfound, 1952)	Emergent wetland Forested wetland	Temporarily flooded Intermittently flooded	Fresh mixosaline
Type 2 Inland fresh meadows Fen (Heinselman, 1963) Fen, northern sedge meadow (Curtis, 1959)	Emergent wetland	Saturated	Fresh mixosaline
Type 3 Inland shallow fresh marshes Shallow marsh (Golet and Larson, 1974; Stewart and Kantrud, 1972)	Emergent wetland	Semipermanently flooded Seasonally flooded	Fresh mixosaline
Type 4 Inland deep fresh marshes Deep marsh (Golet and Larson, 1974; Stewart and Kantrud, 1972)	Emergent wetland Aquatic bed	Permanently flooded Intermittently exposed Semipermanently flooded	Fresh mixosaline
Type 5 Inland open fresh water Open water (Golet and Larson, 1974) Submerged aquatic (Curtis, 1959)	Aquatic bed Unconsolidated bottom	Permanently flooded Intermittently exposed	Fresh mixosaline
Type 6 Shrub swamps Shrub swamp (Golet and Larson, 1974) Shrub-carr, aider thicket (Curtis, 1959)	Scrub-shrub Wetlands	All nontidal regimes except permanently flooded	Fresh
Type 7 Wooded swamps Wooded swamp (Golet and Larson 1974) Swamps (Penfound 1952; Heinselman 1963)	Forested wetland	All nontidal regimes except permanently flooded	Fresh
Type 8 Bogs Bog (Dansereau and Segadas-vianna, 1952; Heinselman, 1963)	Scrub-shrub wetland Forested wetland Moss-lichen wetland	Saturated	Fresh (acid only)
Type 9 Inland saline flats Intermittent alkali zone (Stewart and Kantrud, 1972)	Unconsolidated shore	Seasonally flooded Temporarily flooded Intermittently flooded	Eusaline Hypersaline
Type 10 Inland saline marshes Inland salt marshes (Ungar, 1974)	Emergent wetland	Semipermanently flooded Seasonally flooded	Eusaline
Type 11 Inland open saline water Inland saline lake community (Ungar, 1974)	Unconsolidated bottom	Permanently flooded Intermittently exposed	Eusaline

Table 1.3. continued

Circular 39 types and references for examples of typical vegetation	Classification of wetlands and deepwater habitats		
	Classes	Water regimes	Water chemistry
Type 12 Coastal shallow fresh marshes Marsh (Anderson et al., 1968) Estuarine bay marshes, estuarine river marshes (Stewart, 1962) Fresh and intermediate marshes (Chabreck, 1972)	Emergent wetland	Regularly flooded Irregularly flooded Semipermanently flooded–tidal	Mixohaline fresh
Type 13 Coastal deep fresh marshes Marsh (Anderson et al., 1968) Estuarine bay marshes, estuarine river marshes (Stewart, 1962) Fresh and intermediate marshes (Chabreck, 1972)	Emergent wetland	Regularly flooded Semipermanently flooded–tidal	Mixohaline fresh
Type 14 Coastal open fresh water Estuarine bays (Stewart, 1962)	Aquatic bed Unconsolidated bottom	Subtidal Permanently flooded–tidal	Mixohaline fresh
Type 15 Coastal salt flats Panne, slough marsh (Redfield, 1972) Marsh pans (Pestrong, 1965)	Unconsolidated shore	Regularly flooded Irregularly flooded	Hyperhaline Euhaline
Type 16 Coastal salt meadows Salt marsh (Redfield, 1762; Chapman, 1974)	Emergent wetland	Irregularly flooded	Euhaline Mixohaline
Type 17 Irregularly flooded salt marshes Salt marsh (Chapman, 1974) Saline, brackish, and intermediate marsh (Eleuterius, 1972)	Emergent wetland	Irregularly flooded	Euhaline Mixohaline
Type 18 Regularly flooded salt marshes Salt marsh (Chapman, 1974)	Emergent wetland	Regularly flooded	Euhaline Mixohaline
Type 19 Sounds and Bays Kelp beds, temperate grass flats (Phillips, 1974) Tropical marine meadows (Odum, 1974) Eelgrass beds (Akins and Jefferson, 1973; Eleuterius, 1973)	Unconsolidated bottom Aquatic bed Unconsolidated shore	Subtidal Irregularly exposed Regularly flooded Irregularly flooded	Euhaline Mixohaline
Type 20 Mangrove swamps Mangrove swamps (Walsh, 1974) Mangrove swamp systems (Kuenzler, 1974) Mangrove (Chapman, 1976)	Scrub-shrub wetland Forested wetland	Irregularly exposed Regularly flooded Irregularly flooded	Hyperhaline Euhaline Mixohaline fresh

available data, and the current scientific understanding.

A number of other classifications of wetlands and deepwater habitats have been developed (Golet and Larson, 1974; Jeglum et al., 1974; Millar, 1976; Odum et al., 1974; Stewart and Kantrud, 1971; Zoltai et al., 1975). Most are regional. For instance, Golet and Larson's (1974) constitutes a detailed classification of wetlands in the glaciated Northeast; Stewart and Kantrud's (1971), a classification of wetlands in the glaciated prairies. All systems are readily related to the FWS's.

The initial effort of the FWS to determine quantity and location of U.S. wetlands surveyed 40% of the contiguous 48 states. The more comprehensive effort to develop a National Wetlands Inventory (NWI), initiated in 1974, actually began mapping in 1979 after techniques had been refined. By 1991, the NWI had mapped 70% of the lower 48 states and 18% of Alaska (Environmental Defense Fund and World Wildlife Fund, 1992).

The FWS also has a program to determine the total quantity of wetlands and to estimate wetland losses. This effort uses the classification system developed by Cowardin et al. (1979). The first status and trends report appeared in 1983 and covered the 1950s through the 1970s (Frayer et al., 1983). An updated report was released in 1991 to cover 1975 through 1985 (Dahl and Johnson, 1991). Current work focuses on hydrology.

These efforts have provided a broad range of general information about changes in wetland quantity and quality. In the contiguous 48 states, of the 221 million acres of wetland (or wet land) probably existing in the 1780s, less than half (103 million acres) remained in 1985 (Dahl, 1990). Dahl (1990) indicates that in the 48 states there remained about 98 million acres of freshwater (inland) wetlands and about 5 million acres of estuarine (coastal) wetlands into the 1980s. It is estimated that 2.6 million acres of wetland were converted to other uses between the mid-1970s and the mid-1980s; freshwater wetland underwent 98% of this conversion. Agricultural land uses accounted for 54% of the conversions from wetland to upland and represented a substantial change from the earlier status and trends report in which agricultural conversions represented 87% of all wetland losses (Dahl and Johnson, 1991). Overall, remaining wetland acreage in the mid-1980s constituted 5% of all land area in the United States. The 1991 status report (Dahl and Johnson, 1991) also suggests that since 1985, wetland losses have slowed due to restoration and conservation under provisions of the 1985 Food Security Act, as well as to heightened awareness of the value of wetlands. Conversions also have slowed because of stagnant and falling commodity prices and implementation of Section 404 of the Clean Water Act. Most of the incentives in federal farm programs encouraging conversion were absent in the 1985 and 1990 farm bills. This undoubtedly has reduced conversions.

Care must be exercised in interpreting wetland inventories and trends. Such estimates are subject to a variety of technical problems, not the least of which are the dynamics of both definition of and year-to-year physical changes in wetlands. More importantly, inventory and examination of one resource in isolation are of little use. Unless similar inventories of forest land, agricultural land, grassland, and urban land are available, no meaningful relative basis exists on which to suggest land management or allocation policies.

Wetland Delineation

Wetland delineation—identifying wetland boundaries—is primarily a regulatory issue. After it is determined, according to the applicable regulation, that an area under question is a jurisdictional wetland, the next step in the regulatory process usually is to delineate wetland boundaries. Regardless of the focus of regulation, the boundary must be identified for public and for private interests.

Wetland delineation is based on the two federal manuals mentioned above by the Environmental Laboratory (1987) and the Federal Interagency Committee for Wetland Delineation (1989). Wetland delineation, at the time of this writing, is somewhat subjective. These manuals need to be refined from the experiences gained since they were first introduced. Field tests have indicated a degree of consistency when each was used alone, but they need to be considered as early approximations of manuals that rely on better field indicators, e.g., hydric soils.

Wetland delineation requires identification of hydric soils. Use of the "Hydric Soil List" has not been satisfactory. Many of the soil series that are on the list can be both hydric and nonhydric. Therefore the use of the list is at best only a clue; the soils must be field identified as hydric or nonhydric. As stated by Hurt and Brown (1993), "Because definitions and criteria are not recognizable in actual field situations and proof of their existence is very difficult to verify, the federal definition and criteria (for hydric soils) left much to be desired." Hurt and Brown (1993) recently stated the experience of Florida on the use of "indicators" versus "criteria." The indicators have resulted in less litigation and the litigation quickly upheld the use of indicators. The number of cases requiring litigation has diminished from a flood to essentially nothing. Hurt and Brown make a strong case for the use indicators because indicators are in-place, field recognizable features of a soil. These soil features are in-place and not on a list in an office nor are they defined by something that may take years to verify such as "anaerobic for 2, 10, or 40 or however many days in the growing season."

Indicators are based on real phenomena that are present during dry periods or after drainage. The National Technical Committee for Hydric Soils (NTCHS) is developing easily recognizable "indicators" or field criteria that can be used by soil scientists. A list of these indicators is being established; some are national and some are regional. A soil is a hydric soil if most of the indicators are encountered. The agreement on indicators and their uses has taken several years to develop and field test, but they work in a more satisfactory manner than other approaches because indicators are real; they exist in space on the ground. Locally developed indicators for delineation are quite different from a criterion such as "days of saturation." One problem with indicators is that in some areas such as in the prairie wetlands, reliable, consistent indicators are difficult to find. Using field tested and workable, observable, in place features works. Definitions that are arbitrary do not. We can change definitions and criteria but something else usually changes the observable features in a soil. Soils as noted by Cowardin et al. (1979) are the best long-term indicators of hydrology.

Scores of wetland delineation workshops preparing technicians to delineate wetland boundaries consistently continue to be held around the country. No state or national standards for wetland delineators exist although the USACE has initiated a certification program.

Leitch (1992a) has characterized the delineation issue as one of a debate about the "drier-end" wetlands (Figure 1.1). There is no concern about delineating between wetland and deep water habitats—or the "wetter end," for no one claims that wetlands are dry; nor is conversion at the wetter end an issue. The concern is with distinguishing between regulated or jurisdictional wetlands and adjacent/adjoining dryland. In areas with relatively little topographic relief, tens or hundreds of meters of the wetland boundary easily could be in dispute.

In that wetlands are found along the land-water continuum and often are natural features distinguished with difficulty, the delineation debate likely will not be resolved soon. However, the current work by the National Academy of Science committee may make a contribution.

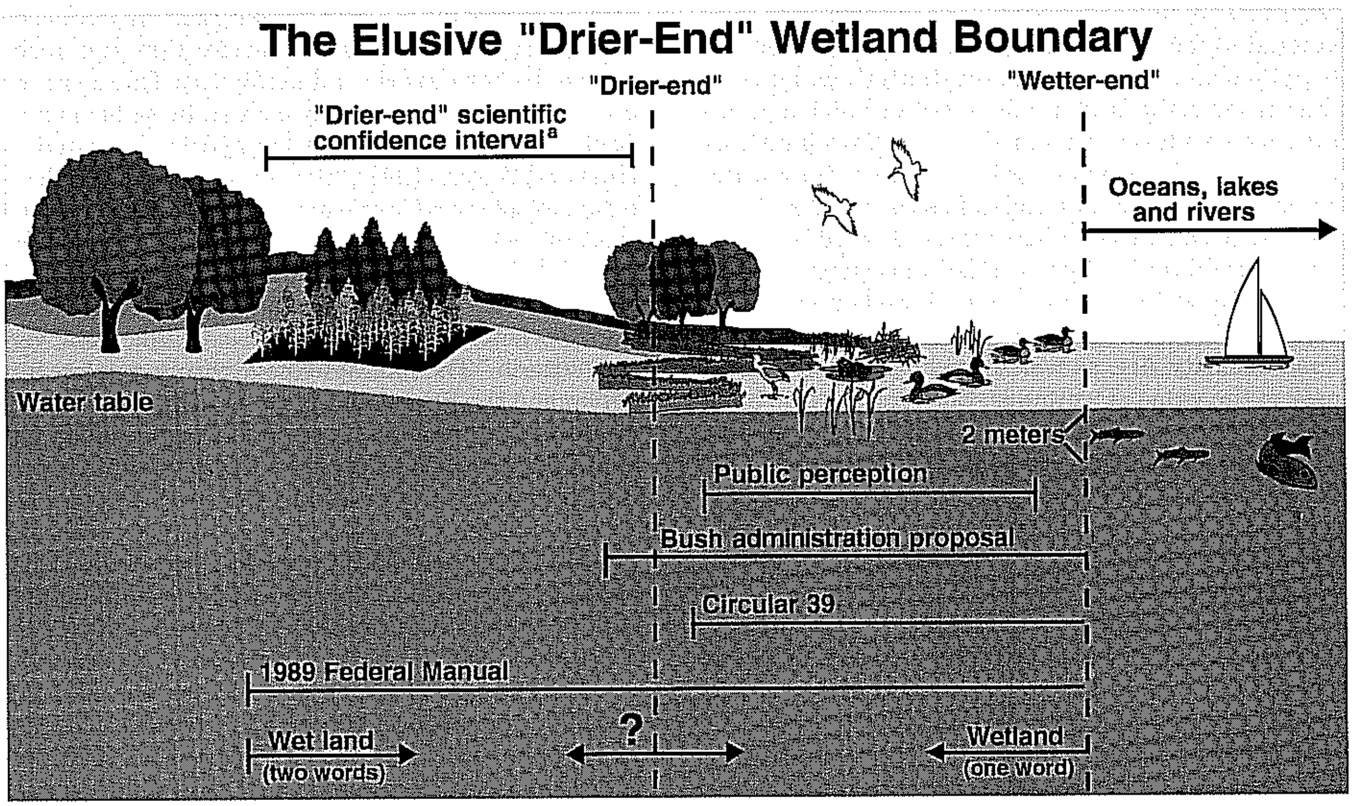


Figure 1.1. Elusive "drier-end" wetland boundary (Leitch, 1992a). [a]Given the scientific subjectivity in the three factors commonly used to "identify" wetlands (soils, vegetation, hydrology), science cannot objectively delineate the "drier-end" any tighter than shown.

2 Functions and Values of Wetlands

In Brief

Reasonable wetland policy requires thorough and theoretically proper consideration of all wetland benefits and costs (expressed as appropriate positive or negative values), including the alternative uses of such lands and the full range of trade-offs involved in both protection and conversion. Establishing that wetlands have a positive socioeconomic value stemming from the output of goods and services is necessary, but not sufficient, evidence that wetlands should be protected. The social opportunity cost of—or everything that society gives up by—maintaining a wetland must be considered if social welfare is to be maximized. So knowing that wetlands generate value is only part of the story; knowing what society must give up to maintain wetland is another part, as is knowing the relative values of other resources, e.g., uplands, deserts, forests, or other nonwetlands.

Function versus Value

A tall oak tree growing in the middle of an urban thoroughfare could be shown to provide ecological services. It would provide nesting sites for birds; it would consume carbon dioxide; it would produce biomass and store energy. But no reasonable person would suggest that society would be better off keeping it there just because it had value. Rather, the marginal value of having it would need to be compared with the value of not having it in the middle of the road. The most valued choice would maximize social welfare, all other things being equal.

A solar powered hand-held calculator can perform many functions. It can divide, multiply, compute square roots and logs, calculate percentage change. But if that calculator were forever misplaced on a camping trip, it would have no value to society other than the potential future value of its metallic components. In other words, function does not create value; it allows for the opportunity to create value.

The no-net-loss policy, taken literally (as is common among many wetland proponents) implies that each and every wetland is more valuable to society than any alternative use of that area and that any other component of the landscape sacrificed to maintain each and every wetland has less social value than does the wetland (Leitch, 1992b). State-of-the-art wetland sciences and social sciences are not able to defend such policies rigorously, nor are such policies intuitively logical. They are in fact unlikely to maximize society's welfare, for they implicitly ignore the downward sloping demand for wetland functions and the positive socioeconomic values of nonwetland. The fact that one-half of the initial endowment of wetland has been converted to other uses has no bearing on how society values what remains.

Social value, an appropriate common denominator for social decisionmaking, frequently is confused with ecologic function. For there to be social value, function must lead to some potential perceptible change in human well-being. Value is multidimensional and depends on the accounting stance and the valuation purpose. The policymaking arena for wetland needs to encompass an accounting of the costs and the benefits of all of society's options with respect to the use or the nonuse of wetland and of all other resources affected by wetland decisions. Decisionmakers also must be aware of the trade-offs between the costs of possibly making a poor decision today and the costs of waiting to make a decision.

Introduction

A physical description of a wetland ecosystem, like that of any ecosystem, includes biotic (living) and abiotic (nonliving) components interacting dynamically in space and time. Ecologists have attempted to understand and to describe how ecosystems operate by defining and by studying ecosystem structure and function (Odum, 1973).

The biotic components of ecosystems may be described as having (1) composition, or essentially an enumeration of the species present; (2) diversity, or the variety of species; (3) spatial organization, or the dynamic distribution of species vertically, horizontally, and temporally; and (4) trophic structure, or food webs or chains (Ehrlich and Roughgarden, 1987; Odum, 1973; Ricklefs, 1990).

Ecosystem function means "this is what happens," or the natural processes that occur in the ecosystem (Miller, 1975). The abiotic components of the ecosystem are matter, which cycles through the ecosystem, and energy, which flows but does not cycle. The biotic structures and the abiotic functions interact on a planetary scale to sustain all life, as long as new energy (the sun) is supplied.

A clear distinction can be and needs to be made between ecosystem function and ecosystem service. Literature about wetland seldom makes any distinction between function and service; lack of separation creates more confusion. Ecosystem functions are processes occurring in the ecosystem. When humanity benefits from these functions, a valuation system can be devised to measure goods and services emanating from ecosystem functions (see forthcoming discussion of economics).

How Wetlands Work

Wetland ecosystems are known to ecologists as ecotones or as transitional systems. Ecotonal wetlands lie along a gradient between terrestrial and aquatic ecosystems (Figure 2.1). Such wetland ecosystems contain elements of both. Because of the complexity of interactions resulting from their structure and functions, wetlands occupying ecotonal positions often are more diverse and productive than neighboring systems. These same properties—complexity and diversity—make wetland ecosystems challenging to understand. Yet the difficulty in defining wetlands has not arisen from the complexity and diversity reflected in their ecosystem structure and function but from the transition from wet to dry.

Factors making terrestrial ecosystems distinct and recognizable from each other are (1) successional stage (maturity state), (2) regional climate, (3) soil parent material, (4) topography, (5) biota, and (6) cataclysmic events such as fires, hurricanes, and earthquakes (Major, 1951). The ways in which these factors combine or exist will determine the type of terrestrial ecosystem that results.

Many of these six factors contribute to structure and function of a wetland ecosystem as well. The presence of water for long periods near or at the surface, however, is the key feature. The major factors determining the hydrological conditions are (Mitsch and

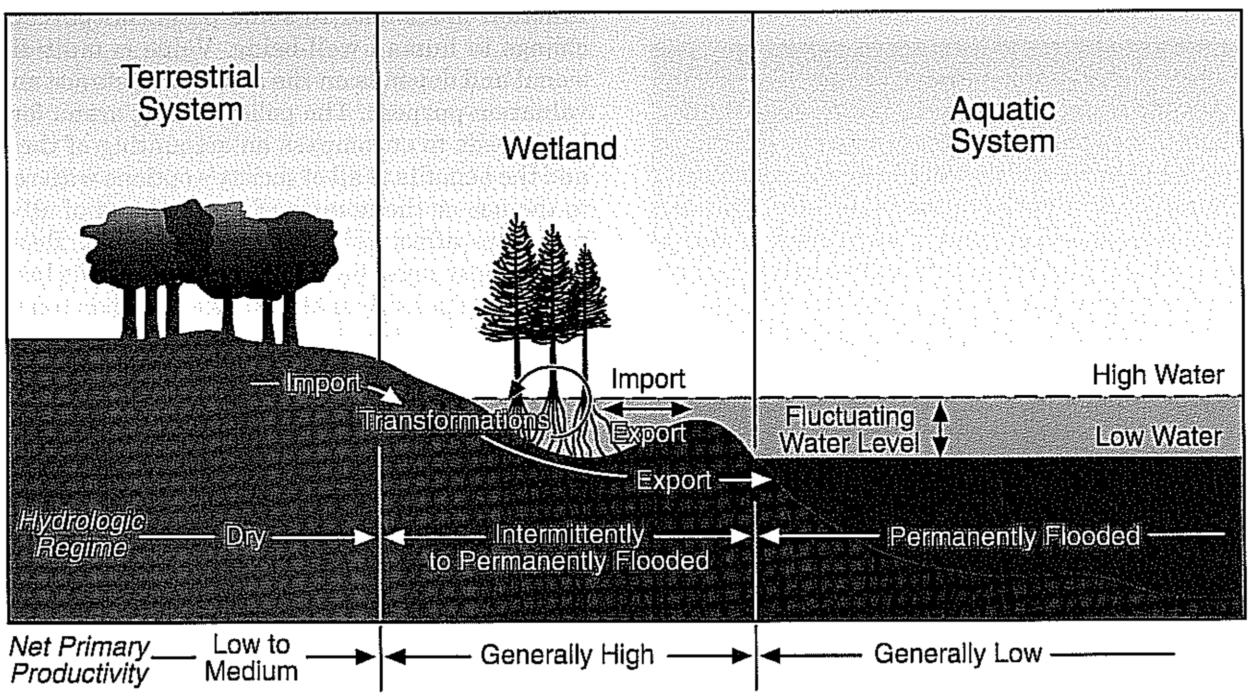


Figure 2.1. Wetland as ecotone, and selected comparative characteristics between ecosystems (adapted from Mitsch and Gosselink, 1986, 10).

Gosselink, 1986)

- surface contours of the landscape,
- balance between inflows and outflows of water, and
- subsurface soil, geology, and ground water conditions.

In general, these hydrological factors operate to accumulate and to retain water. It is where water accumulates that wetland forms. Chemical and physical properties such as nutrients, sediment types, and pH interact with the hydrological and biotic components of the wetland (Figure 2.2). Together, hydrology, biogeochemistry, and biology are the primary interacting factors that produce distinct wetland types.

Several questions underlying wetland dynamics need to be answered if wetland management decisions are to be administered properly (Kusler, 1987):

- What are the major and minor sources of surface and subsurface water?
- What is the magnitude of the sources of water over a specified period of time, including maxima, minima, and mean (average) conditions?
- What are the characteristics of the water source (depth, velocity, turbidity, dissolved and suspended materials, and temperature)?
- What plant, fauna, soil and other associations result or are associated with the sources and their specific characteristics?
- What happens to the water while in the wetland, e.g., reduced velocity and sediment deposition, nutrient removal, and infiltrate to ground water?
- What changes occur in the wetland due to the flow of water and to the substances that it brings in and out of the wetland?

This general discussion of wetland illustrates the complexity of the ecosystem being managed and provides the framework in which we understand that hydrological characteristics are key to determining the attributes of wetlands and their services.

What Wetlands Do

Ecologists describe ecosystems, including wetlands, in terms of structure and function (Figure 2.3). Likewise, natural resource managers have devised schemes for classifying wetland (Cowardin et al., 1979) and for assigning relative comparisons based on valuation estimates (Adamus and Stockwell, 1983). The Cowardin scheme contains some 55 classes of distinct wetland types, and when all modifiers are included there are potentially more than 16,000 different coastal wetlands and 200,000 inland types (Adamus and Stockwell, 1983). The Cowardin method is a taxonomic classification based primarily on vegetation and assigns no priorities to wetland types.

The Adamus method (Adamus, 1988) is used to compare wetlands in terms of function and value. This ranking system assesses ecosystem services or values provided by the different wetland types. Values included are ground water recharge and discharge, flood storage and desynchronization (Figure 2.4), shoreline anchoring, erosive forces dissipation, sediment trapping, nutrient retention and removal, food chain support (Figure 2.5), fish and wildlife habitat, and active and passive recreation. Wetland classification schema necessarily are complex because wetlands are complex ecosystems. Wetland attributes are listed for evaluation purposes under five general categories—planetary function, hydrology, water quality, habitat, and direct human use (Table 2.1).

Science can describe the structure and the function of specific wetlands and can build on these findings to provide descriptions of what wetlands can do in terms of their attributes and composition. These descriptions, however, are general and are incomplete when applied to a specific wetland. There are limitations in both theory and knowledge. Problems do not stand still while scientists refine models and extend knowledge of ecosystem structure and function. Decisions will be made now with our present understanding.

Decisionmakers will not have, nor are they necessarily expected to have, the expertise to apply the Adamus, or some equally complicated, method to evaluate and to compare wetland functions and values. A general overview of structure, function, and ecosystem services provided by wetlands must be part of the decisionmaker's information, however (Figure 2.6). The general background information that follows is to supplement such an overview:

- Wetlands vary structurally and functionally within and between physiographic and biogeographic regions.
- Wetland seldom performs all functions attributable to it.
- All wetlands do not perform the same functions. Those that do perform the same functions may differ in terms of outputs.

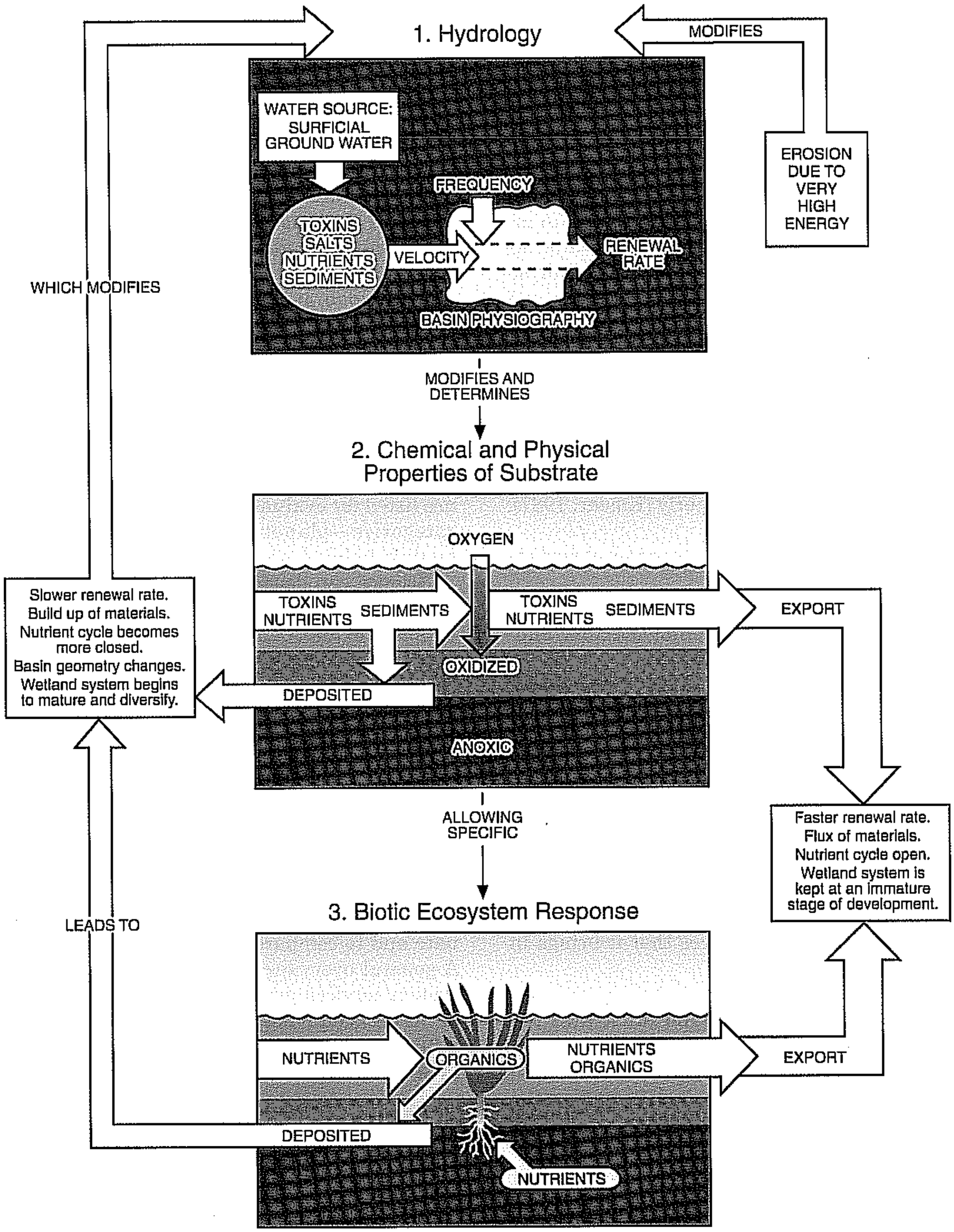


Figure 2.2. Conceptual model of wetland ecosystems showing interaction of hydrological, biogeochemical, and biotic components, with energy flow and atmospheric inputs omitted (adapted from Mitsch and Gosselink, 1986, 57).

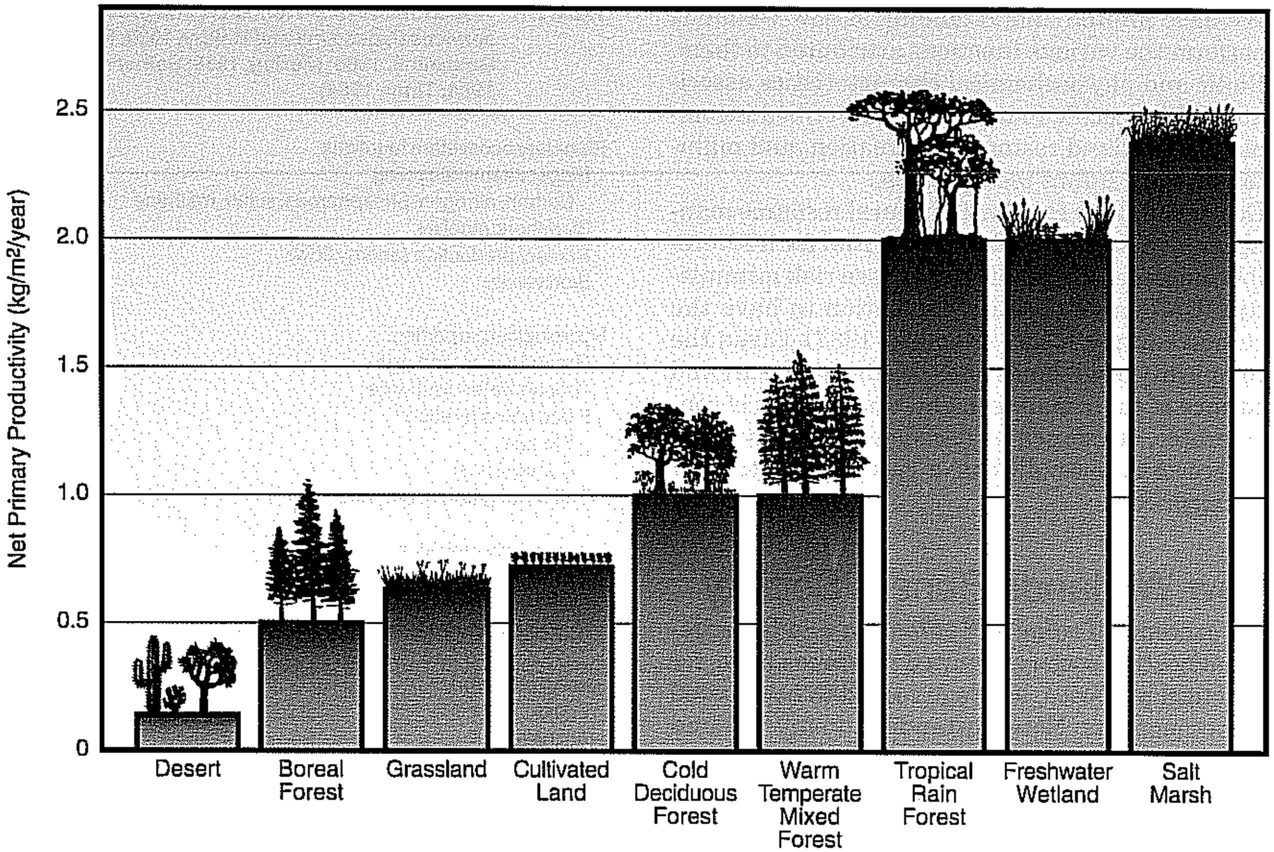


Figure 2.3. Relative productivity of wetland ecosystems in relation to others (adapted from Tiner, 1984).

Physiographic describes a region having a pattern of relief features that differs significantly from that of adjacent regions. A watershed may be considered a physiographic boundary of a region.

Biogeographic describes the physical pattern of plant and animal distribution. Biogeographic regions are continental or large in scale and tend to have their own specialized plants and animals although they can share specific families with other biogeographic regions.

- Wetlands are dynamic ecosystems and differ in the rate and the nature of change. Functional characteristics are altered by changes, and may range from the appearance of entirely new functions to the modification or complete disappearance of existing ones.
- Wetlands fully capable of carrying out certain functions may not have the opportunity to do so, e.g., wetlands located in watersheds with no history of the use of toxicants would have no opportunity to retain toxicants.

The term *upland* or *uplands* should not be used to denote the transitional zone between wetlands and drylands. Uplands can contain wetlands, drylands, or both. The prairie pothole region is an upland wetland, as are *pocasins* (an Algonquin phrase meaning "swamp on a hill" [Mitsch and Gosselink, 1986]), which are evergreen shrub bogs found on the Atlantic Coastal Plain.

The transitional zone between wet land and dry land can perform some of the same ecosystem services (Table 2.1) that the wetter end of the wetland does. For example, a dryland upland may reduce runoff or trap sediments and transform nutrients, as may the upper end of a wetland. Thus, for understanding and discussion, scientists and decisionmakers are encouraged to use the term *upland* in a context not including the transition zone of a wetland.

- We have limited understanding of how wetlands perform the various functions attributed to them. Biotic and physiochemical characteristics associated with specific functions are described incompletely. Wetland restoration, creation, and maintenance are infant technologies.
- Decisionmakers faced with natural resource management decisions with the potential for irreversible outcomes are advised to choose risk minimizing strategies to protect the option to have the resource in the future (Randall, 1987). Given the complexity of wetlands and the state of the art and science of their management, uncertainty is considerable. Inasmuch as decisionmaking can lead to irreversible conditions, a risk-averse strategy is suggested.

How Wetlands Benefit Society

The concepts of *value* and *valuation* and the criteria for allocating society's limited resources have, for all practical purposes, long ago ceased to be debated among economists. Notwithstanding, many wetland scientists, regulators, and proponents are highly suspect or downright skeptical of basic economic principles. Although economics, as the study of how society makes choices, clearly has an important role to play in resource allocation, it often is used to rationalize the choice that is selected as opposed to leading to a rational choice.

Although there may be an ethical component of *value* (Norton, 1987), in a policymaking context value is social (Amacher et al., 1988; Bergstrom et al., 1990; Powell, 1982; Taff, 1992). Not until dramatic and arguably quite unlikely changes occur in world social and political institutions can policymakers even begin to consider such obscure value systems as energy values (Costanza et al., 1989) or intrinsic ecological values, which may exist only because humans think they do. Inasmuch as social values should be the point of departure in any discussion of contemporary wetland policymaking, clarification of what constitutes social value is necessary.

Some have argued that people may not know how important wetland is to their well-being and thus likely would underestimate the "true" value of wetland. Information is similarly limited, however, for most complex choices that consumers face. This lack of public awareness is understandable since wetland proponents seldom discuss wetlands relative to other resources but simply assign absolute values to their functions. Informed trade-off is the mechanism by which value is expressed. However, some people may prefer that experts make decisions for them in cases involving technically complex issues.

Table 2.1. Wetland ecosystem functions and provision of services (Gosselink and Maltby, 1990; Mitsch and Gosselink, 1986; Niering, 1988; Sather and Smith, 1984; Tiner, 1984)

Planetary ecosystem functions
Biogeochemical cycling
Carbon, nitrogen, phosphorous, sulfur, methane
Biospheric stability
Primary production (energy flow)
Biodiversity
Hydrological properties
Ground water recharge
Ground water discharge
Flood flow alteration
Storage
Conveyance
Salt water gradient potentiation
Water quality provision
Sediment stabilization/entrapment
Sediment/toxicant retention
Nutrient removal/transformation/enrichment
Habitat provision
Plants
Animals
Aquatic
Terrestrial
Direct human utilization of ecosystem services
Production/export
Timber, forage, peat, wild rice, phosphate rock, fish, shellfish, game, fur, aquaculture
Recreation/aesthetics
Education
Uniqueness/heritage
Bank stabilization

Economists define *economic value* as the amount that individuals or aggregates of individuals, i.e., society, are willing and able to pay in a private market for specified goods and services (Figure 2.7). In a public market or collective choice system, value is willingness to pay and ability of politicians to appropriate public funds. Values are monetary measures of the change(s) in human well-being brought about by a function or a service (Taff, 1992), whether from a wetland or a golf course. An imperfect market structure results in some less than perfect methods of estimating socioeconomic values for many nonmarket or amenity goods and services. Yet the policy-relevant precision of the valuation tools of environmental economists is no less sharp than the relative outcomes of many of the measurement tools of physical and

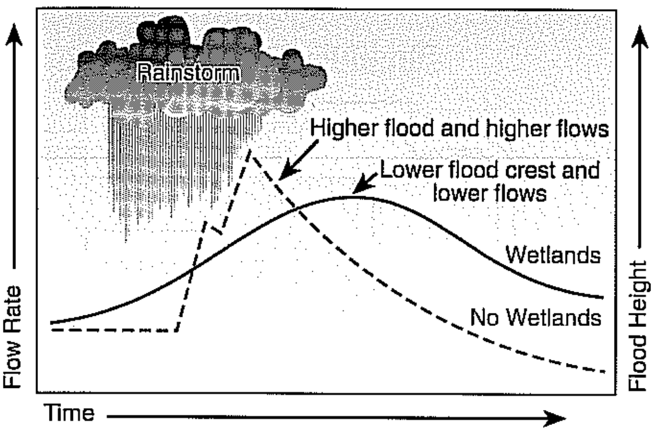


Figure 2.4 Wetland value in reducing flood crests and flow rates after rainstorms (adapted from Tiner, 1984).

natural scientists. As in all areas of science, we must work with what we have until something better is developed.

Economists who have estimated wetland values have all considered wetland functions as producing outputs to be valued; the functions themselves are not values to society although they may be valuable to the natural system. Amacher et al. (1988) provide a comprehensive treatment of how the ecological characteristics of wetlands are transformed into output

Figure 2.6. Interrelation of wetland structure, function, and ecosystem services on following pages.

demanded by wetland users. Demand curves are estimated and the areas under these curves represent the values of wetland outputs to society (Figure 2.7). Without demand now or in the predictable future, there is no socioeconomic value. To avoid semantic quandries, some economists are beginning to use the term *worth* instead of *value*.

The valuation issue is partly disciplinary semantics. Many deduce that function is value when, in fact, function (or wetland service) leads to value in some but not all cases. Total social value includes nonuse values, current-use values, and future-use values (Bergstrom et al., 1990). Resource economists who have modeled wetland valuation (Amacher et al., 1990; Bergstrom et al., 1990; Leitch et al., 1984; Thomas et al., 1979) agree that the conceptual valuation model begins with wetland attributes, which lead to wetland outputs, which may be transformed into potential economic functions, which lead to economic values (Figure 2.8). Neither the ecological function nor the wetland itself is valued directly; rather, it is the way in which these service flows affect societal well-being that impacts value. This fact has important implications in discussions of mitigation, as will

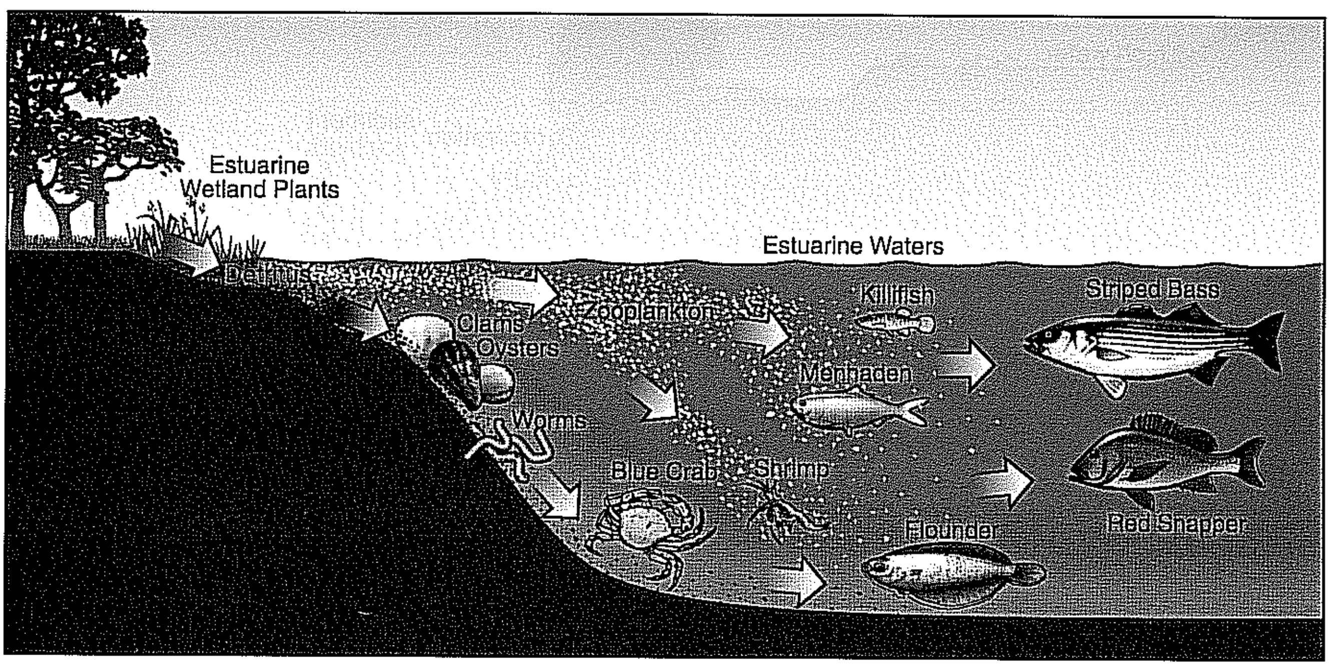
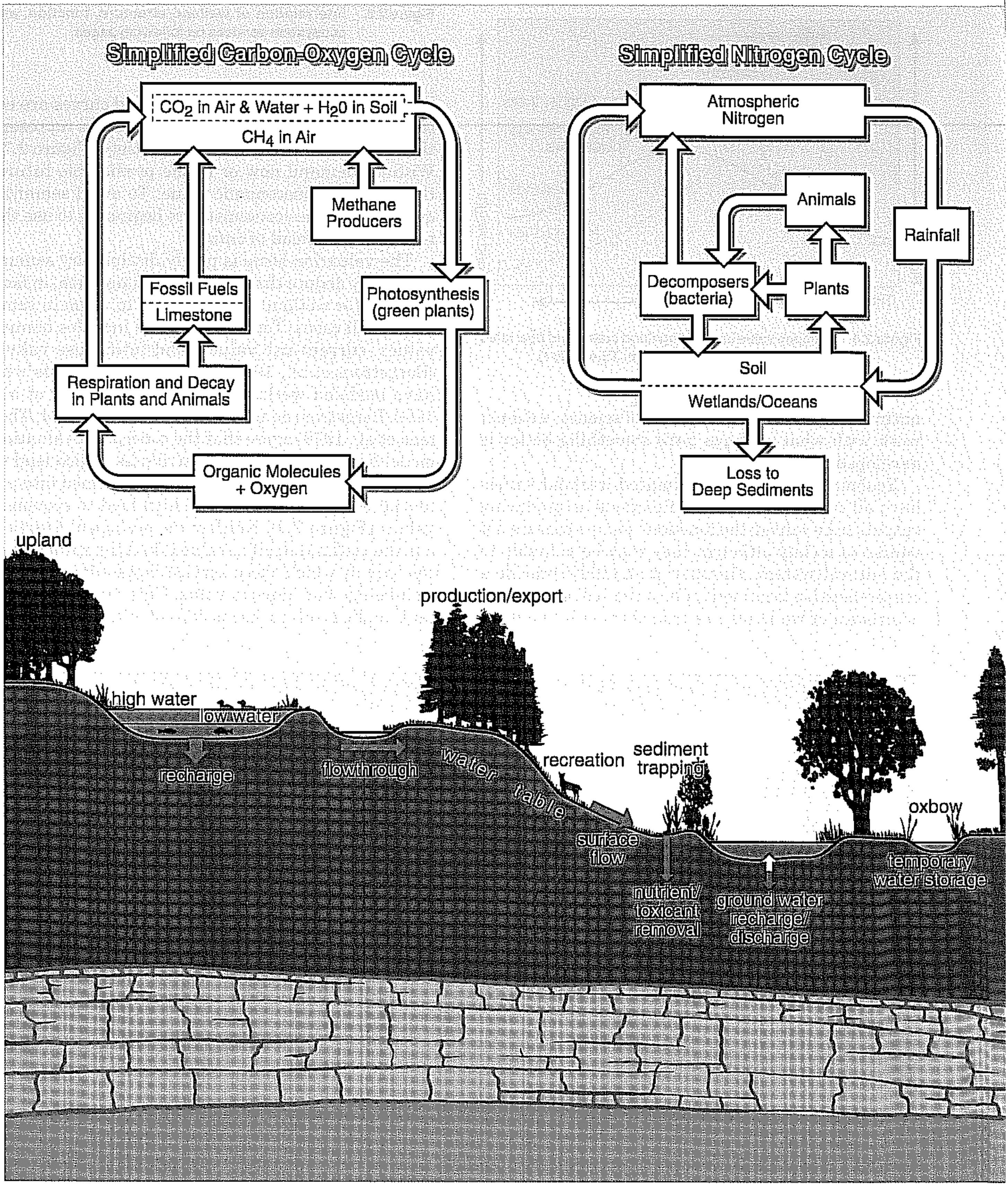
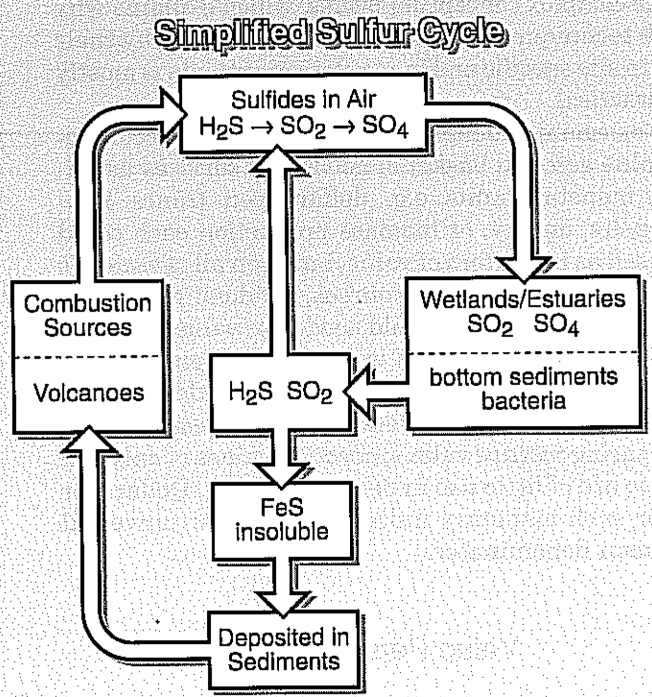
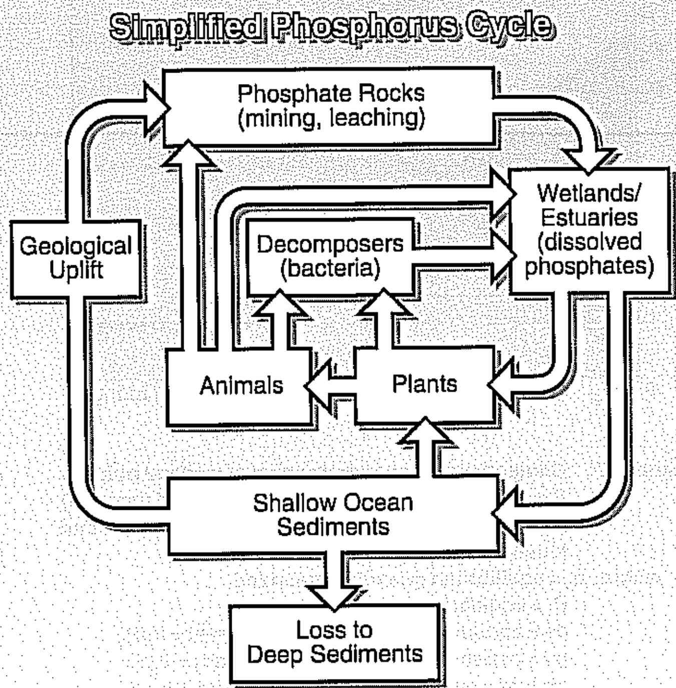
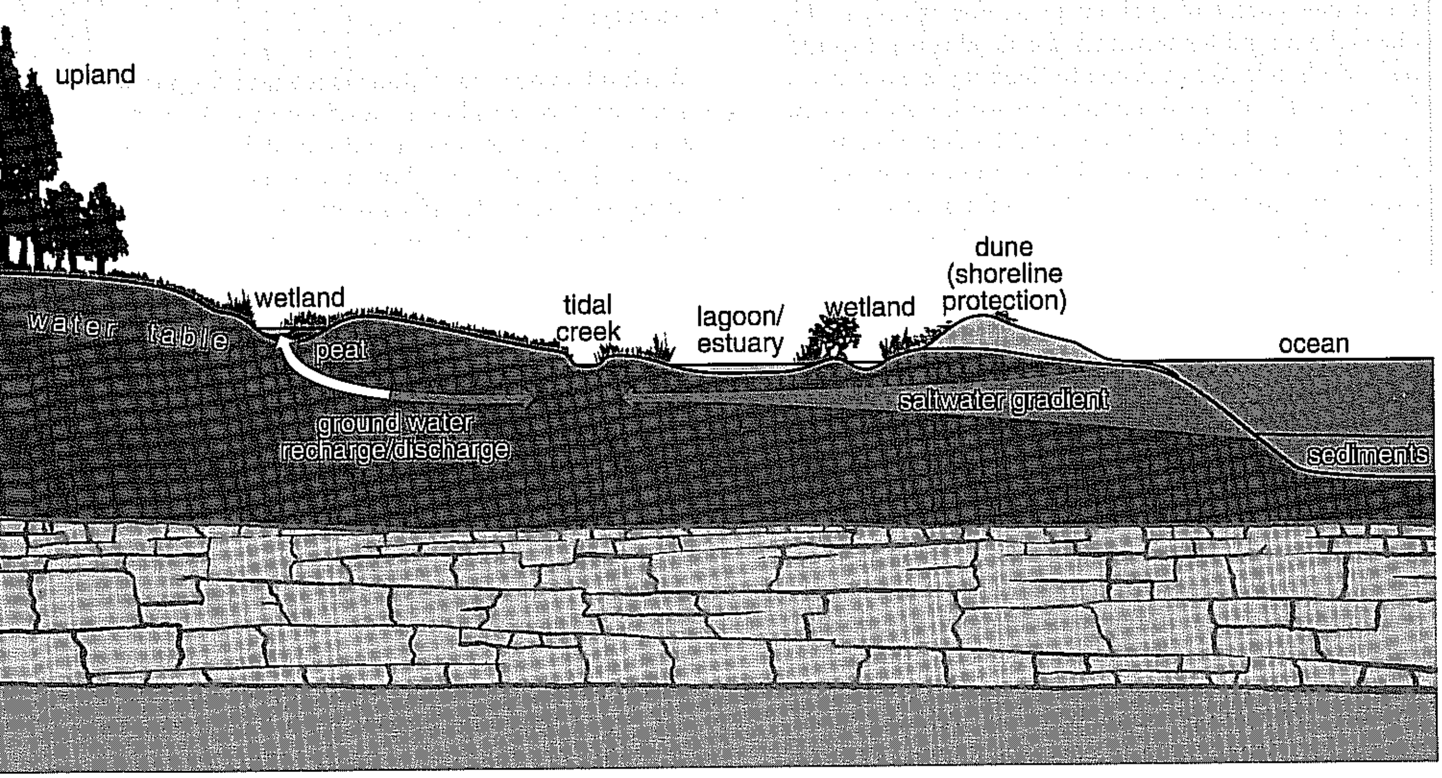


Figure 2.5. Simplified food pathways from estuarine wetland vegetation to commercial and recreational fishes (adapted from Tiner, 1984).


Simplified Carbon-Oxygen Cycle
CO2 in Air & Water + H20 in Soil
CH4 in Air
Methane Producers
Fossil Fuels
Limestone
Photosynthesis (green plants)
Respiration and Decay in Plants and Animals
Organic Molecules + Oxygen
Simplified Nitrogen Cycle
Atmospheric Nitrogen
Animals
Rainfall
Decomposers (bacteria)
Plants
Soil
Wetlands/Oceans
Loss to Deep Sediments
upland
production/export
high water
low water
recharge
flowthrough
water table
recreation
sediment trapping
surface flow
nutrient/toxicant removal
ground water recharge/discharge
oxbow
temporary water storage


Simplified Sulfur Cycle
Sulfides in Air
$H_2S \rightarrow SO_2 \rightarrow SO_4$
Combustion Sources
Volcanoes
H_2S SO_2
Wetlands/Estuaries
SO_2 SO_4
bottom sediments bacteria
FeS insoluble
Deposited in Sediments


Simplified Phosphorus Cycle
Phosphate Rocks (mining, leaching)
Geological Uplift
Wetlands/ Estuaries (dissolved phosphates)
Decomposers (bacteria)
Animals
Plants
Shallow Ocean Sediments
Loss to Deep Sediments


upland
wetland
water table
peat
ground water recharge/discharge
tidal creek
lagoon/ estuary
wetland
dune (shoreline protection)
saltwater gradient
ocean
sediments

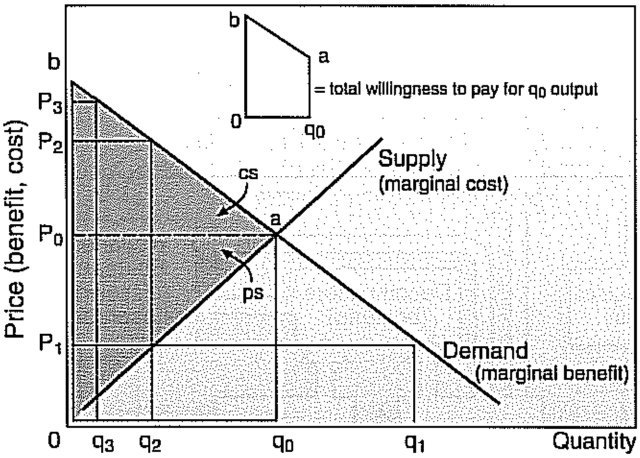


Figure 2.7. Components of economic value of wetland output:
S = supply of wetland output = f_a (wetland function)
D = demand for a wetland function = f_a (wetland location, x_1, x_2, x_3. . .)
where: q_0 = equilibrium quantity demanded
P_0 = equilibrium price
cs = consumers' surplus or net benefit = baP_0
ps = consumers' surplus or net return = P_0a0
cs + ps = net social benefit of wetland output
cost to "use" wetland = aq_00

be explained.

The demand for wetland is derived from both the demand for wetland outputs and the existence of alternative sources of such outputs. For example, the derived demand for wetlands for flood control would be low when land not prone to flooding is not scarce. Likewise, the derived demand for wetlands for flood control would be flat if levees and floodproofing were inexpensive alternatives or if flooding were rare. On the other hand, the derived demand for wetlands as waterfowl producers would be close to the demand for waterfowl, because there are no reasonable substitutes for wetlands in waterfowl production. Even in waterfowl production, many species nest and feed in nonwetland so other landscape components also contribute to their value.

A considerable body of literature deals with techniques for evaluating the full range of wetland outputs (Leitch and Ekstrom, 1989). Techniques are available to value both the market and the nonmarket outputs of wetlands (Amacher et al., 1988). Grouping benefits (functions) into conservation, direct output, indirect output, and nonuse benefit, Pearce and Turner (1990) reviewed the methods of wetland use-valuation. As an example, Bergstrom et al. (1990) estimate the total economic value of wetland based recreation. Application of each technique requires technical expertise as well as careful attention to some complex conceptual issues, which explains why such techniques generally are avoided and why their use in site specific and in regulatory contexts is mostly impractical.

The common denominator used to assess economic value across a basket of goods and services usually is monetary units, e.g., dollars, yen, francs. Beaver pelts, energy, or biomass production each could be used as indicators of value, but then all of society's other options, e.g., golf courses, condominiums, automobiles, farm land, would need to be valued in these unconventional units as well to make comparisons possible so that efficient social choices could be made. In any case, a common denominator is necessary for comparing *relative* values; *absolute* values of only one choice are of little use in decisionmaking. Dollars, or other such monetary units, are the most universal common denominator.

Value Perspectives

Value also depends on perspective, of which there are at least four relevant to the subject at hand:

- wetland owners,
- wetland users,
- business, and
- society.

Wetland owners see value from a market perspective or what wetland can contribute to the owners' revenues. Wetland owner values include revenue from the direct sale of wetland products, e.g., hay and hunting rights. Wetland owners also may increase net revenue from wetlands by using water or hay as inputs into the production of livestock or by converting wetland to another use, e.g., cultivation. Finally, wetland owners may value wetlands for certain nonmarket attributes, e.g., wildlife habitat or aesthetics.

Most wetland users, e.g., recreationists, see wetland value in a nonmarket but nevertheless measurable context that contributes directly to their individual well-being as the enjoyment of wetland outputs. Some wetland users, however, purchase use rights in the marketplace, e.g., hunters paying access fees to wetlands or livestock producers purchasing wetland hay or grazing rights.

Main street businesses view wetlands' value in terms of their effect on the region's economic activity, e.g., sales, jobs, and tax revenues. These regional values often are referred to as the *multiplier effect*, i.e., the impact on local business activity. While not nationally significant since they usually are shifts in activity from one place to another, regional values influence wealth and job distribution among regions.

Finally, society's valuation of wetlands is an aggregation of owner, user, and regional values. User identification is not easy, nor is quantification of user value intensities. Equally difficult is the identification of those to aggregate in estimating social value. The important point is that there is no single value appropriate for all wetland allocation decisions.

Wetlands also have value as location on a spacially limited planet. Most of the alternative uses resulting in wetland loss are to take advantage of the wetland's location. Agriculture, for example, converts wetlands to produce crops or to eliminate nuisances. Transportation converts wetlands to build roadways or airports. Developers convert wetlands to build houses and commercial buildings. Thus, wetlands have value to society when converted to alternative uses; alternative land uses also may provide society with many or even all wetland functions or outputs. Furthermore, value is no single measure; it depends on whether the valuation is for all wetlands as a resource, a subset of wetlands, a single wetland, or a change in wetland outputs. Total, or absolute, value has little meaning in wetland policy except in comparisons among the total values of individual wetlands or of all wetland with all nonwetland. The value of a quantitative or a qualitative change in a resource is marginal value—the value most important to wetland policymaking.

> *Marginal value* is the value of the incremental unit (one more or one less).
>
> *Total value* is the sum of the additive values of all units.
>
> *Average value* is the total value of all units divided by the number of units.

Marginal Value

A problem with implications more serious than those of the semantics issue is that of the conceptual differences among marginal, average, and total val-

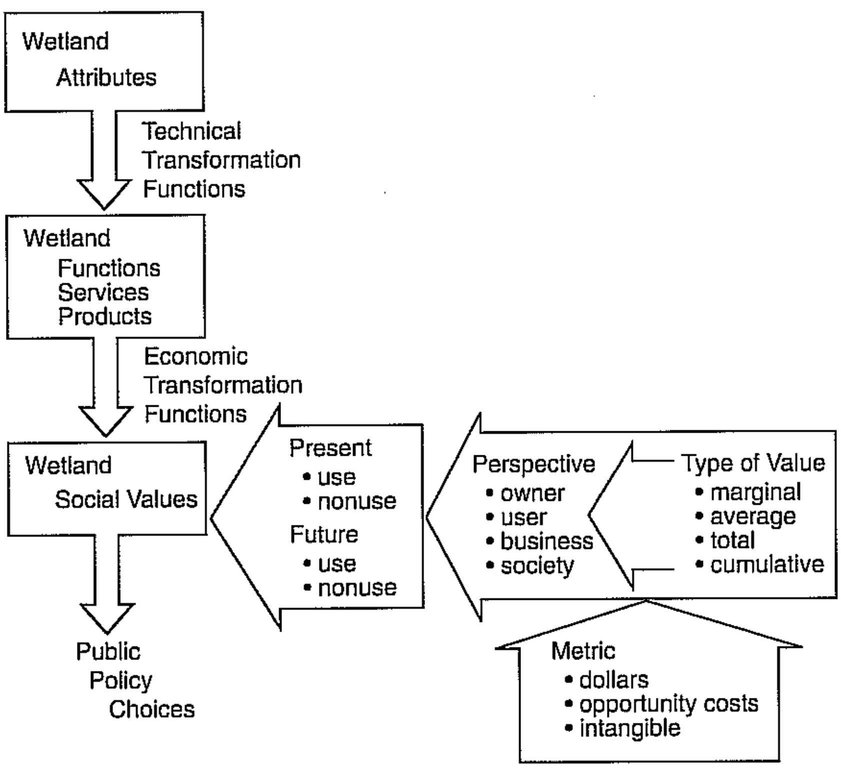


Figure 2.8. Transformation of wetland attributes into social values.

ues. There is longstanding agreement among economists that demand curves slope downward—that marginal utility of more and more of any "normal" good, including wetlands, diminishes. In other words, the 100,000th unit of output from a wetland function (q_1 in Figure 2.7) is not as valuable to society as is the 10,000th unit (q_2), nor is the 10,000th unit as valuable as the 1,000th (q_3). In other words, the more we have of something, the less each additional unit is worth.

One of the early published estimates of wetland value implied that each acre of Louisiana's tidal marsh was worth approximately $80,000 (Gosselink et al., 1974). This sum could represent the marginal value of an acre when there are only a few thousand acres or the average value when there are only a few thousand acres, but the sum very likely is not the marginal value of the next generic acre that could be lost when there are hundreds of thousands of acres. Nor is it likely to be the average value of Louisiana tidal marsh.

Opposition to marginal valuation stems from the notion of "cumulative impacts," or the tyranny of small decisions. One concern is that the systemwide impact of changing one wetland among many wetlands cannot be assessed adequately by observation of the wetland in isolation (Gosselink and Lee, 1989). A comprehensive economic assessment will include but may not always quantify any and all impacts, so this concern lacks a valid basis. The primary constraint to quantifying all impacts is adequate physical and biological data with which to estimate the appropriate transformation function to make the connections between functions and values. As Taff (1992, 19) states, "To do adequate wetland valuation studies, we simply must have more information about the services that result from wetland functions." However, decisionmakers also need more information about services that result from nonwetland functions to provide an adequate valuation. Another concern is that the value of any particular wetland may be low and, therefore, we are not justified in protecting it, especially if a comprehensive evaluation is conducted by comparing relative value with nonwetland.

3 Agricultural Conflicts with Wetlands[1]

In Brief

There are at least two sides to every story—wetlands being no exception. This section highlights a few of the potentially adverse aspects of wetlands. Wetland conflicts arise because ever more people are concerned about a finite, diminishing, and scarce resource with ill-defined property rights. Resolution of most conflict will rest with society, specifically with legislators and courts. Although most causes and consequences of these conflicts can be explained through either scientific inquiry or technical analysis, few if any conflicts can be resolved without social choice making.

Introduction

The great diversity of outputs from both preserved and converted wetlands generates demand from a wide range of potential users. Some users are interested in wetlands as nature preserves, others as flood control mechanisms, and still others as potential cropland or building sites. Many wetland uses are compatible, such as flood flow alteration and wildlife habitat; some are incompatible, such as baitfish harvest and food fish aquaculture. Obviously, most preservation uses are incompatible with most uses resulting in total conversion. The conflicts regarding wetland are (1) among competing users of the outputs of unaltered wetland, and (2) between proponents of preservation and those wishing to convert wetlands to other uses.

Disagreements regarding a wetland can be categorized as involving (1) wetland as a nuisance; (2) wetland conversion as a nuisance; (3) conflicting in situ uses (e.g., cranberry production, peat or aggregate mining, logging, and aquaculture); and (4) legal conflicts over property rights. Each area of conflict has implications from the perspectives of wetland owners, wetland users, and society. Complicating matters even more, the social perspective includes present as well as future generations. Perspectives and potential for conflict at least should be identified during development of appropriate wetland management policies.

Wetland as a Nuisance

Wetlands can be but are not always a nuisance to farm operators, real estate developers, transportation planners, and other extensive users of the landscape. Wetlands also can affect overall public health. For instance, nuisances stem from the financial implications of avoiding wetlands, complying with wetland protection regulations that require mitigation, offsetting preventative health measures, depredation by wetland wildlife, or providing a mosquito breeding area.

Farm operators have at least four reasons for thinking of wetlands as a nuisance. First, wetlands are obstacles to field operations in many parts of the country. This is especially true in the Prairie Pothole Region (Desjardins, 1984). As farm equipment became bigger and more powerful, it became more and more of a nuisance to farm around wetlands (Figure 3.1).

Second, wetland conversion often has been or has been perceived as the least expensive way for an individual farm operator to increase cropland. Although a good deal of research on the economics of wetland conversion to cropland indicates that it is not economical to do so based solely on cash flows, drainage of many wetlands, especially slight or modest depressions and some seasonally flooded areas, has been profitable (Swanson, 1986). Many factors influence whether or not conversion of wetlands to agricultural lands is profitable; these factors include market prices, land prices, and government farm programs (U.S. Department of the Interior, 1988).

Third, not only is wetland an obstacle to normal farming, it also is an obstacle to intensified farming. For example, center pivot irrigation systems are dif-

[1]This section highlights some of the negative aspects of wetlands with respect to agriculture. It is not intended as a comprehensive treatment of wetlands. The previous section presented an overview of how wetlands work and what they do.

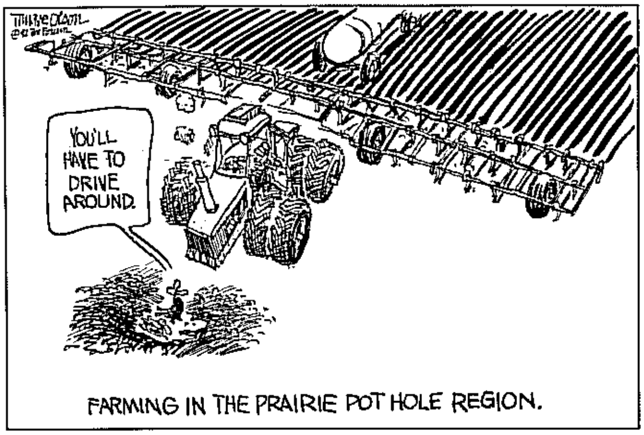


Figure 3.1. Farming in the prairie pothole region (by Trygve Olson, *The Forum*, 1991).

ficult to operate in fields with scattered wetlands. Alteration of wetland to accommodate center pivots may violate federal Swampbuster or state wetland conservation laws.

Finally, wetlands often serve as a seedbed for noxious weeds and as a habitat for wildlife depredating nearby crops. Purple loosestrife and leafy spurge are two examples of noxious, invasive weeds that can grow in wetlands. Migrating blackbirds roosting in cattail marshes are responsible for an estimated $2 million lost per year to North Dakota sunflower producers alone (Baltezore et al., 1994).

On the positive side, however, wetlands benefit farm operators in numerous ways. Wetland may provide a source of hay in drought years. They may provide a source for irrigation or for livestock water by holding water and releasing it slowly. Wetland also may provide an alternative income source if landowners charge fees for recreation access.

Some states have programs outlining the preservation options available to wetland owners. The Minnesota Board of Water and Soil Resources (1988), for example, encourages landowners to consider all alternatives before making a drainage decision. Many Maryland groups, in cooperation with the EPA, have developed the *Private Landowner's Wetlands Assistance Guide* to aid in evaluation of options.

Real estate developers see wetlands as both nuisances and amenities (Steinberg, 1989). Wetlands are nuisances when regulatory programs hinder development schemes; they are amenities when they add value to adjacent residential and commercial property (Doss and Taff, 1993). The value they add, however, may be a function of open space and not other wetland attributes.

Wetland is a nuisance to road builders. Obviously, straight, level roads through wetland usually are less expensive to build than roads around wetland.

Some members of society also see wetlands as a social nuisance. Long ago, wetlands were thought of as wasteland and as potential nurseries for disease carrying biota. Some still view wetlands as wasteland (Ray, 1993). Indeed, considerable evidence indicates that wetlands contribute to mosquito problems (Ha-

Farming in North Dakota in the Prairie Pothole region of the United States often requires farming around significant wetlands. Photograph courtesy of Jay A. Leitch, North Dakota State University, Fargo, North Dakota.

An aerial view of the Prairie Pothole region in the north central United States. Photograph courtesy of Jay A. Leitch, North Dakota State Universtiy, Fargo, North Dakota.

zeltine, 1992). Malaria was as far north as Michigan and Wisconsin in the late nineteenth century. Some wetlands also are responsible for municipal water quality problems because natural chemical and biological changes affect taste and odor characteristics.

Drainage as a Nuisance

Drainage, or—more generally—wetland conversion, is a nuisance to those desiring unaltered wetlands, to those living downstream, and sometimes to society as a whole. Those residing or engaging in economic activity near drained wetland may see their activities affected. For example, drainage may increase the depth of water that stands on a neighbor's field. Drainage increases flood flows, thereby potentially impacting adversely downstream property and activity. One person's decision to drain for his or her own well-being usually does not entail consideration of those downstream who may be affected adversely. Generally, drainage eliminates or drastically reduces most, if not all, of the positive aspects of unaltered wetlands. Society thus views drainage as a nuisance, because it affects society's well-being. On the other hand, society also may benefit from drainage (e.g., new shopping opportunities, increased agriculture output). The key is to balance these costs and benefits.

Captured Values

During the past two decades, a number of conflicts have arisen as a result of wetland regulations. The primary source of conflict has been specifying, either explicitly or implicitly, property rights when none had been specified legally before. What had been specified "clearly" was the property right in an area of land, some of which happened to be wet. The new right is the right to drain, which has led to most of the takings cases, in which landowners claimed that their right to the best use of the land had been infringed when they were forbidden to convert wetland. In many ways, the government reinforced this perception by subsidizing wetland conversion for decades (Office of Technology Assessment, 1984).

The takings issue is extremely complex and involves legal, ethical, and philosophical issues. It is discussed further in Chapter 4. It is important to understand that social values change over time, which also may alter society's perceptions of land ownership. As views of social nuisance change, so do choices of societal control. What some landowners may have thought were their rights with respect to wetland may have evolved into a social right.

4 Socioeconomic Issues

In Brief

Socioeconomic issues are straightforward conceptually, but in operation these issues are quite complex. Of paramount importance is a *specification of property rights to resources being regulated.* Only after these rights have been specified can the impact of alternative policies be assessed.

All wetland regulations will affect the economic decisions of individuals, firms, and the public. Ideal regulations will contribute to overall economic efficiency at the expense of certain segments of society.

These socioeconomic issues should be an explicit part of wetland policy and decisionmaking. There will need to be compromises and trade-offs. Questions of who and of whether or not to compensate must be answered. All perceptions of fairness will have to be considered. Clearly, wetland issues are not solely within the domain of technicians: many nontechnical and noneconomic values come into play.

Introduction

Society has four types of tools with which to influence or to control use and allocation of natural resources: education, government purchase, command-and-control regulations, and market-like incentives (Baumol and Oates, 1979). Each has been at one time or another applied to wetlands. Wetland educational programs have been developed by many government agencies, as well as by special interest groups. The federal government has purchased wetlands through their wetland acquisition and refuge programs. Federal, state, and local government regulations concerning the use of wetland by individuals, industry, and government are becoming increasingly common. Finally, market-like incentives include the federal government's easement programs, Water Bank, and in a sense, Swampbuster. And at state and local levels market-like policies have focused on property tax credits for preservation.

Development and implementation of efficient, equitable, and effective wetland policies require careful consideration of several important issues. The potential impacts of such policy tools can be assessed on the basis of income distribution, economic efficiency, and effect on property rights. The most problematic of these bases continues to be property rights.

Individual Versus Societal Property Rights

How land is defined and classified can have important implications for an owner's use of the land. Much of the controversy about wetland definition, classification, and delineation results from concerns by landowners that their rights to an economic return from their land will be infringed or eliminated if it is identified as a wetland and subsequently is regulated. The interests that one has to land can be individual, societal, economic, ecological, or philosophical in nature; we are interested in the individual and social concepts of ownership. (For discussions of the other points of view, see Machan, 1987; Randall, 1987; Stone, 1974; Tullock, 1970). Much of the following discussion of individual and societal property rights is summarized from Barlowe's (1990) essay entitled "Who Owns Your Land?"

Barlowe (1990) suggests that property involves the recognized and defendable rights of individuals and "other legal persons" to possess, enjoy, use, and dispose of economic goods such as land and buildings. Rights to use land exist because governments are willing to recognize and to enforce them. Without this protection, rights of ownership would be meaningless. We often think of property as something substantive and permanent, but in reality it is nothing more than a social promise. Property consists of rights that can be exercised with respect to things—not the objects themselves.

Property rights spring from society. While individuals may feel their rights are sacred and inviolate, in practice, rights depend on the interpretations accepted by society. Barlowe points out that rights are real only when the sovereign power, which acts as the agent of society, recognizes them, and willingly defends them.

Property rights involve a number of separable rights. These are like a bundle of sticks, with each stick representing a separate right. Some sticks involve the right to sell, to lease, to subdivide, and so on. Others involve interests such as water, mineral, and development rights. Each right can be separated from the others and exercised separately, as happens when one leases property or sells an easement (Barlowe, 1990).

When owners enjoy all the property rights permitted individuals at a point in time, they are called "fee simple" owners. Although they possess most property rights, their rights are not absolute. Four property sticks not part of the private owner's bundle are held by society and are exercised by its agent, the state. These sticks include the right to tax, the right to take for public use, the right to regulate or to control use (police power), and the right to possess when owners with no known heirs die without a will. Additionally, the government has auxiliary powers to influence owners in their use of land through powers of persuasion, public opinion, and so on.

Attitudes about land rights have changed in the United States. Historically, public policy emphasized private ownership rights and laissez-faire economics. Although we continue to cherish individualistic views popular on the American frontier, we have accepted an expanding governmental role in recent decades. This change has come about because of increased population, rising living standards, intensified competition for resources, broader education, wider suffrage, and expanded environmental and conservation concerns. Whereas several of these changes have influenced wetland issues, increased competition for resources and environmental concerns have been paramount.

Property is a dynamic concept. In the last 70 years, we have broadened our interpretation of public powers as regards property. Legislative actions and court decisions have broadened the basic rights that society holds in property. Some private rights have shifted to the public rights category, such as the private rights of control over water and air. How far this trend will go is uncertain. Barlowe contends that there is considerable sentiment for moving toward acceptance of stewardship, or the public trust view of rights, in land. He also contends that acceptance of this view calls for recognition of the fact that those rights enjoyed by owners of private property carry with them several responsibilities.

As evidenced by the high level of concern with regard to the "taking" of private property, it is highly likely that both competition for the use of land and conflicts of interest concerning use will increase. Such conflicts may be especially intense regarding wetlands when the public interest very often is at odds with private uses.

The Fifth Amendment to the U.S. Constitution lays out the basic rule that a person may not be deprived of property without due process of law, "nor shall private property be taken for public use without just compensation." This latter phrase was intended to ensure that the state, unless it paid the owner reasonable compensation, could not confiscate an individual's property.

It is not surprising, then, that extensive debate and litigation have occurred over precisely when a property has been "taken" and when the right to "just compensation" accrues. Meltz (1992) suggests that when the government formally appropriates property or physically occupies it, constitutional takings are identified easily. But the question is far more difficult when all that the government does is restrict property use—the so-called "regulatory takings." Society ultimately must attempt to balance the property rights of individuals against the community's health and welfare.

One such regulatory takings issue involves land use regulations. Powers (1985) suggests that land use regulations generally constitute an exercise in police power—the governments's right to regulate to protect the general welfare of its citizens. She also states that once the court reaches the takings issue, it will examine the property owner's "bundle of rights" to determine whether the effect of the government actions is to deprive the property owner of all reasonable use of the property. The government may remove from the bundle certain rights, e.g., the right to develop the property, without depriving the owner of its total use. If the court decides that the governmental restriction is too severe, just compensation is awarded to the owner. The court continues to stress that taking determinations remains an ad hoc matter (Meltz, 1992).

The takings issue has presented especially difficult questions for wetland regulation because the activities contemplated by the landowner do not seem inherently harmful, whereas the effect of prohibiting these activities may leave the landowner with little alternative use of the property (Powers, 1985). Zinn and Copeland (1982) contend that the wetland debate focuses on the effectiveness, equity, and costs of wetland protection. It seems that the court has sought a balance between a landowner's rights to use wetland and the public's desire to preserve it (Goldman-Carter, 1991).

Are remaining wetland resources protected adequately by existing laws and policies while the rights of landowners are similarly protected? This question is complicated by the fact that there are many different kinds of wetland and many laws involved. Some believe that protection efforts need to be enhanced, whereas others believe that they already are excessive and inflexible. Until the values of wetlands are quantified and contrasted with those alternative uses, this debate will continue. And even then there may be no agreement. The various governmental agencies responsible for managing and for regulating activities affecting wetland often are unable to reach consensus.

The number and the scope of federal and state laws protecting wetland likely will increase as our understanding of wetland improves. (For detailed discussions of laws relevant to wetland regulation and public trust doctrine, see Environmental Law Institute, 1993; Slade, 1990; or Want, 1990). The transition in public perception of wetland from nuisance to natural resource has not been smooth, and efforts to protect wetland continue to meet with misunderstanding and resistance. To develop a national wetland policy, all government branches and the various parties involved, e.g., landowners, developers, environmentalists, scientists, and others must work together, recognizing that both science and politics are involved (Kusler, 1992).

Economic Efficiency

One of the functions of wetland regulation is to enhance or to maintain the level of national economic well-being, which in the broadest sense entails more than financial statements. Economic well-being measures the welfare of society. Public policy is thought necessary because the open market fails to allocate resources efficiently and equitably although public policies do not necessarily always do better. Economists may disagree specifically on what to call this "market failure," but they agree that it exists because of ill-specified property rights, common property resources, external costs and benefits, differences between society and individual values of the future, imperfect markets, and, oddly enough, government intervention (Johnson, 1991; Randall, 1987).

The U.S. Water Resources Council (1983) identified national economic development (NED) as the primary decisionmaking criterion for water projects assessed from a national perspective. This term, which refers to the change in economic value of the national output of goods and services, usually is a point of departure for environmentalists who argue that it is inappropriate to place a dollar value on wetland.

The four public policy tools already mentioned—education, government purchase, command-and-control regulation, and market-like incentives—each impact NED. The effects of education; being voluntary, it will have little impact on NED apart from other policy instruments. Government purchase, as well will have little impact because the total dollar outlays affect few wetlands compared to regulation. The majority of wetland policies affecting individuals deal with either command-and-control or incentives.

Command-and-control regulations can take a variety of forms. Generally, they set standards, mandate or prohibit certain activities, or prescribe equipment. Inasmuch as the purpose of regulation is to correct for the absence of markets in wetland resources, the outcome should be to improve efficiency. Only under the best of conditions, however, will regulation achieve optimal allocation, for the cost of information and transaction can be high. A great deal needs to be known about a resource if we are to devise regulations improving the existing allocation. The economics literature on environmental and pollution control generally concludes that market-like incentives lead to greater efficiency than do command-and-control regulations. In each case, however, since not enough is known about wetland, a "second-best" (Randall, 1987) outcome is better than inaction. In other words, it is usually better to make an immediate decision with a reasonable amount of data than to wait until perfect or complete information becomes available. In any case, policy decisions usually will be made, regardless of the amount of information available.

Regulations controlling the use of any scarce resource add to an individual's or a firm's cost of doing business. In fact, the intended function of the regulation may be to increase cost, thereby approximating the full social cost so that allocation decisions are based on appropriate cost signals. For example, wetland regulations increase the cost to agriculture by increasing production costs. Because agriculture is a highly competitive industry, most of these added costs are absorbed by producers and are not passed on to consumers. Costs likely will be capitalized into reduced land values, in much the same way as increases in property tax are capitalized. Individual producers will be made less well off (in the absence of offsetting compensation). If the regulation was designed properly, society would, in total, be better off, because the level of NED would increase although NED is a slippery concept in a subsidized sector such as agriculture.

Wetland regulations increase the costs to other less-than-perfectly-competitive industries as well. But these industries are better able to pass along some or all of the costs of regulation to their customers or backward to input suppliers. The economic impact of wetland regulations on business is to increase costs of any affected activity. Thus, the price of outputs, e.g., clothing, lumber, automobiles, condominiums, will be increased; quantity demanded reduced; and some of the productive inputs freed for use as inputs in other areas of the economy. In an ideal world with corrected market failure and effective public interest review, regulation encourages the movement of resources to their best use.

Market-like incentives include primarily subsidies, taxes, or trading systems (e.g., mitigation banking and credit markets). Subsidies are used to encourage the market to produce what society wants, e.g., education, soil conservation, or wetland restoration. Subsidies generally imply that the property right to drain lies with the person or the firm subsidized. Taxes (fines, charges) are used to encourage the market to restrict production of anything causing negative externalities, e.g., production activities generating air or water pollution. Taxes and charges generally imply that the property right lies with society. Market-like incentives work like command-and-control except that they minimize the loss of efficiency by relying on voluntary action and free market adjustments. The outcome is the same, and the costs of correcting resource allocation are less than under regulation.

Ideally, wetland regulation improves the allocation of society's resources by making more efficient use of them. Such an improvement will come at the expense of certain individuals and firms. What society decides to do about compensating those who lose becomes another policy choice (dependent in part on property rights decisions). Resource and welfare economists have written extensively about how to account for these changes in the distribution of income, or equity.

Income Distribution, or Equity, Concerns

Almost any change in the status quo comes at the expense of some for the benefit of the whole (or for some group of others). That is, it affects the pattern of income distribution and includes, therefore, equity considerations. The U.S. Water Resources Council (1983) institutionalized equity as a public policy criterion, but for only a very limited domain. Some have characterized environmental concerns as "environmental equity" (Mallory, 1993), which is one aspect of the overall equity discussed here. Thus, both the efficiency changes and the subsequent equity implications are important to policymakers. Whereas NED measures the former, the "other social effects" (OSE) account takes into consideration changes in the distribution of income.

Equity considerations among people and groups alive today or between present and future generations can be addressed. What is important with respect to wetland regulations is that equity be an explicit factor in the decisionmaking process. Equity can be represented by a Lorenz Curve (Hyman, 1993), which abstractly depicts the distribution of wealth (although we usually measure income) across a population (Figure 4.1). An improvement in equity would move the "actual" curve toward the 45 degree, "preferred," line, which represents an equal distribution among all people. In principle, we could improve both

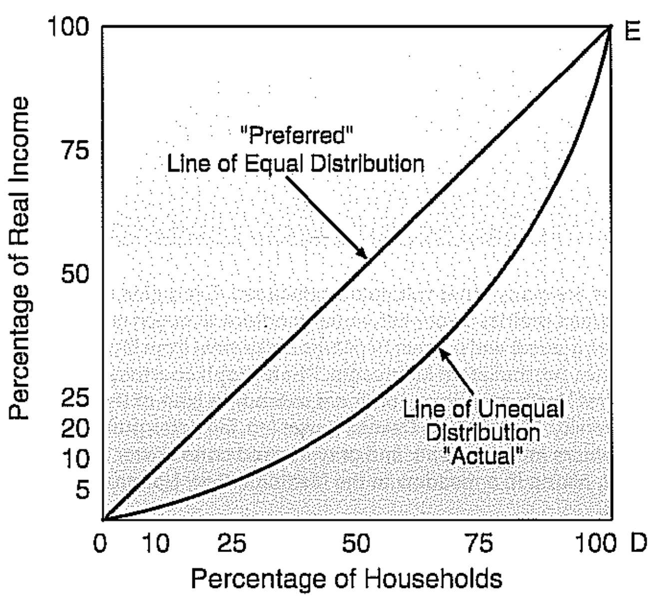
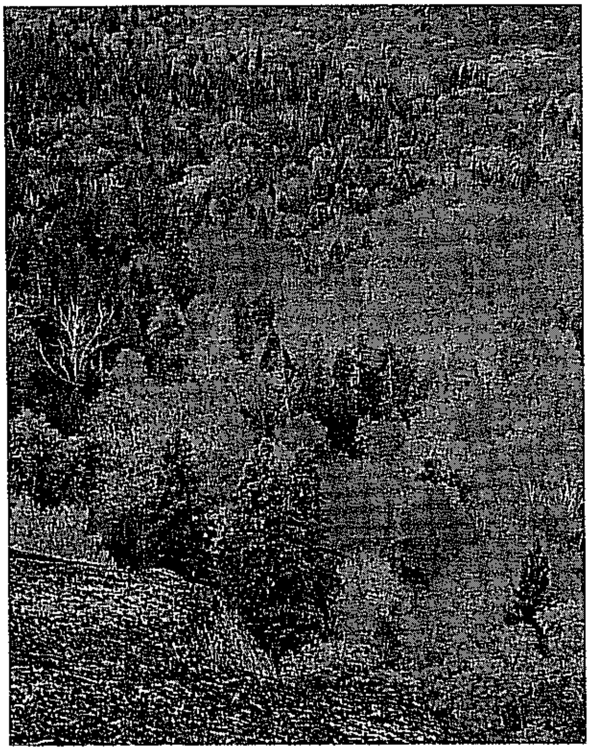
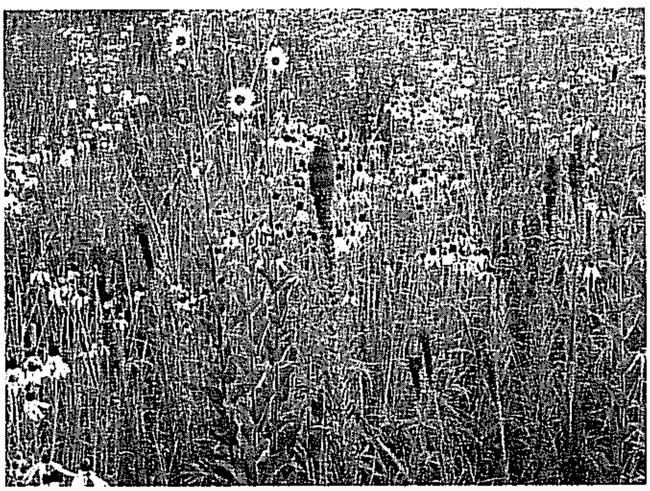
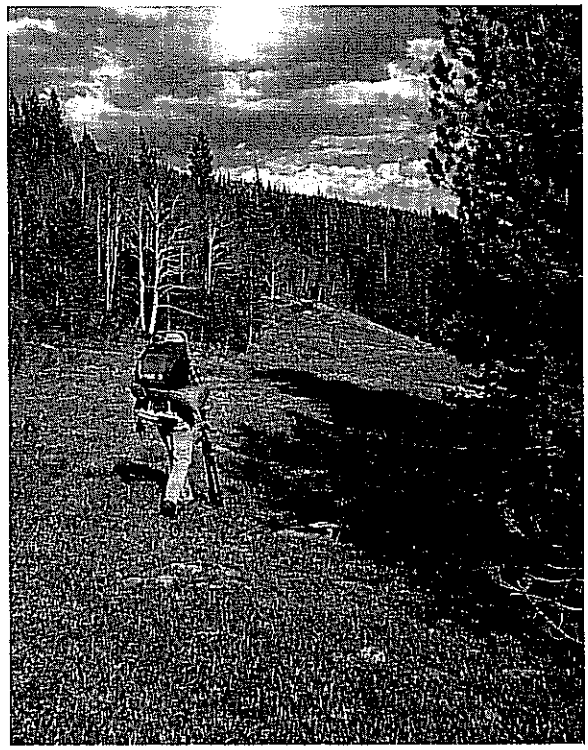


Figure 4.1. Lorenz curve.







There are many other valuable landscapes. Examples include hardwood forests, short and mid-grass prairies, mountain meadows, and tall grass prairie. Upper left, autumn colors of sugar maple (*Acer saccharum)*, red maple (*Acer rubrum*), and the spires of white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*) from Mystery Mountain looking toward Moose Mountain in Superior National Forest, Cook County, northeastern Minnesota. Photograph courtesy of Carl Kurtz, St. Anthony, Iowa. Upper right, the short to mid-grass prairie of the central North American continent extending east of the Rocky Mountains. Photography courtesy of Jay A. Leitch, North Dakota State University, Fargo, North Dakota. Lower left, tall grass prairie in Marshall County, Iowa with tall blazing star (*Liatris pychnostachia*), rosinweed *(Silphium integrifolium*), and gray headed cone flower (*Ratibida pinnata*). Photograph courtesy of Carl Kurtz, St. Anthony, Iowa. Lower right, hiking in a meadow in the Medicine Bow National Forest, near Laramie, Wyoming. Photograph courtesy of Tom Rosburg, Colo, Iowa.

efficiency and equity through wetland regulation, but generally the two criteria are to some extent mutually exclusive and therefore necessitate trade-offs.

An improvement in equity would result if wetland regulations made poorer people wealthier without also making already wealthy people proportionately even more so. If those benefiting from preserved wetland generally are poorer than those bearing the economic burden of preservation regulations, then such a regulation would improve equity.

On the other hand, if poorer people bear the burden of preservation so that wealthier people can enjoy the benefits, equity would be reduced. Again, any number of institutional schemes to implement policy could come into play. For example, those benefiting could compensate those losing. But to improve equity, relative wealth holdings also would have to increase. By offsetting compensation alone, regulators would be unable to achieve this end, for the wealthy have also had an improvement in their wealth.

Finally, to avoid diminishing the social wealth of future generations present generations may be required to forego certain activities such as wetland (or upland, or forest, or desert) conversion. This issue can be debated best by ethicists. Neither physical nor natural scientists nor economists can argue on the basis of their science that the future deserves (or does not deserve) sacrifice from the present. What can be argued in scientific terms are what constitutes a sustainable environment and the trade-offs required to achieve it.

Although discussed fairly thoroughly in the literature, equity issues are extremely difficult to incorporate into legislation, especially in concert with efficiency considerations. Nonetheless, wetland policymakers need at least to have been exposed to these issues if they are not to be blindsided. Inherent in any policy decision is an equity statement.

5 Wetland Conservation Concepts

In Brief

None of the many often required mitigation activities—restoration, replacement, creation—is defined uniquely in law or in practice. In drafting wetland legislation, lawmakers unknowingly use one or more of these terms to ensure that they have their political bases covered. In some places and times, these terms have one meaning and in other places and times they have another. Lawyers interpret one meaning; economists, another; ecologists, yet another. Until each of these much used terms is concisely and unambiguously defined, there will be controversy surrounding its use with respect to wetland allocation and management.

Meaningful discussion about implementation requires consensus regarding the meaning of these terms. Once all parties agree what mitigation and mitigation measures mean, the terms can be written precisely into regulations. We still have a long way to go.

Introduction

Wetland regulations more than likely will continue to call for protection, restoration, avoidance, minimization, replacement, sequencing, mitigation, and/or creation. These are not parallel terms but nonetheless often are used in sequence and interchangeably in the literature and in the law. Despite a vast and growing literature (e.g., Kentula et al., 1992), these terms are ill defined in the literature and in legislation. But the policy implementation process is considerably more complicated than the simple language of enabling legislation may suggest (Bromley, 1993). No-net-loss goals, for example, seek to maintain the overall area of wetlands within a region. This leads to wetlands creation, restoration, replacement, and/or enhancement.

The underlying philosophical and scientific concerns are how to identify what has changed, where in the system it should be accounted for, and how to compensate for a change. For example, to mitigate the effects of urban development, developers are often required to maintain open space. The question with wetland mitigation plans is whether they replace the exact ecological circumstances that existed and the functions that existed, and whether they enhance the well-being of society, or neither. Increased attention is being paid to the functions, leading away from preserving the wetland status quo and toward an attempt to maintain society's well-being. Additionally, what is the appropriate measure of success when so little is known about wetland? Answers are being developed; in the interim, however, decisions and regulations continue to be made.

Wetland regulations often are vague with respect to what the appropriate mitigating measures might be. This is because, on the one hand, regulations often intentionally are written vaguely (Beam, 1983), and, on the other, not enough is known about replacing natural systems. The result is that regulators often are reactionary "just to be sure."

> "It will be argued that the natural and social uncertainties surrounding wetland function and structure values are such that the adoption of a conservation-biased safety margin approach to policy is the most rational course of action." (Turner, 1988, 122)

Mitigation

Mitigation of adverse impacts is a common requirement of wetland legislation. A legal requirement literally meaning "to lessen the impacts of" or "to cause to become less harsh or hostile," mitigation does not necessarily mean to account for all changes—only to make the negative aspects of a change less harsh. In the wetlands genre, the term has the *de facto* meaning of at least one-for-one replacement of the exact ecological circumstances, i.e., *compensatory mitigation*. Much legislation actually calls for greater than one-for-one replacement, just to make sure! Exactly how to mitigate under any circumstances is unclear. But because everything comes at a price, such excesses may involve unwise use of society's scarce resources. Indeed, government failure, evidenced in this instance by poor legislation, is one component of overall market failure.

Restoration

Restoration is one technique for accomplishing the "mitigation" requirements of wetland regulations (White et al., 1992). *Wetland restoration* usually refers to the rehabilitation of wetlands that may be degraded or hydrologically altered and often involves reestablishing hydrologic regime and vegetation (Mitsch and Gosselink, 1993). Although many successful restorations have been accomplished, some environmental purists still believe that what has been restored is not "authentic." Additionally, restoring something to its exact original condition may be neither physically possible nor always desirable (Turner, 1988). While some types of wetland can be restored satisfactorily (LaGrange and Dinsmore, 1989), it may be impossible or impractical to restore other types.

Creation

Wetland creation involves developing a wetland where none existed before (Mitsch and Gosselink, 1993). Although viewed with even more skepticism than is restoration, creation efforts are quite common. Wetlands (in this context, often a trendy euphemism for wastewater lagoon!) frequently are created to treat point and nonpoint pollution (Olson, 1992). Wetland creation crowds out other land uses, either directly on the creation site or indirectly through avoidance. Frequently, many individuals in society believe that the native habitats being destroyed to create wetland are more valuable to society than the wetland being created (Ray, 1993). Wetlands often are assumed to be infinitely valuable, whereas all other land uses are inferred to be finite in value.

> "For some more common, lower order, or already degraded, wetlands outright development or modified development might, in principle, prove to be socially optimal." (Turner, 1988, 122)

Replacement

Replacement can mean to put back or to replace something missing with something else. Change in ownership often is involved: for example, when wetland lost during a highway project is replaced by purchase of similar wetlands within (or nearby) the watershed. The number of wetlands would be diminished, but protection through preservation of remaining wetlands would be increased. Replacement also could be interpreted to mean restoration or creation.

Enhancement

Another potential "mitigation" mechanism is to enhance existing wetlands to compensate for those that are damaged or converted. Enhancement increases the beneficial outputs of existing wetlands by intensifying management or improving habitat conditions.

Sequencing

In view of less than favorable outcomes of many past wetland mitigation efforts, some have begun to call for better sequencing of mitigation and development. Frequently, mitigation has not only been less than successful technically, but also has been accomplished after, or well after, the development took place. This has resulted in the loss of wetland outputs during the time between conversion and the time of mitigation. Delayed mitigation also may lead to less attention paid to the success of such mitigation measures. Sequencing is a concept whereby required mitigation is carried out concurrent with, or even prior to, the activity necessitating mitigation. More recently sequencing has another regulatory meaning whereby developers are required to avoid first, minimize second, and compensate as a last resort.

No-Net-Loss

In general, no-net-loss (NNL) is analogous to the economist's version of causing no harm to any individual without offsetting compensation. In practice NNL of the physical quantity of wetlands is commonly applied to most permit cases, requiring the "with project condition" to have no fewer wetlands than the "without project condition." However, NNL can be accomplished in a variety of socially efficient ways. A more efficient approach would be to require NNL of social welfare. In other words, maintaining what the wetland did for society rather than maintaining wetland *per se*. Simply put, if a wetland provided recreation, then providing alternative recreation of equal value to what the wetland provided would lead to no-net-loss.

Economic Perspective

Making no one worse off implies offsetting measures for any individual or firm whose well-being is reduced. Conversion of wetlands to alternative land uses imposes real costs on individuals and firms, to the extent that they had a real or a perceived property right to these goods and services. One way to mitigate costs is to replace exactly the attributes of the wetland that provided the function leading to the output, which was valued. Another way to return individuals and firms to their original level of well-being is to compensate them with cash—a common denominator representing well-being. Economists would agree that such redress would put society's level of well-being back to where it was before the change in wetland use. Alternatively, goods and service flows from the former wetland could be replaced by other means, such as wastewater treatment, flood plain regulations, or synthetic erosion control. In other words, giving society enough apples to make up for their loss of oranges is the equivalent of giving them oranges for their loss of oranges.

Society is interested in maintaining and enhancing individual and social well-being, and there are numerous mechanisms for doing so. Some special interests, however, are interested first in maintaining the status quo with respect to ecosystems and the natural environment. But maintaining the natural environment as sacrosanct ignores the fundamental principle of trade-offs in consumption choices of society. It also ignores the concept of consumer sovereignty—that consumers be allowed to consume whatever bundles of goods and services they choose (within their budget and legal bounds) even if that means exchanging apples for oranges. Which perspective is better in all senses is a matter of public policy.

Postscript

There seems scarce middle ground in the discussion of wetlands—or at least there are few willing to occupy it. Those informed and interested enough in the subject matter to take a position usually end up at one or the other extreme. Reviewers of drafts of this manuscript—some identified in the acknowledgments, others not; all eminent scholars and wetland scientists—disagreed with many statements made or conclusions drawn. They offered counter arguments and anecdotes as evidence supporting their views. But for each pulling up, another pulled down; and for each pulling to the left, another pulled to the right. We must be somewhere near middle ground.

Science has made contributions toward resolving the issue, but, despite decades of excellent wetland science, the issue remains largely (1) an issue of philosophical and ethical value differences, (2) a politico-legal issue of explicitly assigning property rights, (3) a social-technical issue of defining exactly what a *wetland* is, (4) a disaggregate (regional-local) issue discussed at the aggregate (national) level, and (5) a matter of having to make decisions today in spite of not resolving (1) through (4).

Some ecocentrists argue that all wetland should be protected. Such protectionist stances fail to take into account what must be given up to protect wetland. Quantification of the value of wetland is of little use unless similar quantification allows comparison with the values of society's other resources. Because the wetland issue quickly becomes a land use issue, attention must be directed to the values of all land uses, not only those of wetland.

This review of the wetland controversy, especially in rural America, gives rise to a number of conclusions, recommendations, and implications for participants in the wetland controversy:

For Wetland Scientists

- Keep up the good work, but do more interdisciplinary research across the line from wet to dry.
- Recognize the legitimate bounds of your disciplines and the role of science in policymaking.
- Absolute values of wetlands are of little use; relative values of wetland and other landscapes are necessary for making wise choices.
- Leave policymaking to policymakers (unless you are a policymaker, then do not make policy strictly on the basis of your science); science is not the fourth branch of government.
- Wetland definition and delineation can be fully resolved only by policymakers, but with your objective input.

For Policymakers/Regulators

- All wetlands are not equal and should not be treated equally.
- The property rights issue needs to be resolved.
- *Wetland* needs to be defined clearly and unambiguously.
- Wetland decisionmaking cannot be done in a vacuum; other landscapes have value too.
- There is more than one "value" of wetland.
- Science should counsel but not control wetland policy.

For Agriculture (and Other Regulated Publics)

- The world is changing.
- Learn the other side(s) of the issue.
- Trade-offs are necessary in a world of scarcity.

For the Public

- Don't rely on science or public officials to determine what (and how much) you want—get involved.

For Ecocentrists

- Government is anthropocentric (like it or not).
- Money is the common denominator for exchange.
- Trade-offs are necessary in a world of increasing scarcity.
- Learn the other side(s) of the issue.

- Yes, wetland has value, but so do all other landscape features.
- Encourage efforts to identify values of nonwetlands to the degree of effort expended on wetlands.

It was difficult keeping this report to 40-some pages. The compulsion was to explain fully each and every issue, of which there are many. Not explaining everything leaves room for accusations of omission or ignorance. The greatest shortcoming at present, however, is the need for a broader appreciation of the social-legal-political-technical environment within which choices about wetlands are being made.

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