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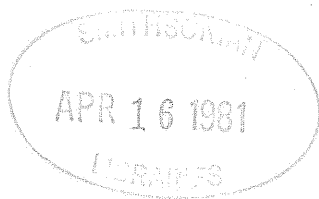
workshop report on  
**RESEARCH PRIORITIES for  
WETLAND ECOSYSTEM  
ANALYSIS,**

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National Wetlands Technical Council

Ecosystem Diversity Panel Report

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## ECOSYSTEM DIVERSITY

### I. What factors influence diversity in wetland systems?

Diversity refers to the variety of elements within the universe of study. In wetlands, diversity may be expressed in several dimensions: level of resolution, manifestation at each level, general regulatory factors, and specific driving forces. These are elaborated in the following table.

Resolution	Manifestation	Regulation	Driving Force
Geographic	Composition	Habitat size	Substrate/Relief
Ecosystem	Structure	Habitat diversity	Water quality
Subsystem	Spatial Relations	Nutrient availability	Isolation
Species	Function	Species availability	Temperature
Population	Time Relations	Species interaction	Hydroperiod
Genetic	Human Values	Natural stress	Exposure
		Man-made stress	Catastrophism

Although diversity, per se, is of little concern to the ecologist, the general importance of the concept lies in the fact that diversity, in its various manifestations, reflects more fundamental aspects of the wetland systems. Thus, under appropriate conditions some measures of diversity may be used as indices of the state of the wetland systems. Therefore, it is of considerable theoretical and practical interest to determine, in detail, the factors which influence wetland system diversity in its several manifestations and at all operational levels.

### II. The Need for Development of a General Theory Relating Wetland Change to Diversity

A need exists to develop a general theory of how the processes of change which occur in wetland systems affect diversity. Traditional concepts of succession and climax inadequately describe these processes, their regulating mechanisms and outcomes. Wetlands are inherently dynamic systems. Future work should question previous notions of stability, diversity, and their relationship to each other.

The state and change of wetland systems represent the simultaneous and sequential interplay of internal and external factors. Rather than focusing upon their separate roles, research should examine the significance of their coupling and feedback in regulating diversity.

Wetlands have evolved in response to variable environmental regimes. In examining the relationships of change processes to diversity, we need to reconsider definitions of what constitutes a disturbance. The limits of adaptability and the effects of changes in rates, frequencies, ranges, and magnitudes of variability need to be investigated. Any general theory of the relationship between processes of change and diversity must include but specifically identify the various levels of resolution, both spatially and temporally, under consideration.

### III. Coupling Wetlands With Other Ecosystems

Wetlands do not exist in a vacuum. They are juxtaposed to open water, terrestrial communities, and other wetlands in various combinations. These neighboring communities constantly exchange nutrients and provide sources for immigrants and sinks into which organisms disperse. Some animals move regularly from one community to another. In the case of birds, insects and some mammals, the wetland combination may consist of individual habitats separated by many miles. Each combination provides different habitat. The degradation of one element in the combination may drastically affect some particular species. As a result, it is fruitful to examine the diversity of community combinations containing wetlands. Such studies should concentrate on the unique characteristics of each combination. Particular emphasis should be paid to flows and all relations at the interface between the individual communities in the combination.

Here we need:

- (1) Studies of community interactions between upland and wetlands;
- (2) Studies of community interactions between both adjacent and distant wetlands; and
- (3) Studies of the mechanisms of movement between systems.

### IV. Determining Wetland Boundaries

Wetland regulation requires three sorts of boundaries. The primary line separates the wetland from the surrounding terrestrial community. A secondary division separates functional subunits within the wetland. Thirdly, a boundary encircles an area which influences or is influenced by the wetland within it. Usually the areas within these boundaries have distinct floras, which may or may not contain indicator species. It is unclear whether function and vegetation are tightly correlated. Decisions to preserve, manage or destroy wetlands depend on these limits. If boundaries are placed for legal, political, or other ecological arbitrary reason they may defeat their intended purpose. Scientists must understand wetlands well enough to place these lines to encompass functional units and really work to preserve or manage wetlands. This calls for: indicator species studies, vegetation function relations, and other studies evaluating the significance of these boundaries.

### V. Autecological Studies of Wetland Species

There is a dire need for further research on the autoecology of both freshwater and saline species. These studies should emphasize such aspects as the ecological tolerances or amplitudes of the species through their entire life history including reproductive strategies. Such studies should help to elucidate species population interactions within systems of differing species diversity. In addition such research will contribute immeasurably toward our understanding of species interaction at the ecosystem level. These studies may be individual or team efforts, but in either event, such data are critical to the understanding of the larger systems of which they are a part.

## VI. Studies of Genetic Diversity in Wetland Systems

Genetic diversity refers to the variety of genetic material present in the gene pools of the individual populations throughout the range of a species. It determines the range of adaptability of the individual populations, and cumulatively, it determines the plasticity and ability of the species to survive under conditions of environmental stress. Knowledge of the genetic diversity, further, provides information on the degree of isolation or genetic exchange of adjacent populations and some measure of the past history of each population. At the present time very little is known about the genetic variability of most of our wetland species or of the interplay of genetic and environmental factors in determination of the physiological, biochemical and other characteristics of local populations and of differences from one population to another. We specifically need to understand the relationships between true genetic diversity and biochemical diversity and biochemical diversity. We also need to understand the relationship between genetic diversity within species and species diversity within individual wetland systems. As the native genetic material diminishes before the advance of civilization and as man transports organisms from one area to another, the opportunity of ever investigating problems of native genetic diversity is rapidly disappearing. For these reasons it is urgent that we provide documentation of the genetic diversity of our native wetland populations and species and to relate genetic diversity with other ecological parameters.

## VII. Practical Taxonomy of Wetland Species

Any measurement of diversity or application of diversity results presupposes that the taxa involved are reliably identified. While many birds, mammals and higher plants of wetlands are fairly well known, other important groups, such as sphagnum mosses, invertebrates, and microorganisms present almost insurmountable problems to the nonspecialist.

Species of important wetland organisms must be known well enough to facilitate dependable identification by nonspecialist professionals. The present objective is not to support pure systematic studies aimed at fundamental relationships or evolutionary problems. The taxonomic work envisioned here is intended to fulfill a supporting role in wetland ecosystem studies. The research should provide consistency and reproducibility of results and nomenclature among studies. Appropriate taxonomic tools should help to prevent taxonomic lumping that large numbers of unidentifiable species can encourage.

The research envisioned might involve production of manuals, keys, and reference collections specially adapted to wetland organisms which are often found lacking traditional taxonomic characters; the surveying of geographic variability or the variability along environmental gradients; or the use of taxonomic specialists as members of teams conducting multidisciplinary wetland studies.

## VIII. Historical Reconstruction of U.S. Wetlands

In many states over 90 percent of the original wetlands have been destroyed, mostly for agriculture or other land uses. Using land survey records, soil surveys, plant collections and historic documents some states have mapped these former wetlands as well as other land uses. Other states have not done so. Weather data, hydrologic data (flood period, turbidity, etc.), crop data and erosion data exist since the late 19th century in the

midwest and west and earlier along the east coast. Paleoecological studies greatly increase the perspective of these studies. Creative examination of these data may tell us a great deal about the long-term ecological consequences of wetland destruction, particularly as it interacts with other land use changes such as agriculture, lumbering, mining and urbanization. These historical studies make it possible to understand the present-day distribution of isolate wetlands. Thus we call for historical and paleoecological studies coupled with present-day ecological studies.

#### IX. Overview Wetland Inventories

Wetland studies at various levels of refinement are needed in order to inventory wetland types which have not yet even been surveyed by ecologists. Overview surveys are visualized as species inventories and general descriptions of wetlands within areas where little such data now exist. Considering the rapid manner in which man is impacting natural ecosystems of all types around the world, i.e., acid rain in pristine lakes of the Adirondacks, such surveys are critical. They will serve as a research base for determining priorities for more intensive studies.

#### X. Holistic Approach to Wetland Systems Research

Most wetland systems consist of a series of subsystems whose internal dynamics and whose relationships with one another and with the external environment are very poorly understood. Traditional concepts are of limited usefulness in elucidating basic processes by which wetland systems persist and through which they change.

Because of the complexities and interrelationships of wetland systems and subsystems, it is axiomatic that the most fundamental and pervasive results are most likely to accrue from those studies which are approached holistically. The introduction of systems analysis procedures at the inception of the projects should permit better experimental designs and more thorough analyses, especially when coupled with modeling techniques. Wherever possible, such studies should be approached from an interdisciplinary point of view.

Holistic studies of wetland systems are required at all scales of resolution. It is especially important to include some large-scale, long-term studies of wetland system types to be carried out by large teams of research specialists, because it is only by such means that some of the most important knowledge may be generated. Such studies should be based upon hierarchical conceptual models. Data input should derive from real-world information from a wealth of mid-level natural history studies of key compartments and processes.

Insights from holistic analysis are most likely to provide the basis for development of fundamental ecological theory.

#### XI. Long-Term Environmental Studies

Natural assemblages of organisms are the results of the complex interaction of biotic and abiotic factors. These assemblages are subjected to periodic and aperiodic alterations in the interaction of these factors. Short-term rhythmic fluctuations may occur within seconds, minutes, or hours. Other periodic variations are on daily, lunar, seasonally, or yearly basis.

Still other cyclic fluctuations occur on a longer basis. To the geologist, cycles of a longer period are observed. Coupled with periodic changes, are those fluctuations which result from "abnormal" or aperiodic catastrophic events, such as storms and floods.

Unfortunately the study of natural systems are frequently limited to a relatively short period of time of one or two years. Since natural assemblages are subjected to both short- and long-term environmental fluctuations, a basic understanding of the variability in structure and function of this assemblage is lacking. A knowledge of the homeostatic characteristics of a natural assemblage over a long period of time is vital to a basic understanding of the system, but it also has important implications for environmental management decisions. What are the so-called baseline characteristics of a system against which the impacts of environmental perturbation are compared? How long does it take for a system to recover from the insult of a catastrophic event?

We recommend that a program of long-term studies of wetlands be funded.

To initiate and maintain such a program involves the intent of a granting agency to provide long-term support and a firm commitment by an institution for the management and utilization of a given wetland for long-term studies. The site should be regarded as a national facility and available to any scientist who has an active research interest in this type of wetland. Further, these wetland sites may vary in size and intensity of study. Hence not all sites need not represent a large research program. To augment this program, data from similar sites which are not part of this primary site will be used for comparative purposes. However the criteria for site selection should include, representativeness and quality of a specific type(s) of wetland(s), long-term control of the site, existing data base, and existing research facilities. The recommendation to establish and support long-term environmental studies is supportive of and consistent with the Experimental Ecological Reserve concept as reported to the N.S.F. in 1977 and with reports to the N.S.F. from two recent conferences held at Woods Hole, Mass.

## XII. Establishment of Research Experimental Areas for Manipulative Research

Wetlands are adapted to a variety of biotic and abiotic driving forces which control diversity patterns at all levels of ecosystem organization. With few exceptions, we can not predict short-term or long-term changes in diversity that will occur when the driving forces are altered. Even more important, we know very little about what factors control diversity under normal conditions. To answer these basic questions, we recommend that wetlands research areas be established where long-term and short-term manipulations can be conducted. We recommend that emphasis be given to manipulations of, at least, the following driving forces that ultimately influence diversity: (1) hydroperiod, (2) degree of inundation, (3) water quality, (4) substrate and relief, (5) temperature.

The research sites should be large enough to contain representative's of regional wetland types and they should receive long-term funding to assure continuity of data gathering and maintenance of experiments. In addition, the program should include funding to perform related studies in other wetlands within the same geographic region.