PROCEEDINGS OF THE NATIONAL WETLAND CLASSIFICATION AND INVENTORY WORKSHOP 1975

Fish and Wildlife Service
U.S. DEPARTMENT OF THE INTERIOR

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EDITOR'S NOTE

In 1974 the U. S. Fish and Wildlife Service directed its Office of Biological Services to design and conduct a new national inventory of wetlands. For a number of reasons, it was decided that an attempt be made to develop a new wetlands classification system that would fit the needs of a broad spectrum of users and provide flexibility required for the incorporation of new knowledge concerning wetlands.

A meeting was held in January 1975, to explore the possibilities of developing a new and better classification system. A relatively few wetlands experts from various sections of the United States attended that meeting. The first draft of a new system evolved from that meeting. It was then decided that the draft version should be critically reviewed by a much broader representation of wetlands workers. The workshop reported on here represents the attempt to obtain that input, and at the same time review the current status of wetlands work being carried on by certain governmental and private agencies.

The "Interim Classification of Wetlands and Aquatic Habitats of the United States" appended to these proceedings incorporates many suggestions emanating from the workshop. <u>As the title indicates, this is an interim classification; it must be field tested and refined before a final version is prepared</u>.

Lastly, I hope that those who took part in discussions at the workshop will forgive me if I have misinterpreted any of their comments.

TABLE OF CONTENTS

Editor's Note ii

FIRST GENERAL SESSION: WELCOME AND OVERVIEW OF

CURRENT STATUS OF THE NATIONAL WETLANDS

INVENTORY AND NEW CLASSIFICATION SYSTEM

Welcoming Remarks 1
Lynn A. Greenwalt

Current Status of the National Wetlands Inventory 6
Allan Hirsch

SECOND GENERAL SESSION: OVERVIEW OF CURRENT

WETLAND CLASSIFICATIONS AND INVENTORIES IN

THE UNITED STATES AND CANADA

SESSION A. FEDERAL AGENCIES AND CANADA

U.S. Geological Survey 14
Virginia Carter, Richard E. Witmer
and Franklin S. Baxter

U.S. Forest Service 25
Charles Cushwa
(Paper presented by Charles R. Hartgraves)

U.S. Army Corps of Engineers 31
Col. John R. Hill, Jr.

U.S. Soil Conservation Service 38
Ronello M. Davis

Bureau of Reclamation 53
George H. Wallen

Tennessee Valley Authority 61
James H. Burbank

U.S. Environmental Protection Agency 74
Harold Kibby

U.S. Bureau of Land Management 83
Richard R. Olendorff, John E. Crawford,
William A. Kennedy and J. David Almand

National Marine Fisheries Service 93
Dale R. Evans
(Paper presented by Robert L. Schueler)

U.S. Fish and Wildlife Service 102
Jerry L. Stegman

U.S. Office of Coastal Zone Management 121
Edward T. LaRoe

Canadian Wildlife Service 131
N.G. Perret

SESSION B. STATE AGENCIES AND PRIVATE ORGANIZATIONS

Overview of State Sponsored Wetland Programs 142
Jon Kusler and Barbara Bedford

Wetland Activities in New York State and
Their Relation to a National Wetlands Inventory 148
Herbert Doig
(Paper presented by Porter B. Reed, Jr. and Eric Fried)

Texas Wetlands -- Classification, Inventory,
and Mapping 158
Harold D. Irby

The State of Washington 162
David W. Jamison

The Nature Conservancy 169
Robert M. Chipley

Wildlife Management Institute 181
Keith W. Harmon

Institute of Ecology 187
W. Brian Bedford

Sport Fishing Institute 205
Carl R. Sullivan

The Conservation Foundation 212
John Clark

WORKSHOP SESSIONS: CONCURRENT WORK-STUDY GROUP SESSIONS

Workshop Sessions 219

THIRD GENERAL SESSION: REPORTS BY MODERATORS OF WORK-STUDY GROUPS AND SUMMARY STATEMENT

Reports by Moderators 221

Definition of Terms Used in the Classification System 221

Miscellaneous Comments and Suggestions 228

Summary Statement 234
Laurence R. Jahn

List of Participants 245

ADDENDUM

Interim Classification of Wetlands and Aquatic Habitats of the United States . . . . 110 pp.

FIRST GENERAL SESSION: WELCOME AND OVERVIEW OF CURRENT STATUS OF THE NATIONAL WETLANDS INVENTORY AND NEW CLASSIFICATION SYSTEM

Sunday, July 20, 1975, 7:00-9:00 p.m.

Presiding: John Montanari, National Wetlands Inventory Project Leader, U.S. Fish and Wildlife Service

WELCOMING REMARKS

by

Lynn A. Greenwalt, Director
U.S. Fish and Wildlife Service

Ladies and Gentlemen, I am pleased to be here to welcome you to the U.S. Fish and Wildlife Service's National Wetlands Classification and Inventory Workshop.

This audience needs no discussion from me concerning the unique and valuable role of wetlands in supporting diverse food chains, fish and wildlife resources, and in maintaining natural hydrologic systems. You probably all can cite many examples of the importance of wetlands in terms of waterfowl and fish produced, floods averted, recreational opportunities provided, and the like. You are also probably all familiar with the threats facing the Nation's wetlands today, from drainage, filling, and pollution. The need for greater wetlands protection is widely recognized, probably by every organization represented in this room. So I want to focus my brief introductory remarks on the importance of the National Wetlands Inventory--the subject of our meeting here tonight.

It has been almost 20 years since the Fish and Wildlife Service published its now historic Circular 39 entitled, "Wetlands of the United States." As we review that report and the methods used in conducting that first inventory, they may seem unsophisticated and almost simplistic by comparison with the approaches that you will be hearing about during the next three days. Yet, as many of you can attest, Circular 39 over the years has been one of the basic sources of information about this important resource. It has been used and cited widely and the classification system therein has been incorporated in a number of wetland protection laws. That inventory, conducted 20 years ago, but still referred to today, reflects the need for inventory information on the Nation's wetlands. Your presence here tends to confirm that Circular 39 is outdated in relation to today's environmental pressures and our resulting information needs.

Those information needs are manifested by the range of agencies and interests represented at this workshop and on this program. Certainly, the Fish and Wildlife Service needs better information on the extent and nature of the Nation's wetlands in meeting our agency's responsibilities for managing migratory birds, for acquiring refuge lands, for protecting endangered and threatened species, for providing advice on the effects of developmental activities under the Fish and Wildlife Coordination Act, and in many other ways. Needs for this information range from Fish and Wildlife Service's top management to our working biologists out in the field. It is clear that the States urgently need wetland information in meeting their own responsibilities including, but by no means limited to, those under the Coastal Zone Management Act of 1972. The Federal agencies whose missions span the spectrum of activities ranging from resource development to environmental protection need wetlands information as well. These needs have perhaps nowhere been highlighted more clearly than in connection with the recent issue concerning implementation of Section 404 of the 1972 Federal Water Pollution Control Act Amendments. The Department of the Interior has taken the stand that the provisions of Section 404 should be applied quite broadly to protect the wide range of wetland situations. However, no matter how this issue is ultimately resolved, the point is clear--more up-to-date and precise wetlands information will be needed to intelligently manage this important regulatory provision.

Considerations such as these led the Fish and Wildlife Service to plan for and initiate a new National Wetlands Inventory this year. You will be hearing discussions of the scope and nature of that activity later this evening. I will not address the details of that effort in my comments--I merely want to focus on the reason why we have invited you here to meet with us during these next several days.

I want to stress that in undertaking this inventory, we have no intention or expectation of supplanting the wetlands studies of other agencies and particularly of the States. We are well aware that many of the States have conducted or are conducting wetland inventories, particularly the coastal States in connection with provisions of the Coastal Zone Management Act. We are aware of and have cooperated with the Soil Conservation Service in its pilot studies correlating wetland soils and vegetative types. We recognize that wetland surveys must continue for many purposes, at many levels, and in varying degrees of detail.

At the same time, we see the need for a nationwide approach which provides data which are consistent and comparable on a regional and even national scale. What the Fish and Wildlife Service is hoping to accomplish is as follows:

1. First we want to conduct a nationwide inventory that will provide an overall framework within which the extent and value of wetlands can be broadly considered and assessed. This is only fitting for a resource for which many of the values are of such widespread significance--a resource which is already subject to the cumulative impact of many small scale, localized decisions. Many of the values of wetlands are of national significance. What happens to a marsh in North Dakota has an effect on bird populations in Arkansas, and marsh destruction in Maryland or New York may affect the abundance of striped bass off the coast of North Carolina. Drainage of wetlands in the Dakotas can increase the siltation and flooding in the Mississippi River, necessitating additional expenditures far down stream to provide for the control and escape of flood waters. Management decisions dealing with problems of this scale and magnitude will require a consistent data base.

2. Second we hope to produce a classification system that is operationally sound for the nation--and in many ways the classification system is the basic key to a meaningful national

inventory. That is why the overall thrust of this workshop will deal heavily with wetlands classification, which is only one of the overall facets of the inventory.

3. Third we hope to produce a system that can be related to the majority of systems currently in use by the States or others. It is our intention to build upon the good work already under way, not to supplant it.

We have invited you to this workshop to solicit your help in this endeavor. We thank you for being here and look forward to a fruitful three days.

CURRENT STATUS OF THE NATIONAL WETLANDS INVENTORY

by

Allan Hirsch

In his opening remarks, Director Greenwalt has explained why a new National Wetlands Inventory is needed. I would like to briefly review how the Fish and Wildlife Service is going about this task, what we have done to date, and where we expect to go from here.

We visualize the Inventory as consisting of three major phases. Phase I involves the definition and classification of wetlands. The central focus of this workshop is on this aspect of the Inventory. It is hoped that our discussions over the next few days will enable us to devise a wetland classification system that will fit the needs of a broad spectrum of users.

Phase II will be the Inventory itself. The wetlands will be classified using the system we are currently developing; they will be displayed in graphic form on maps; and they will be digitized and machine-stored for quantitative and qualitative evaluation and comparison.

Phase III may be referred to as the "interpretive phase." Having obtained estimates of the extent and locations of wetland habitats, we must now ask: 1) What does it mean in terms of ecological values (food chains, endangered species, etc.)? 2) What does it mean in terms of hydrological values (flood and drought prevention, water quality, etc.)? 3) How can we translate these values into terms that will provide "decision-makers" with a better understanding of the diverse types of competing land uses which threaten wetland habitats?

Our work on the Inventory began in earnest during the Fall of 1975. During the past nine months our efforts have been focused primarily upon the development of a new wetlands classification system. We anticipate that the ideas and suggestions contributed by the participants in this workshop will enable us to devise a classification system that will fit the needs of a broad spectrum of users.

During these past several months we have also initiated a number of other projects that we refer to as "pre-operational tasks." The following are tasks that we felt had to be completed before we could proceed with the operational phase of the Inventory itself:

1. Documentation of the location and type of existing regional or State wetlands inventories.

    This task is scheduled for completion in February 1976. Publication of the results will be two, cross-referenced volumes. Volume I will be an atlas of the 50 States and will show in detail the geographic location of existing wetlands inventories (through 1976). Volume II will be a summary description of each existing or on-going inventory and will address all pertinent aspects of that inventory--including its potential value to the new National Wetlands Inventory.

2. Documentation of the location, type, and availability for use of aerial photography (sub-orbital) that exists in the United States (from 1970 through June 1975).

    The results of this work will be published in atlas form using the same base maps as described above.

3. Research in the viability of the LUDA (Land Use and Data Analysis) Program software, base maps and aerial photography as a potential operational system for the performance of the National Wetlands Inventory.

   This research will be performed in three different wetlands regions and publication of the results is scheduled for November 1976.

4. Research on systems to determine procedures for estimating wildlife values of different wetlands types as described by the new wetlands classification system.

   Results are scheduled for publication in October 1976.

5. The location of and delineation on reasonably large-scale maps of physiographic province boundaries suitable for use by all interested agencies in the adoption . . . use of the new wetlands classification system.

   These boundaries will also be digitized.

That is a brief resumé of what we have been doing up to this point. Where do we go from here? In FY76 we hope to complete the remaining steps necessary to make the Inventory operational. Included are the following steps:

1. Performance of a series of pilot inventory programs within representative wetlands regions.

   These programs will be designed to test the validity of the work resulting from those efforts described above in quasi-operational situations. The purpose of this program will be to determine the technical/economic trade-offs possible in such situations and to formalize operational procedures and levels of effort necessary and possible in the performance of the operational phase of the National Wetlands Inventory.

If the work on the Wetlands Inventory using the LUDA material is successful, it might be possible--given sufficient funds--to shortcut or constrain the pilot programs. We would be looking at a more limited range of options concerning operational techniques; in effect, the first efforts might not be pilots, but actually represent initial efforts in the operational Inventory. This alternative is presently under study.

2. Preparation of guidebooks.

We plan to prepare guidebooks for regional use in the performance of the National Inventory so that contractors, wetlands coordinators, and others concerned, will fully understand the procedures to be followed.

3. Develop liaison procedures.

We intend to develop procedures to assure continued liaison with other federal, state and private agencies to ensure maximum utility of the products being developed.

4. Hydrologic value of wetlands.

We will be beginning work on this second aspect of the interpretive task. We will conduct research on systems to determine the hydrologic value of wetlands which have been classified according to the new wetlands classification system.

After completion of most of these so-called pre-operational tasks, we hope to move into the full operational phase. The operational phase will cover the period FY77-79, and it is during that period that the actual inventory is to be conducted and completed. It goes without saying that accomplishment of this task is dependent upon budgetary approval, a matter somewhat less certain than death and taxes. If the results are to be meaningful, we must not drag out the Inventory; it must be completed within a two- or three-year period so that it is a true measure against which future quantitative and qualitative wetlands modifications can be compared.

What are the anticipated products and results of the Inventory? As currently visualized, the end results will include:

1. Maps of the wetlands of the United States at a scale of 1:250,000 or perhaps 1:100,000. Mapping of all wetlands will be completed to five (5) acre minimums except in selected regions where more detail is necessary. In such cases, it will be necessary to produce maps of larger scale, perhaps 1:24,000.

2. A classification of wetlands based upon the National Wetlands Classification System currently being developed.

3. Digitized and machine-stored information for quantitative and qualitative evaluation purposes. This system will include the following types of information for each wetland mapped:

    a. Location by geographic coordinates

    b. Location within physiographic provinces

c. Location by major watershed

d. Location by flyway

e. Location by political division (State, County)

f. Location by census district

g. Area of each wetland in acres

h. Classification of wetlands according to the new classification system

i. Surrounding upland land use

j. Estimated wildlife value

k. Estimated hydrologic value

4. Summary descriptive and interpretive reports for the Nation and by region.

We also intend to build in procedures that will enable us to easily and frequently update our information, particularly in those regions where pressures (population, industrial, agricultural, etc.) are greatest.

In closing, I would like to highlight two key issues related to our efforts. Inasmuch as you represent a broad spectrum of collectors and users of wetlands data, we hope that in the next few days you will face these issues head-on and give us your best advice.

First of all, we are especially concerned about how the present inventory will relate to the many current ongoing data collection efforts of public and private agencies. As Director Greenwalt has stated, we certainly do not want to "reinvent the wheel," and we certainly have no intention of trying to supplant or usurp wetlands survey activities of other agencies; we couldn't if we wanted to. We do hope that we can assist in bringing together in a meaningful way the diverse types of wetlands information being gathered by the various agencies. This then means that we must come up with a classification system and an inventory program that will not supplant other efforts, but which will assist us in achieving comparability among them.

The second major issue involves user needs. Which of the many needs for wetlands data will the Inventory serve? The needs are very diverse, varying from identification of broad scale national trends at one end of the spectrum to precise delineation of individual wetland boundaries for legal purposes at the other end. I do not believe that any one nationwide effort can attempt to meet all needs. This poses a real dilemma which can probably best be illustrated by discussing the question of map scale.

I suspect that many eyebrows were raised when I mentioned that we presently think that all wetlands down to five acres in size would be included in the National Inventory. We all know that in many areas, wetlands of under five acres will be of critical importance. However, delineation of all wetlands down to say one-half acre on a nationwide basis would be a formidable task. The number of maps required for this type of coverage would be very great, and the costs would be prohibitive. Even more basic, standard base maps between 1:250,000 or 1:100,000 scale simply do not exist for many portions of the country.

Our current thinking with regard to this dilemma is about as follows:

1) For those areas of special interest to the Fish and Wildlife Service--such as prairie potholes--the widescale approach will be supplemented by more detailed mapping and/or statistical sampling procedures.

2) For similar areas of interest to other agencies or states, it may be possible to develop cooperative efforts to obtain more detailed information. As a minimum, we hope that the National Inventory will provide a consistent framework of information within which more detailed study results can be compared.

It is our hope that over the next several years we will be able to devise procedures, techniques, and cooperative approaches that will help reconcile any such problems as these. I think we must distinguish between the requirements for a periodic national and regional overview that will be characteristic of a national inventory and the requirements of many agencies for wetlands data of a more detailed nature. For us, this workshop is an important step in that direction, and we look forward to receiving your advice.

SECOND GENERAL SESSION: OVERVIEW OF CURRENT WETLAND CLASSIFICATIONS AND INVENTORIES IN THE UNITED STATES AND CANADA

Monday, July 21, 1975, 8:00 a.m.-5:00 p.m.

Presiding: John Montanari

SESSION A. FEDERAL AGENCIES AND CANADA

U.S. Geological Survey

by

Virginia Carter
Richard E. Witmer
Franklin S. Baxter

The U.S. Geological Survey (USGS) is engaged in a wide variety of operational activities that have a direct or indirect relationship to wetlands. These include the acquisition of geologic, topographic, hydrologic, and land use data and the presentation of that information on maps. The USGS also conducts research in the development of remote sensing applications in wetland hydrology, ecology, classification, and mapping.

Many previous studies by the USGS involve examining the interrelationship of geology, water regime, water chemistry and wetland vegetation. Hydrologic studies were made in the prairie potholes (Eisenlohr, Jr., and others, 1972) and in the Great Dismal Swamp of Virginia and North Carolina (Lichtler and Walker, 1974) in cooperation with the U.S. Fish and Wildlife Service (FWS). Other studies have been carried out in the Great Swamp in New Jersey (Vecchioli et al., 1962) and in the Cranmoor Area and Central Sand Plain of Wisconsin (Hamilton, 1971; Weeks and Stangland, 1971). The USGS has published a number of studies on peat resources in the United States (Cameron, 1973). These studies relate the origin of peat to the vegetation of the wetland (marsh, swamp, bog) in which they were formed. A classification system for peats has also been developed (Cameron, 1968).

The USGS has conducted research into the application of remotely-sensed data to many types of wetland problems. Early studies (Anderson, 1972) showed the utility of aircraft photography for studies of wetland ecology. More recently, studies along the Atlantic Coast and in Florida have shown that satellite data can also be used to provide wetland information. In cooperation with the American University, LANDSAT data have been used to classify and map coastal wetlands, identify plant species and study tidal flooding (Anderson, et al., 1973; Anderson, et al., 1975). Stage information, relayed via a satellite system from remote sites of NASA data receiving stations, was correlated with area measurements made from LANDSAT imagery to determine the volume of water stored in the Conservation areas supplying water to the Florida Everglades (Higer, et al., 1973). Recent studies by USGS in the Green Swamp, Florida (with Bendix Corporation as contractor), and in the Chesapeake Bay area (in collaboration with the American University), have shown the utility of SKYLAB photographic and multispectral sensor data for the classification and mapping of wetlands (Coker, et al., 1974; Alsid, 1974).

In response to increased interest and legislative requirements, the USGS is increasing emphasis on providing users with accurate and up-to-date maps for the entire coastal zone. There are approximately 3,600, 7.5-minute quadrangle areas that constitute the land areas of the coastal zone of the conterminous United States, Hawaii, and Puerto Rico. Of these, about 700 require new mapping and 2,000 need revision. Products prepared quickly in response to urgent requests, such as orthophotoquads and interim revisions, will be provided for many coastal areas.

A recent USGS research project in Georgia resulted in the mapping of the wetlands in the Doboy Sound, Georgia, 7.5-minute quadrangle. Wetland vegetation associations and the wetland/upland boundary were delineated and compiled on six orthophoto map bases (1:10,000 scale) using remote sensing data and supporting field investigations. The State of Georgia was selected as the experimental site because (1) the wetlands in the vicinity of Sapelo Island, Georgia, were relatively undisturbed by man; (2) the Marine Institute at the University of Georgia at Sapelo Island could provide needed support; and (3) the Georgia Coastal Marshlands Protection Act of 1970 declares certain species of vegetation and their presence in the Coastal Zone as prima facie evidence of the limits of wetlands.

Several research projects are also being conducted in nontidal wetlands. In a cooperative research project with the Tennessee Valley Authority (TVA), selected wetlands in western Tennessee are being mapped at 1:24,000 scale using National Aeronautics and Space Administration (NASA) high altitude infrared photography. The seasonal fluctuation of dynamic wetland boundaries is being documented and will be tied to available stage and discharge records. Adjacent land use is also being mapped at Level I. In the Great Dismal Swamp, Virginia and North

Carolina, the USGS participated in a congressionally authorized study (Public Law 92-478) by supplying a preliminary report on the hydrology of the swamp (Lichtler and Walker, 1974) and a report summarizing available remote-sensing data and its application to swamp management needs (Carter, 1974). Continuing studies in the Dismal Swamp include a study of water regime/vegetation relationships, and cooperative research with FWS and NASA to map the vegetation and drainage in the swamp and explore the possibility of using LANDSAT digital data to monitor future changes in the succession of swamp vegetation as the vegetation responds to changes in hydrologic conditions. Research taking place in the central and eastern parts of the Nation is testing the feasibility of incorporating inland or nontidal wetland classes as a new feature on standard USGS base maps. Research results related to maps and, for example, ecological predictive models, will be tested to see if they will meet the needs of agencies responsible for administering inland wetlands. Preliminary results show that seasonal color infrared photographs are necessary to map both marshes and swamps adequately.

The classification and inventory of wetlands are also important components of the USGS national land use mapping effort to provide systematic and comprehensive collection and analysis of land use and land cover data. The initial collection of these data is planned for completion within a 5-year period with individual land use/cover maps being released as they are compiled. Periodic revision of the data is planned beginning in FY 1978. The nationwide land use mapping program is the operational outgrowth of several years of research and demonstration mapping using the Level II categories of a land use/land cover classification system developed by USGS in cooperation with other

Federal and State agencies. This classification system originally appeared in Anderson and others (1972). Since that time, the classification system has undergone extensive review and a revision is being prepared, Anderson and others (1975). A summary of Levels I and II of the revised classification system appears in Attachment 1 and the revised definition of wetlands appears in Attachment 2.

The land use/land cover mapping currently underway on a nationwide scale involves the compilation of land use/cover data at approximately 1:125,000 scale topographic map series. Additional overlays are produced for political units, hydrologic units, census county subdivisions, Federal land ownership, and State land ownership when such data are supplied by the individual States. The land use/land cover data are digitized together with the data on the individual overlays, allowing extraction and aggregation of the data by county, river basin, census tract, land holding, or other combinations of overlay categories. Ten acres (4 hectares) is the smallest area mapped for urban and built-up uses, water area, confined animal feeding operations, and strip mines, quarries, or gravel pits. All other uses (including wetlands) have a minimum mapping unit of 40 acres (16 hectares). Demonstration maps at larger scales ranging from 1:24,000 to 1:100,000 are also prepared for selected areas to test large scale/small scale land use map interrelationships as well as to test variations and additional detail of classification.

Other USGS wetland involvements include development of a hydrologic classification for Wisconsin wetlands and assistance to FWS in wetland inventories. The Wisconsin classification is being developed in cooperation with the State of Wisconsin in conjunction with ongoing wetland hydrology studies. The USGS has assisted the State of Connecticut in its inland wetland inventory (Lavine and others, 1974). At present, the USGS is cooperating with the FWS on the development of a new classification system for the national wetland inventory, as well as the collection of data necessary to perform the inventory. The USGS is supplying information to the FWS on USGS, NASA, and most U.S. Department of Agriculture (USDA) aerial photography for the preparation of indexes of all existing aerial photography needed for the national inventory. The information will be collected in a form that can go directly into the USGS High Altitude Photography (HAP) summary record system.

In summary, the USGS activities involve many aspects of wetlands--hydrology, ecology, classification, inventory, and mapping. These activities are both operational--for example, the production of maps or collection of water data and experimental--for example, research into hydrology/vegetation relationships or wetland boundary dynamics.

Attachment 1

U.S. GEOLOGICAL SURVEY
LAND USE AND LAND COVER CLASSIFICATION SYSTEM FOR
USE WITH REMOTE SENSOR DATA
Excerpt from: Anderson and others (1975)

LEVEL I		LEVEL II	
1	Urban or Built-up Land	11	Residential
		12	Commercial and Services
		13	Industrial
		14	Transportation, Communications and Utilities
		15	Industrial and Commercial Complexes
		16	Mixed
		17	Other
2	Agricultural Land	21	Cropland and Pasture
		22	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas
		23	Confined Feeding Operations
		24	Other
3	Rangeland	31	Herbaceous Range
		32	Shrub-Brushland Range
		33	Mixed
4	Forest Land	41	Deciduous
		42	Evergreen
		43	Mixed
5	Water	51	Streams and Canals
		52	Lakes
		53	Reservoirs
		54	Bays and Estuaries
6	Wetland	61	Forested
		62	Nonforested
7	Barren Land	71	Dry Salt Flats
		72	Beaches
		73	Sandy Areas Other than Beaches
		74	Bare Exposed Rock
		75	Strip Mines, Quarries, and Gravel Pits
		76	Transitional Areas
		77	Mixed
8	Tundra	81	Shrub and Brush Tundra
		82	Herbaceous Tundra
		83	Bare Ground Tundra
		84	Wet Tundra
		85	Mixed
9	Perennial Snow or Ice	91	Perennial Snowfields
		92	Glaciers

Attachment 2

6. Wetland
Excerpt from: Anderson and others (1975)

Wetlands are those areas where the water table is at, near, or above the land surface for a significant part of most years. The hydrologic regime is such that aquatic or hydrophytic vegetation is usually established, although alluvial and tidal flats may be non-vegetated. Wetlands frequently are associated with topographic lows, even in mountainous regions. Examples of wetlands include marshes, mudflats, and wooded swamps situated on the shallow margins of bays, lakes, ponds, streams and man-made impoundments such as reservoirs. They include wet meadows or perched bogs in high mountain valleys and seasonally wet or flooded basins, playas, or potholes with no surface water outflow. Shallow water areas where aquatic vegetation is submerged are classed as open water and are not included in the Wetland category.

Extensive parts of some river flood plains qualify as Wetlands, as do routinely flooded irrigated overflow areas. These do not include agricultural land where seasonal wetness or short-term flooding may provide an important component of the total annual soil moisture necessary for crop production. Areas in which soil wetness or flooding is so short-lived that no typical wetland vegetation is developed properly belong in other categories.

Cultivated wetlands such as the flooded fields associated with rice production and developed cranberry bogs are classified as Agricultural Land. Uncultivated wetlands from which wild rice, cattails, or wood products, etc., are harvested, or wetlands grazed by livestock, are retained in the Wetland category.

Attachment 2 (continued)

Remote sensor data provide the primary source of land use and vegetative cover information for the more generalized levels of this classification system. Vegetation types and detectable surface water or soil moisture interpreted from such data provide the most appropriate means of identifying wetlands and wetland boundaries. Inasmuch as vegetation responds to changes in moisture conditions, remote sensor data acquired over a period of time will allow the detection of fluctuations in wetland conditions. Ground surveys of soil types or the duration of flooding may provide supplemental information to be employed at the more detailed levels of classification.

Wetland areas drained for any purpose belong to other land use categories such as Agricultural Land, Rangeland, Forest Land, or Urban or Built-up Land. When the drainage is discontinued and such use ceases, classification may revert to Wetland. Wetlands managed for wildlife purposes may show short-term changes in land use as different management practices are used, but are properly classified Wetland.

Two separate boundaries are important with respect to wetland discrimination: the upper wetland boundary above which practically any category of land use may exist, and the boundary between wetland and open water beyond which the appropriate Water category should be employed.

Forested Wetland and Nonforested Wetland are the Level II categories of Wetland.

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Discussion

Mr. Montanari: I have a question, Virginia. What was the number of quadrangle areas constituting the land areas of the coastal zone?

Ms. Carter: Approximately 3,600, 7.5-minute quads.

Mr. Montanari: Did you say that 700 need to be revised?

Ms. Carter: Well, 700 require new mapping; 2,000 need to be revised.

Mr. Montanari: That is the coastal zone, including the Great Lakes?

Ms. Carter: That is correct.

U.S. Forest Service

by

Charles Cushwa *

The natural resource decision-maker is faced with the problem of allocating land, water, labor, and capital resources in the most efficient manner, in an attempt to meet demands of society and to stay within ecological limits of his land and water area. He is, therefore, faced with the problem of converting masses of data into information usable in decision-making. If the Nation's requirements for goods and services are to be met efficiently, the best decisions possible will be needed.

To meet such needs, it is absolutely essential that we intensify our communication and coordination of land use planning activities among all ownerships and among all levels of planning. Our existing methods must be revised and new ones devised. Our methods must be hierarchical and integrated, and they must deal with the same measurement-units, value systems, and goals if the challenge is to be met.

Land and water classification is, of course, an everyday activity of the land manager. Every time a map is made and land or water areas are delineated, some sort of a classification system has been applied to describe areas with common properties or characteristics. Land use, soil, vegetation, precipitation, and elevation are typical aspects of land and water which are mapped.

Today, we find it more informative to consider land or water areas as ecosystems. When we map, we attempt to delineate units of land or water with similar ecological characteristics. The Forest Service,

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* Paper presented by Charles R. Hartgraves.

however, has not identified, classified, or inventoried wetlands *per se* in the 185 million acres of National Forest System lands under our administration. We cannot even tell you the percentage of National Forest lands that can be defined as wetlands.

Although the Forest Service has not been working on a wetland classification, we are heavily involved in other classifications and inventories, and we do need data about the national wetland situation. The Congress in 1974--in passage of the Renewable Resources Planning Act (P.L. 93-378)--required the Forest Service to make a continuing assessment of the renewable resources on *all* forest and range lands in the United States. We are looking to the Fish and Wildlife Service--specifically to the outcome of this workshop--to provide information on the national wetlands.

As an introduction to our workshop, I will discuss briefly some of the problems that we feel influence classifications and inventories.

Definitions Past and Present:

Today, public land managers are confronted with increasing pressures for *multiple resource* use of all acres. In order to satisfy multiple resource needs, the manager must analyze a complex array of alternatives. He must be concerned also about public reaction to his decisions. Public involvement, therefore, is a must in the development of all programs.

In the past our public land management responded primarily to resource needs--the need for timber, the need for water, the need for livestock forage, the need for areas of outdoor recreation, and the need for wildlife habitats. We dealt with those needs as if there were an unlimited supply of land and resources. Many citizens of the United States had their first experience in resource limitation during the recent energy crisis. The energy crisis emphasized warnings about the condition of our environment--its ability to sustain man's use of renewable resources.

Most of us now are aware that there is a finite limit to our resources. The public land base in the United States is not increasing, and we do not anticipate major additions. We know we must develop intensive management systems and long-range plans--to sustain renewable resource production from public lands for generations to come.

The concept of finite limitations presents a new ball game to most land managers. They must now identify, collect, analyze, and interpret much more data in order to plan multiple resource use and development. Thus, those functional inventory techniques--and functional research in specific resources--we have used for the last 75 years do not provide adequate data for making today's short- or long-range multi-resource decisions.

Today we must change many of the approaches we have used in data collection, data storage and retrieval, and in decision-making. We must also train other people to become effective in using new techniques. It will be an expensive but unavoidable proposition, and it is mandatory that we move in new directions. A single individual working with a tablet and pencil in a back room can no longer handle the complex job of planning and analysis required to manage public lands.

Planning and decision-making also require the development of new rules for collecting and managing data. Decisions on management of natural resources require an inventory of resources to determine what they are, where they are, and how much there is. Although the basic natural resources--vegetation, soils and water--exist naturally as continua, it is impossible for management to deal with a complex pattern of distribution-curves illustrating diverse patterns. The continua must be recognized and classified on bases of relative homogeneity appropriate to different levels of decision-making.

Many classifications of basic vegetation, soil, and water resources are possible, and they may be either natural or technical. Natural classifications, sometimes referred to as "taxonomic" systems, are based on the genetic characteristics of objects classified. They are classifications made without premeditated consideration of use--an example being the classifications of plant or animal species.

A technical classification, on the other hand, is one which arranges objects in categories which permit more or less specific statements about use or management. Examples would be classifications of good or poor range forage species, good or poor trees for structural lumber, good or poor soils for road building, good or poor plant communities for a specific resource use, etc. Most current resource inventories--range inventories, forest surveys, and wildlife habitat inventories--include basic technical classifications of the land.

Consequently, simultaneous comparisons of resource inventories for total assessment are extremely difficult, because of the different bases from which technical and natural data are developed. Basically, two kinds of data are needed today:

1. Data that characterize the land. These inventories describe only what there is and attempt to represent the world just as it is--no more: taxanomic classifications.
2. Interpretive data collected for pre-defined problems and applicable chiefly to specific problems. These types of data

describe trees or grass in terms of uses or products. These are "functional" types of inventories: technical classifications.

Using these two types of basic data and the computer, we can aggregate and display to whatever unit at whatever resolution for whatever problem.

Goals for the Future:

A "catalyst" or focal point is needed to speed up what is already occurring at present. All of us involved in classification and inventory have a relatively similar concept of the process. We do not use the same words, charts, or figures, and we do not have the same goals in mind. Still, given enough time, we think these differences will iron out. Unfortunately, we do not have the time. We must get on with the job for the future.

Independent classifications and inventories result when people have a particular need or problem. No two have totally similar problems, and thus no two have totally similar solutions. What we find is one long continuum of problems. We know we will never develop a perfect overall classification, forcing everyone into one mold, nor do we want to. What we must strive for immediately, though, is general agreement on philosophy and concepts for the future.

Fragmentation is our root problem. Information is fragmented because no one person can encompass all problems adequately, and decision-making is fragmented as a result. We endorse the approach the Fish and Wildlife Service has taken in this workshop, and we support the idea of group participation in problem solving and decision-making.

Classifications are simply means used by people to suit their purposes; they are not "truths" that can be discovered. Therefore, there is no single, true classification--no perfect one without drawbacks. The best classification will be the one which best serves the purpose or purposes for which it is to be used.

U.S. Army Corps of Engineers

by

Col. John R. Hill, Jr.

I would like to briefly touch upon the responsibilities that Congress has assigned the Corps of Engineers that have and will continue to impact upon our wetlands. Corps responsibilities fall under the three broad categories of navigation, regulatory functions, and flood control.

Since 1824 the Corps has been responsible for the planning, construction, and operations and maintenance of our navigable waterways. The maintenance of these waterways necessarily involves dredging. Large quantities of material must be removed each year from the Nation's waterways. The disposal of this material is a major problem. I'll talk more about that later.

The regulatory responsibilities of the Corps are derived from several different authorities, but I'll discuss just those having a direct effect on wetlands--the Rivers and Harbors Act of 1899, and the Federal Water Pollution Control Act Amendments. Section 10 of the Rivers and Harbors Act of 1899 makes the Secretary of the Army, through the Chief of Engineers, responsible for regulating a broad range of construction-type activities in or affecting navigable waters of the United States. The permit program under Section 10 has been in effect for many years and has been expanded with the help of a landmark court decision from its original concern with effects on navigation to the overall public interest.

Section 404 of the Water Pollution Control Ace Amendments of 1972 gave the Secretary of the Army, again acting through the Chief of Engineers, authority to establish a permit program to regulate the disposal of dredged or fill material into the navigable waters.

The extent of this jurisdiction is presently the subject of some controversy. The controversy involves limits of the Corps jurisdiction and the scope. None of the present controversy should be interpreted as shirking our responsibility. On the contrary, the Corps of Engineers strongly supports the protection of the important wetlands of the United States. We are willing and ready to carry out whatever scope our regulatory responsibilities might cover and do so in the most effective manner possible within the resources that are made available to accomplish the task. The final regulations are scheduled to be published on 26 July.

Our existing regulations which guide our District Engineers in making decisions on permit applications recognize the ecological importance of wetlands as a productive and valuable public resource, and that unnecessary alteration or destruction of wetlands should be discouraged as contrary to the public interest. The regulations also provide that: Unless the public interest requires otherwise, no permit shall be granted for work in wetlands identified as important unless the District Engineer concludes that the benefits of the proposed alteration outweigh the damage to the wetlands resource and the proposed alteration is necessary to realize those benefits. In evaluating whether a particular alteration is necessary, the District Engineer shall primarily consider whether the proposed activity is dependent upon the wetland resources and environment and whether feasible alternative sites are available.

In order to better fulfill our responsibilities in protecting valuable wetlands under our regulatory authorities, our planning and construction missions and our waterway maintenance responsibilities, we have undertaken a variety of studies. Let's return for a moment to the problem of what to do with the 400 million cubic yards of dredged material that we expect to have to handle annually.

The Corps initiated a two-pronged attack several years ago. First, we started looking for new disposal concepts and techniques which would convert dredged material from a vexing problem into a valuable resource. Our environmental and recreational staffs have been working with our engineers to develop beneficial ways to use dredged material. In some areas we have created new wetlands, created water-based recreational areas, nourished beaches, created wildlife habitat, and created or extended highly attractive islands. (As the public and other agencies become convinced that dredged material can serve useful, beneficial purposes, the task will become easier.)

Second, in 1973, we embarked on a 5-year, $30 million Dredged Material Research Program (DMRP) being managed at the Waterways Experiment Station (WES) located in Vicksburg, Mississippi, by a staff of experts selected from the governmental, scientific, industrial and academic communities. The object of this research is to consider dredged material as a renewable, recyclable resource and find ways to use it beneficially--develop methods of on-site testing of dredged material to determine quickly its degree of pollution, if any, and the origin of any contaminants--determine the environmental impacts of both water and land disposal--explore new disposal concepts--and to make use of improved dredging and disposal equipment and techniques.

Initial studies begun under the DMRP considered state-of-the-art research on natural wetlands systems to determine the important contributing parameters operative in wetlands and aquatic communities. Studies on marsh productivity in Louisiana, Georgia, Delaware and Maine were begun along with plant physiological studies to determine the importance of various types of marsh plants. Subsequent to this, five active dredged material disposal sites were chosen for marsh creation. These sites represent both saline and brackish marsh types and are well distributed over the geographical region of the country. It is hoped that data received from the baseline studies can be compared with the results observed in the newly created marshes to give an adequate appraisal of the feasibility of enhancing wetlands through actual creation.

Further studies in the DMRP will concentrate on the reestablishment of seagrass beds on dredged materials.

Out of all this we should learn where dredged material is harmful and where it is not. We should learn what additional costs are justified in the interests of environmental protection. And, equally as important, we must learn enough to answer the kinds of questions that will make impact statements not only technically viable, but sufficiently authoritative to satisfy the public; a public that wants the assurance that not only will there be an absolute minimum of environmental impact, but that any change required to maintain navigation will also be mitigated as much as possible.

Efforts are also underway at WES on wildlife mitigation and a comprehensive study of side channels in the Middle and Upper Mississippi River. The studies in the Mississippi River included an intensive study of the terrestrial and aquatic vegetation and an inventory of the existing organisms and communities located in the floodplain in an effort to determine some of the ecological relationships in the Mississippi River.

At the Coastal Engineering Research Center (CERC) in Fort Belvoir, Virginia, a number of studies have been initiated or completed which compliments the effort at WES. One of the first studies in this area by CERC centered around determining the best marsh plants and planting techniques available for marsh development. Much of the CERC work on the coastal dunes and marsh areas has been coordinated by the University of North Carolina.

A recent study for CERC centered on the utilization of marsh plants for erosion control in Chesapeake Bay. Similar studies are now underway in Trinity Bay, Texas and San Francisco Bay, California. In conjunction with these studies, temporary barriers are being experimentally used to dispel wave energy and thus lend protection to the newly established vegetation.

Another program--related, but not confined to wetlands--was the preparation of Environmental Inventory Atlases for the States of Washington, Vermont, and North Carolina, and other atlases for the Charleston and Pittsburgh Districts and south Louisiana. These atlases were designed to provide an overview of known environmental values over a large geographical area. They are not suitable, nor were they intended to be used, for detailed planning. Several of these atlases are here and are available for your perusal.

The Corps has done and continues to do a considerable amount of testing of potential uses of remote sensing technology. Several remote sensing programs are now in operation in the Corps. The San Francisco District uses color infrared aerial photos at a scale of 1:10,000 to plan and monitor activities in the San Francisco Bay. The Norfolk District uses low altitude color infrared aerial photos at a scale of 1:5,000 to locate potential areas for disposing of dredged material from Norfolk Harbor. The New Orleans District used high altitude, high resolution (12 ft) color infrared photos at a scale of 1:120,000 to update the South Louisiana Environmental Atlas.

The Corps is involved in a number of other studies around the country which involve wetlands--an example in this area is the Chesapeake Bay Study which is a multi-objective study authorized by the Rivers and Harbors Act of 1965. As part of the study an existing conditions report has been prepared which includes an assessment of wetlands, their productivity, rate of loss and potential controls.

Another joint effort involving wetlands is the Great River Environmental Action Team (GREAT) which is a Federal, State, and local study effort addressing a broad range of problems in the Upper Mississippi River Basin.

Maintenance dredging in the channel, along with natural accretions, has created a series of small islands which act to reduce the water surface, narrow existing wetlands, and in some cases cause shoaling. One of the important near-term objectives of the study is to develop recommendations for channel maintenance.

From this brief overview of the Corps of Engineers activities and responsibilities in wetlands, it can be readily seen that much more information than is presently available is needed. We are pleased that the Department of the Interior is embarking on this program to classify and delineate the Nation's wetlands at this time. Such information is particularly critical to the Corps planning and regulatory responsibilities. We are anxious to assist the Fish and Wildlife Service in this important program and look forward to a productive workshop.

Discussion

Mr. Marland (Fred Marland, Georgia): You mentioned that the May 6th regulations as a result of NRDC vs. Calloway would be in final form on July 26th, as per order of the Judge. When the State of Georgia prepared its comments in light of those 6th of May regulations, we were advised that there were some 4,000 or more responses to those regulations. Do you think that you will have had enough time and information on which to base final regulations as of the 26th of July?

Col. Hill: I would say it has been a very demanding situation; people are working on the final stages over this weekend. I would say yes, there has been enough time. It is entirely conceivable that not everybody will be happy with the final regulations. I have not personally been involved in the details of the planning. The work has been handled on a task force basis.

Mr. Marland: On the basis of our personal contact with this issue, I would say that the Corps isn't ready, or EPA is not ready. It is inconceivable to me how you could, in such a short period of time, incorporate 4,000 comments into a meaningful set of regulations which would apply nationwide.

I would also like to point out that in your comments regarding your $30 million program at the Waterways Experiment Station nothing was mentioned about the shallow productive bottoms or mud flats that are covered up. When you run out of mud flats and productive bottoms, what is the new wrinkle going to be?

Col. Hill: That is part of the program. We have people here who are more technically qualified than I to answer such questions. After this session we would be happy to discuss that aspect of our program with you in more detail. Thank you for your comments.

U.S. Soil Conservation Service

by

Ronello M. Davis

The Soil Conservation Service recognizes the value of wetlands and the critical nature of the problems affecting these areas. The extent of this concern is evidenced in a number of ways.

The SCS was formed in 1935. That same year we issued a national policy on wildlife management. In 1939, detailed instructions for drainage were spelled out, recognizing drainage as an activity with constraints against reclamation as a sole purpose and providing that "Drainage plans shall give proper consideration to wildlife conservation."

(1) In the early 1960s, the growing need for a comprehensive program for dealing with migratory waterfowl habitat led to the signing of a joint agreement between the United States and Canada. It coordinates the efforts of agencies of USDI and USDA, along with their Canadian counterparts. These joint efforts led to establishment of the Water Bank Program in the United States. They have also assisted in getting authority for the Fish and Wildlife Service to acquire wetlands, a program that has halped achieve a significant level of public-federal wetland ownership or leasing control.

(2) P.L. 87-732, the so-called Drainage Referral Act, came about as a result of coordinated efforts. It was enacted October 2, 1962 and applies to Minnesota, South Dakota, and North Dakota. In these three states, it prohibits the Department of Agriculture from assisting landowners in draining potholes and marshes without first referring their

request for assistance to the Secretary of the Interior so that he may determine whether wildlife preservation will be materially harmed by the proposed drainage. If it is determined that wildlife preservation will be materially harmed and that preservation of such land in its undrained condition will significantly contribute to wildlife preservation, the Secretary of the Interior or a State government agency may, within one year of this determination, offer to purchase or lease the wetland in question. If the landowner rejects the offer, federal drainage assistance cannot be extended to him for a period of five years following the above-mentioned determination. Responsibility for making these determinations in the field is carried by the U.S. Fish and Wildlife Service.

(3) Since 1963, the following language has been included in the section of the Department's appropriation that authorizes Agricultural Conservation Program funds administered by the Agricultural Stabilization and Conservation Service:

> . . . no portion of the funds for the current year's program may be utilized to provide financial or technical assistance for drainage on wetlands now designated as wetland Type III, IV, and V in the United States Department of Interior Fish and Wildlife Circular 39, Wetlands of the United States 1956.

This language was inserted in the appropriation bill as the result of a coordinated effort by the congressional committee, USDI, USDA, and other fish and wildlife interests.

SCS Wetland Policy:

Waterfowl and other wildlife of farm and ranch lands are a valuable resource. Assistance in supporting or producing them--either on land managed specifically for that purpose or as secondary to other uses--is an important activity of the Soil Conservation Service. The SCS works to promote the management of wetland. Several kinds of management practices can be used to enhance, maintain, or restore wetlands, including improving plant species composition or their density through such measures as water depth control, salinity control, prescribed burning, and pollution abatement.

SCS also promotes the creation of wetlands in certain areas, primarily to increase wildlife production. This involves impounding shallow water behind levees and dams and establishment of desired vegetation.

In addition, SCS is sometimes contacted by landowners who want to convert wetlands to other uses. All of these requests are evaluated carefully by our technicians to assure that any drainage or other alternative proposed is within SCS policy on wetland conservation.

In 1951, a Joint Study was conducted by SCS and the Fish and Wildlife Service of the impact on wetland of agricultural drainage in the Louisiana marshes. This Study led to the marsh evaluation procedure now used by SCS.

Wetland concerns are part of an even larger problem: that of identifying and protecting critical areas. More than 35 kinds of critical areas--including wetland and prime agricultural land--are listed in a report published in April 1975 by the Council of State Governments (figure 5, page 63). The report is entitled, "Land--State Alternative for Planning and Management."

SCS believes that it is important to assess long-term needs for protecting wetlands and other unique resources so that future generations may enjoy them. Then, a balance must be struck between environmental needs and anticipated needs for food and fiber.

Unfortunately, wetland and prime agricultural land are difficult to protect in an economic system which permits a high return from other land uses. When good farmland is covered by a housing development or a superhighway, the productive capacity that is lost must be made up somewhere else. That "somewhere else" might well be wetland or the wet soils adjacent to it. This might appear to create competition between agricultural and wildlife interests, but it really represents the impingment of h igher economic forces on both types of land.

In consideration of these national issues, SCS revised its wetlands policy on May 5, 1975 (See Appendix A). This policy is keyed to the wetland types described in Circular 39, but it can be adjusted to fit any improved classification system that may be developed.

Assistance to Decision Makers:

SCS throughout its forty years has not been a decision maker. Instead, it assists local decision makers by collecting and analyzing data and presenting alternatives. It also works with local people to arrive at reasonable resource uses that meet both local needs and broader national interests. SCS contributes its expertise and aid through conservation districts that are organized as local units of state government, but without general governmental powers. The conservation districts concept originated in 1936. Today, nearly 3,000 districts have been organized, encompassing almost the entire country.

For the first 20 to 25 years, SCS and conservation districts were concerned almost exclusively with agricultural conservation. But this concern has grown increasingly more comprehensive. Today, we deal with all kinds of landowners and operators.

We collect, integrate, analyze, and develop special presentations of natural resource data for individuals, groups, and units of government; for example: (1) providing soil survey interpretations, vegetation inventories, and conservation treatment alternatives to individual farmers, ranchers, and other land users; (2) helping conservation districts in the technical review of an urban developer's erosion control plans; (3) helping local groups determine natural resource conditions and community aims in a watershed project; (4) working with other agencies and states in a river basin study; or (5) assisting councils of government on regional resource problems.

SCS is proud of its field delivery system for giving such assistance. The system encourages a two-way flow of ideas and understanding. Because SCS senior leaders have started out as field technicians and risen to positions of greater responsibility, they provide a built-in means for keeping in touch with the field.

Local people can make workable judgments regarding wetlands, if they are provided natural resource data and a logical wetland classification system that they can use--a system that clearly describes the location; amount; importance; nature; and local, regional, national, and international interrelationship of wetlands in their area.

They also need a wetland inventory. But most importantly, they need to develop a level of awareness which will permit them to use the classification system and inventory to maintain, protect, improve, and create wetlands--or to convert them to other uses.

Wetlands and SCS Programs:

All SCS programs assemble technical information on wetlands and put it to use.

For example, SCS has leadership in the National Cooperative Soil Survey, whose field data and interpretations go back to 1899. This and other SCS assistance--such as engineering, vegetative, and other natural resource information--is provided through local soil conservation districts (SCD's) to individuals, groups, and units of government.

Through the authority of basic technical assistance programs (P.L. 74-46, April 27, 1935) SCD cooperators maintained, improved, or managed about 510,000 acres of wetland in 1974 with SCS technical assistance.

SCS provides technical assistance for conservation practices cost-shared by the Agricultural Conservation Program (ACP) administered by the Agricultural Stabilization and Conservation Service (ASCS). SCS also provides technical help to farmers and ranchers in developing and carrying out conservation plans used as the basis for long-term agreements in ACP.

Our plant materials program provides the mechanism for locating, evaluating, and providing basic plant stock or seeds for newly found or improved wetland plant species.

The Resource Conservation and Development (RC&D) program provides an opportunity for SCDs, local units of government, and individuals to improve their communities in multi-county areas by enhancing their economic, environmental, and social well-being. This is accomplished primarily through prudent use, management, and protection of natural resources. Wetlands are an important part of these projects.

The Watershed Protection and Flood Prevention Act, P.L. 83-566, was approved by the President on August 4, 1954. It provides technical and financial assistance in planning and carrying out work to protect, develop, and utilize land and water resources. Under the Act, SCS provides help in flood prevention, agricultural water management, sediment control, fish and wildlife development, and public recreation. The act terminates USDA activities under the Omnibus Flood Control Act of 1936, as amended and supplemented, except for completion of work on 11 special authorized watershed improvement programs and emergency measures for runoff retardation and soil erosion prevention. Section 6 of the act provides authority for making river basin investigations and flood hazard analyses in cooperation with other organizations.

The Small Watershed Program is a popular one, providing significant project type assistance throughout the country. Wetland information is obviously critical to the multidisciplinary team of planners who work with the people in a project area to develop sound plans for a watershed. The SCS Environmental Assessment Procedure is designed to recognize wetland classes and to look at the impact on wetlands and the values of fish and wildlife alternative actions. SCS provided technical assistance with the management of about 7,000 acres of wetland in watershed projects during 1974. In addition, about 132,000 acres of water have been created by P.L. 566 projects through Fiscal Year 1976.

The Great Plains Conservation Program (GPCP) was established by P.L. 84-1021 in 1956 to minimize climatic and economic hazards in the ten-state area constituting the Great Plains. The Program's main objective is to provide technical and cost-sharing assistance to farmers and ranchers for developing and carrying out an enduring conservation plan. This assistance includes alternatives for creating, preserving, enhancing, and restoring wetland.

The Water Bank Program was established by the Water Bank Act, P.L. 91-559, December 19, 1970. Its primary purposes are to (1) prevent serious loss of wetland; (2) preserve such wetlands; and (3) restore and improve wetlands. The Water Bank Program is applicable in important migratory waterfowl nesting and breeding areas.

Participants in the Water Bank Program develop 10-year agreements with the Secretary of Agriculture to set aside wetlands and enough adjacent land to make viable waterfowl habitat. All conservation practices needed to protect the land in the WBP agreement must be established in accordance with a conservation plan developed by the local conservation district with SCS technical assistance. The Agricultural Stabilization and Conservation Service has general administrative responsibility for the WBP and accepts requests, approves agreements, and makes annual payments to eligible participants.

The 1975 WBP is operating in 72 counties in 13 states. Over 100,000 of the total 130,000 acres designated in WBP agreements as of June 30, 1974 were in the states of Minnesota, North Dakota, South Dakota, and Wisconsin. The average WBP agreement to date contains 26 acres of Type III, IV, or V wetlands and 48 acres of designated adjacent land protected for migratory waterfowl breeding and nesting areas. Type I and II wetlands are often included in the adjacent land area.

Wetland Inventory Work:

The Department of Agriculture has a history of involvement with wetland inventories. The first attempt at a national inventory of remaining wetlands was made in 1906 by USDA at the request of Congress. The second inventory of wetlands, conducted in 1922, was recorded in the 1923 Yearbook of Agriculture. This inventory showed a total of 91.5 million acres of wetland. Two other estimates were made by USDA in more recent publications. A drainage reconnaissance survey made by

SCS in 1940 estimated that there were 97.3 million acres of "wet, swampy, and overflow land outside organized drainage enterprises." The latest (1953) USDA publication on the subject estimated that there were 125 million acres of undeveloped wet- and swamp-lands which are subject to overflow.

The most recent national inventory, completed in 1954 by the U.S. Fish and Wildlife Service of the Department of the Interior, and published as Fish and Wildlife Service Circular 39 in 1956, showed 74.4 million acres of wetlands in the 48 coterminous states. The Fish and Wildlife Service had leadership responsibility for the inventory, and SCS was one of the many Federal and State agencies that assisted. The result is a nationally recognized inventory and classification system of wetlands that SCS uses in its present work.

The Rural Development Act of 1972, Section 302, Public Law 92-419, "Soil, Water, and Related Resource Data," states in part:

> . . . the Secretary of Agriculture is directed to carry out a land inventory and monitoring (LIM) program to include, but not be limited to, studies and surveys of erosion and sediment damages, flood plain identification and utilization, land use changes and trends, and degradation of the environment resulting from improper use of soil, water, and related resources.

The Secretary of Agriculture has assigned this responsibility to the Soil Conservation Service. Section 302 gives SCS the authority to gather data that, when interrelated, would produce an inventory of wetlands. We feel that data on soils, vegetation, flooding, use and conservation treatment can be used to help locate and classify wetlands.

SCS and USDA land inventorying and monitoring groups have agreed on 15 primary data categories needed to provide a response to Section 302 of the Rural Development Act of 1972. Since one of the 15 data categories is wetlands, SCS formed a LIM Task Force on Wetlands Inventory on June 21, 1973, to help with this job. This task force has met periodically to work out a definition of wetlands and procedures for inventorying wetlands. The task force completed a draft definition of wetlands in October 1974.

SCS has worked closely with the Fish and Wildlife Service on three pilot studies of wetlands in Louisiana, Maryland, and South Dakota as an outgrowth of the 1975 National Water Assessment. Some of the questions looked at were:

a. What are the relationships between wet soils and wetlands?

b. Can soil surveys be used to predict aquatic vegetation?

c. Are soil surveys useful in delineating wetlands? Wetland classes?

d. What kinds of information, other than soil surveys, are needed to delineate wetlands? Wetland classes?

e. How can soil surveys be improved for purposes of delineating wetlands?

The three pilot studies demonstrated a significant correlation between wet soils and wetland plants. This correlation will be useful in any wetland classification system and inventory. However, in some soil surveys, SCS has not mapped with enough detail to recognize all wetland types. This kind of detailed mapping can be done in every survey in the future, if resources are provided and there is general agreement on the need for this type of data.

In short, soil surveys can be of substantial help inventorying and classifying wetlands.

Wetland Classification System:

A wetland classification system can be developed to serve many purposes. It must be based on scientific facts, or we in SCS will have difficulty in interpreting the resulting inventory so that it can be readily understood by land users, operators, and decision makers. It must result in an inventory that tells us all we need to know about wetlands so that each area can be used and managed wisely.

An effective wetland classification system must take into account natural and introduced vegetation, quality of impounded water, the soil characteristics, meteorological data, landscape features and configuration. It must also consider flooding, tidal surge, elevation, size and shape of area, and the relationship to ground water recharge areas. It should define each class or type of wetland in such a way that each can be distinctly separated from every other class or type.

To help provide the information needed by land users, operators, and decision makers, a wetland classification system should establish the boundary of wetlands on the dry side and the water side. Almost everyone can agree on what constitutes a "good" wetland. Conflicts arise on the marginal wetlands--those that are marginal to drylands and those that are marginal to water.

A wetland boundary on the dry side is difficult to define, but important to recognize. This boundary land is--or is adjacent to--land that is in demand for uses other than for wildlife, watershed hydrology, and recreation. There are usually strong pressures to develop this land for farming, commercial, industrial, or residential purposes.

The boundary of wetlands on the water side is also difficult to define. For instance, how far into a large body of water does wetland go? This boundary is not as critical as a boundary on the dry side, because pressures to change the land use are not as powerful; but it is important.

The classification system should be compatible with other land related classification systems and standards. It should take full advantage of soil and plant taxonomy, water quality standards, and other established and defined parameters associated with the physical sciences. This is very important if we are going to develop new wetland areas.

The system must result in an inventory that provides data on each class or type of wetlands so that any given area can be interpreted as to its potential for wildlife production, ground water recharging, aesthetic value, environmental significance and use for other purposes.

In summary, I want to say that SCS will continue to work with others in developing a standard wetland classification system. Once the system is finalized we will contribute any data we have available and stand ready to assist others in the collection of factual site data as a part of a national wetland inventory.

I wish you success in carrying out your important workshop objectives. SCS is pleased that a high priority has been placed on providing the base for a better understanding of our wetlands.

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Conservation Service

Washington, DC 20250

APPENDIX A

May 5, 1975

CONSERVATION PLANNING MEMORANDUM-15

FROM: Kenneth E. Grant, Administrator

RE: Conservation of Wetlands

This memorandum states Soil Conservation Service policy regarding wetlands. The policy applies in all cases except where SCS commitments were made prior to the date of this memorandum. Policies, procedures, and guidelines in other SCS documents that are inconsistent with this policy are superseded. Those documents are to be revised to be consistent with this policy. Biology Memorandum-2 and -3 and Inter-agency Memorandum-8 are canceled.

SCOPE

This memorandum applies to wetland types 1 through 20 as described in Circular 39 of the Fish and Wildlife Service, U.S. Department of the Interior, published in 1956.

It does not apply to lands artificially diked and flooded to produce commercial crops of domestic rice, wild rice, or cranberries nor to previously wet soils converted to other substantially irrevocable uses.

BACKGROUND

Because of the fragile nature of wetlands, human activity can and often does inflict lasting change on them, sometimes seriously altering their natural functions. Millions of acres of the Nation's original wetlands have been impaired or converted to other uses. Extraordinary care and effort are required to protect the remaining aquatic ecosystems.

Wetlands moderate extremes in water flow and have value as natural flood-control mechanisms. They aid in water purification by trapping, filtering, and storing sediment and other pollutants and by recycling nutrients. Many serve as ground-water recharge areas. All function as nursery areas for numerous aquatic animal species and are critical habitat for a wide variety of plant and animal species. Wetlands produce economically important crops of fur, fish, wildlife, timber, wild rice, wild hay, wild cranberries, and other products. Many return profits through fees for hunting, fishing, and trapping privileges.

The plants that grow in tidal marshes and other estuaries yield the nutrients required to sustain high yields of aquatic life. Tidal and wind currents redistribute the nutrients and sediments throughout the aquatic areas, thereby helping to maintain the substrate for all creatures using these areas. Tidal marshes and other estuaries are a primary base for many of the Nation's marine and maritime commercial and sport fisheries. A large number of salt-water finfish and shellfish spend some phase of their lives in such areas.

Riparian wetlands similarly support adjacent or downstream aquatic ecosystems in addition to the complex web of life within those aquatic environments. Bordering marshes, for example, provide the spawning areas required by northern pike to maintain their populations in associated streams, rivers, lakes, and reservoirs.

Various kinds and degrees of management may be required to insure desired stages of productivity of existing wetlands. Management involves manipulation of plant species and densities through measures such as water depth control, burning, grazing, and mowing. Offsite measures are often essential to control wind and water erosion, to minimize sedimentation, to maintain optimum salinity, and to divert pollutants.

On the other hand, many wetlands, if drained, could be used as prime cropland for the production of food and fiber. It is important to assess long-term needs for protection of environmental resources for the enjoyment and well-being of future generations and to reach a balance with projected needs for food and fiber. The resource inventory, interpretation and planning assistance provided by the SCS is of value in halping achieve this balance.

POLICY

1. SCS is not to provide technical and financial assistance for draining or otherwise altering wetlands types 3 through 20 in order to convert them to other land uses.

2. SCS can provide technical and financial assistance to alter wetlands types 1 and 2, including conversion to other uses such as cropland and pastureland. Such assistance in Minnesota, South Dakota, and North Dakota is to be given in accordance with item 3. SCS is to encourage the preservation of wetland types 1 and 2 where they are adjacent to wetland types 3 through 20 and are needed to maintain a balanced aquatic or semiaquatic ecosystem. When a decision is made by the land owner or user to alter wetland types 1 and 2 or to convert them to other uses, SCS is to encourage the application of land treatment measures needed to reduce erosion and sedimentation and protect environmental values; and SCS is to encourage decisions to preserve key areas and, where possible, to include enhancement measures on such areas.

3. In the states of Minnesota, North Dakota, and South Dakota, SCS technical or financial assistance for draining or otherwise altering wetlands of types 1 and 2 in order to convert them to other uses is to be provided in accordance with provisions of P.L. 87-732.

4. Project actions, such as watershed or RC&D projects, are not to include features designed for the purpose of draining or otherwise altering wetlands types 3 through 20 in order to convert them to other land uses. If such projects include features for other purposes that unavoidably result in losses to types 3 through 20 wetlands, the loss is to be mitigated by establishing wetland habitat values in the same vicinity that are equivalent, insofar as possible, to the wetland habitat values lost.

   Provisions are to be established for managing these wetlands on a comparable or more intensive basis than those lost. Sponsors, conservation organizations, state fish and wildlife agencies, or others can assume these management responsibilities.

5. SCS is to assist in restoring damaged wetlands that are not irrevocably committed to other uses and in establishing wetland habitat, where appropriate.

6. SCS is to encourage landowners and project sponsors to consider and use the programs of other federal, state, and local agencies and private organizations that may help to preserve wetlands.

Norman A. Berg (signed) Acting
KENNETH E. GRANT
Administrator

Bureau of Reclamation

by

George H. Wallen

The Bureau of Reclamation's program has operated for 70 years to assist in the conservation and development of water and related land resources in 17 Western States. That area includes the States, exclusive of Alaska and Hawaii, generally lying on or west of the 100th meridian. Operations take place in four physiographic regions, including all of the Rocky Mountain, Intermontane, and Pacific Mountain divisions and a portion of the Interior division. While the Bureau of Reclamation may be best known for its construction and operation of facilities for irrigation development, it also constructs and operates water use and control facilities for power, municipal and industrial water, fish and wildlife conservation, and recreation as parts of multipurpose projects.

The Bureau is concerned with the conservation of wetlands in the Western States. Several wetland areas of primary importance to waterfowl lie on or adjacent to Reclamation projects, and cooperative programs have been established in many of those areas for maintenance of wildlife habitat and public use. In 1973, the latest year for which complete statistics are available, more than 4.3 million acres of land and about 1.7 million surface acres of water were available for recreation, including fishing and hunting at Reclamation projects. According to our estimates, more than 19 million fish and 255,000 waterfowl were harvested from those areas. About 400,000 acres of land and 300,000 acres of water at Reclamation projects are managed by Federal and State fish and wildlife agencies for conservation and development of fish and wildlife resources, including waterfowl.

During the conduct of the Westwide study, a multiagency study led by the Bureau of Reclamation, an attempt was made to point out and define the critical water-related issues in 11 Western States. One of the issues defined for the Wast was the determination of how to treat the problem of preserving wetland areas for their inherent natural resource values. Development and use of the water resources in the West is dependent upon how the problem is resolved. The only clear picture emerging is that a great deal more information on the extent, value, and use of wetlands is necessary before informed decisions can be made.

A few examples may be helpful to illustrate the interface between the development and use of water resources and the preservation of wetland areas.

At the Columbia Basin Project, located in the State of Washington, more than 500,000 acres are presently being irrigated. Water is provided through a system of storage and conveyance facilities to land suitable for irrigation. Over 100,000 acres of land not suitable for irrigation is subject to seepage from irrigation developments or contains ponded water from irrigation return flows. Wildlife resources have been enhanced by the existence of those wetland areas.

Information on nonirrigable lands that are predicted to become wet but are economically infeasible to drain is made available to fish and wildlife interests. Where the fish and wildlife potential is apparent, lands in Federal ownership can be turned over to fish and wildlife agencies for management of the resources associated with wetland.

Plans have been proposed for development of additional irrigation in connection with the Columbia Basin Project. At this point, information is needed on how to plan effectively for development of wetland areas that may provide additional benefits to fish and wildlife resources.

The Bureau's Central Valley Project includes a complicated system of water control and conveyance facilities which operate in conjunction with State and private facilities. Major wetlands also lie within the Central Valley Basin. It has been estimated that about 3-1/2 million acres of wetlands in California could have been classified as good waterfowl habitat at the beginning of the 20th century. Since then, those wetlands have dwindled rapidly because of urbanization and industrial and agricultural developments. A complete inventory of remaining wetland areas and their value is important to decisions on management and development of water resources for future use.

Bureau facilities in Montana and North and South Dakota generally involve the streams of the Missouri River drainage where upland areas are arid. However, in northwestern North and South Dakota, projects planned by the Bureau pass through or are adjacent to extensive wetland areas. Loss of wetland acreage and alterations of wetland characteristics are among the chief environmental controversies associated with water projects in those areas.

At the Garrison Diversion and Oahe Units of the Pick-Sloan Missouri Basin Program in North and South Dakota, initial wetland inventories were conducted by the Fish and Wildlife Service when those projects were studied in the late 1950s and early 1960s. Topographic maps, aerial photographs, and limited field work were employed to identify and classify wetlands according to the categories described by Shaw and Fredine (1956) in Fish and Wildlife Circular No. 39. Those data were used initially in planning and subsequently in preparing an overall environmental statement for each unit.

Currently, detailed plans and impact statements are being prepared for the major service areas on the Garrison Diversion Unit. Detailed planning, drainage, and soil investigations, as well as a change from gravity flow to sprinkler irrigation, have resulted in modification of earlier irrigation plans. Some acreage included under the old scheme may not be irrigated under the updated plan and vice versa. To a degree, the effects of the project on wetlands were considered in preparing the overall statement, but for the detailed environmental statements more definitive information is required. In addition, it was necessary to assess those changes in wetlands which have occurred as a result of man's activities since the last inventory.

The Fish and Wildlife Service conducted a new, detailed inventory last year on the first service area (La Moure and Oaks Section) to be covered by a detailed environmental impact statement. The field work was extensive and soil surveys were also employed in wetland identification. This later inventory used the terminology of the old classification system in that acres of types 1, 2, 3, 4, and 5 wetlands were specified. However, it was found that larger individual wetlands were made up of several types when evaluated under a classification system based on water depth. The procedure used was somewhat similar to that used by Stewart and Kantrud (1971) in describing a system for classification of natural ponds and lakes in the glaciated prairie region. It was quite disturbing to learn that the earlier inventory had apparently underestimated wetland acreage significantly.

Investigations of potential water use and control projects generally take several years between the time that an investigation is initiated and construction is completed. During the initial phases of an investigation, an effort is made to identify all resources in a study area and the uses being made of them. In most past efforts, we have relied on the Fish and Wildlife Service to identify wetland acres of importance and to suggest measures that could be taken to preserve or enhance them in connection with project development. The information obtained through the first National Wetlands Inventory has been used extensively; however, there are several problems in the use of that inventory that can be corrected in the present effort.

Some of the data supporting the first wetlands inventory were hastily developed and, as pointed out, detailed field investigations indicate that substantial differences occur in some locations. Some of the differences may be explained by the difficulty in using portions of the background data since it is hard to identify all areas originally included. The data on specific areas were not sufficiently detailed to be readily usable in all cases.

The first inventory focused primarily on waterfowl values and, although values for other wildlife were discussed, they were not evaluated for specific wetland areas. While the importance of wetlands to waterfowl is defined generally, it is difficult, if not impossible, to assess the contribution of specific wetland areas.

Man-made wetlands were excluded from the initial inventory. To continue that exclusion would overlook a substantial area of land and water available to and providing habitat for a large number of animal species. There has been extensive development of ponds and lakes in most areas of the country, and, in the West, substantial acreages of wetlands are interspersed among irrigation developments such as the Columbia Basin Project. Wetlands found along the shoreline of many man-made lakes and ponds now are as important to wildlife as natural areas.

To assist agencies such as the Bureau of Reclamation in their work, it would be helpful to identify wetlands that are critical to the maintenance of viable populations of wildlife as contrasted to those that may be of low wildlife value. It would be especially useful to identify areas of critical importance to endangered and threatened species. It would also be useful to identify where problems occur and where the allocation of water for creation of wetlands would be beneficial. Assuming that there is an ultimate goal of establishing a wetland preservation and enhancement program, the inventory information should result in the development of a plan for that program showing areas with potential for expansion, areas where additional wetlands are needed, and guidelines for increasing wetland productivity.

It has been stated that wetlands are threatened, but information of which wetlands are threatened, by what, and in what time frame is not readily available. A survey of who owns and who administers wetland areas seems warranted as well as information on what those owners and/or administrators intend to do with the wetland areas in the future. That information would also facilitate the development of plans for protection and enhancement.

To summarize, it may be most useful to conduct the inventory under a classification system that includes three dimensions. These are quantity, quality, and use. The quantity dimension should include physical aspects of size, shape, amount, and duration of water supply, quality of water, and types of associated habitat. The quality dimension should include an expression of the relative value or criticality of each wetland area to important animal species that require this habitat. The use dimension should include an expression of the extent of use by important animal species as well as the uses now being made or contemplated by those owning or administering such areas.

We tend to favor the system used by Shaw and Fredine as a beginning point in preparation of the first national inventory. In comparing Shaw and Fredine's system with others, such as that used by Stewart and Kantrud, we tend to favor the former because of its relative simplicity and long-established use. It can be used to classify wetland types and is more understandable by those using the information. On the other hand, other systems provide a far more precise classification of a wetland at any given time, but the classification of specific wetlands may vary from year to year depending on water conditions. The choice is like describing an automobile simply as a Chevrolet or a 1974 Chevrolet Impala 2-door hardtop, etc. The decision on which to use depends on how much information must be conveyed. Detailed information about each specific wetland area may be more useful than a summary of the acreage falling in each type. Rather than meticulously classifying wetland types based on physical and biological parameters, it may be more important to provide more details on associated wildlife values and wildlife usage.

The Bureau of Reclamation does not have a specific program for inventory of wetland areas. It does, however, attempt to identify important wetlands that may be affected by the water use and control projects it constructs and operates. In planning investigations as well as during environmental assessments, wetlands are generally identified by the Fish and Wildlife Service or State wildlife agency personnel. In addition, the Bureau of Reclamation classifies lands for irrigation suitability in investigations where irrigation appears to be a likely alternative use of water supplies. Presently, classification procedures include consideration of additional desirable uses such as fish and wildlife protection and enhancement. While the classification indicates the suitability of lands for various uses, it does not in any way zone land for a particular use.

Remote sensing techniques for classifying wetlands and measuring acreages are badly needed. Existing procedures are time consuming, subject to the vagaries of weather which limit field work and climate which may drastically alter the appearance of wetlands from season to season and year to year. They are also subject to bias resulting from the experience of the classifier.

Obviously, the Bureau of Reclamation relies heavily on the Fish and Wildlife Service for information on wetlands and their values. The present inventory effort will facilitate the exchange of information and further document the wetlands of importance to both agencies.

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Stewart, R. E. and H. A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. U. S. Fish Wildl. Serv. Resour. Pub. 92. 57 pp.

Tennessee Valley Authority

by

James H. Burbank

The Tennessee Valley Authority, a Federal agency with corporate character and governmental powers, is charged by the TVA Act [48 Stat. 58 (May 18, 1933) as amended] to foster the social, economic, and environmental progress of the people of the region and the nation through a unified approach to resource development, employing the application and advancement of technology, innovation, and planned change.

In carrying out this task, TVA has mustered a corps of professionals and technicians embracing an enormous array of disciplines. These disciplines are exercised collectively to meet seven continuing objectives of the agency (Figure 1). This point is being made to emphasize the variety of agency interests and concerns brought to bear on all terrestrial and aquatic ecosystems within the 36-million-acre Tennessee Valley--and even beyond, occasionally, in TVA's Power Service Area (Figure 2). Wetlands, as other ecotypes, receive attention commensurate with the agency's efforts to meet its continuing objectives.

TVA's Division of Forestry, Fisheries, and Wildlife Development (FF&WD) has the most active interest in wetlands for their own sake, i.e., for the natural resources and public benefits they can provide. The Division's mission and specific objectives are listed in Figure 3. This paper summarizes the major wetlands-oriented activities and needs as perceived by the staff of FF&WD.

Fisheries

TVA's reservoir system has over 650,000 acres of surface water and over 11,000 miles of shorelines (see Figure 2). Its reservoir lands

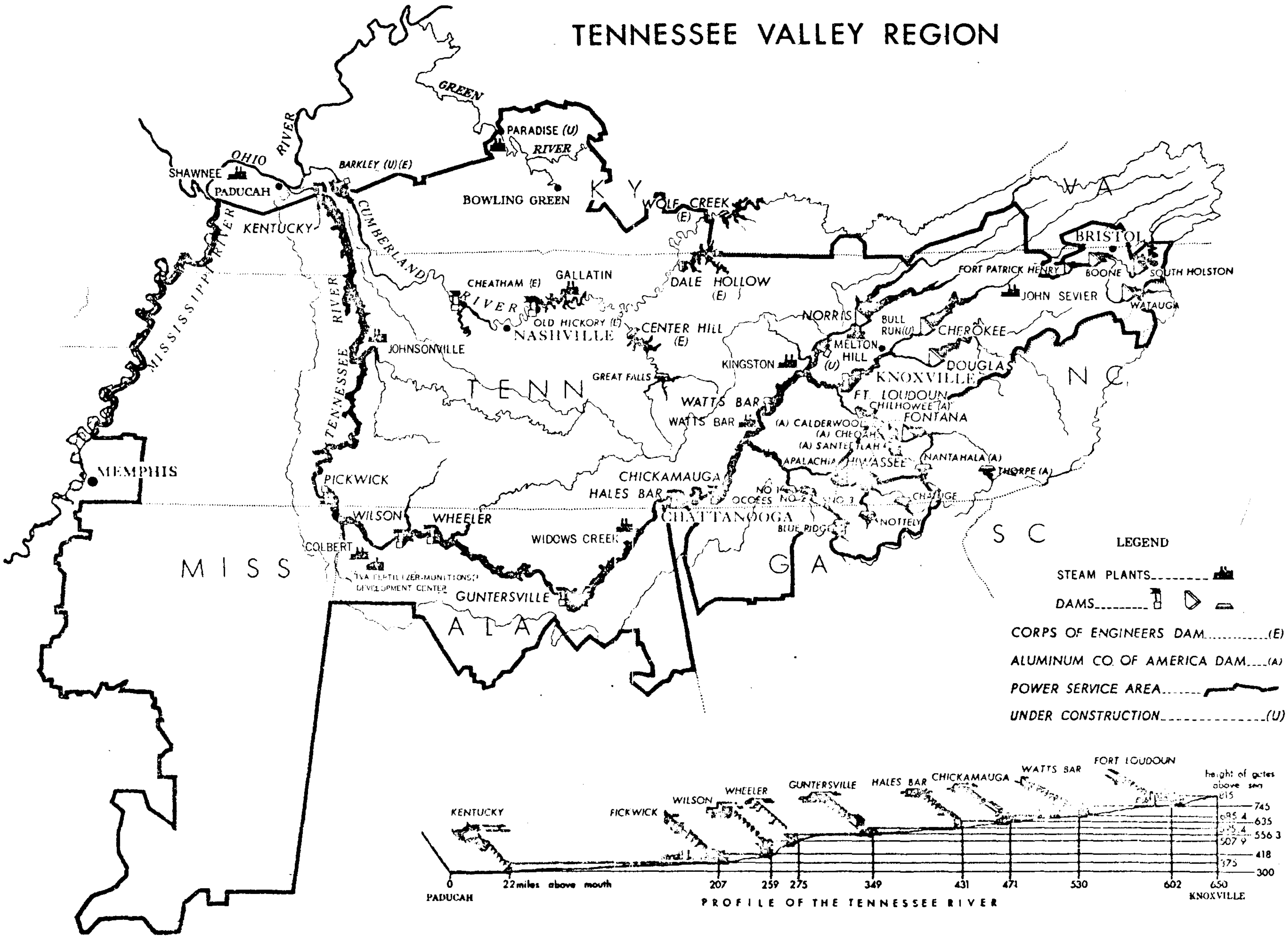
FIGURE 1

TVA's Mission

To use TVA's unique corporate and governmental powers to foster the social, economic, and environmental progress of the people of the region and the Nation through a unified approach to resource development employing the application and advancement of technology, innovation, and planned change.

TVA's Continuing Objectives

1. The Natural Resource Objective: to develop, conserve, and utilize the region's physical resources so as to foster a better quality of life.
2. The Power Resource Objective: to improve the quality of life in the region through provision of an adequate regional power supply on a sound financial basis.
3. The Institutional Resources Objective: to enhance the capabilities of the region's public and private institutional resources to provide the services and opportunities necessary for a better quality of life.
4. The Human Resource Development Objective: to assist in the development and utilization of human resources in the region, including especially agency employees.
5. The Agricultural Development Objective: to meet the national need for low-cost, effectively used fertilizers and to further the well-being of agricultural and related enterprises in the Valley.
6. The National Defense and International Assistance Objective: to provide requested support for defense and international assistance programs of the Nation.
7. The Agency Image Objective: to establish and maintain general public interest and confidence in the agency through an overall high-quality level of performance



TENNESSEE VALLEY REGION
GREEN
PARADISE (U)
RIVER
OHIO
RIVER
SHAWNEE
PADUCAH
BARKLEY (U)(E)
BOWLING GREEN
K Y
WOLF CREEK
(E)
KENTUCKY
CUMBERLAND
CHEATHAM (E)
GALLATIN
RIVER
OLD HICKORY (E)
NASHVILLE
DALE HOLLOW
(E)
CENTER HILL
(E)
MISSISSIPPI RIVER
TENNESSEE RIVER
JOHNSONVILLE
TENN
GREAT FALLS
WATTS BAR
KINGSTON
NORRIS
MELTON HILL
(U)
BULL RUN (U)
KNOXVILLE
FT. LOUDOUN
CHILHOWEE (A)
FONTANA
(A) CALDERWOOD
(A) CHEOAH
(A) SANTEETLAH
APALACHIA
HIWASSEE
NANTAHALA (A)
THORPE (A)
NOTTELY
BLUE RIDGE
CHATTANOOGA
CHICKAMAUGA
HALES BAR
OCOEE
MEMPHIS
PICKWICK
WILSON
WHEELER
WIDOWS CREEK
COLBERT
TVA FERTILIZER-MUNITIONS DEVELOPMENT CENTER
GUNTERSVILLE
MISS
ALA
G A
S C
N C
V A
BRISTOL
FORT PATRICK HENRY
BOONE
SOUTH HOLSTON
JOHN SEVIER
WATAUGA
CHEROKEE
DOUGLAS
LEGEND
STEAM PLANTS
DAMS
CORPS OF ENGINEERS DAM (E)
ALUMINUM CO. OF AMERICA DAM (A)
POWER SERVICE AREA
UNDER CONSTRUCTION (U)
KENTUCKY
PICKWICK
WILSON
WHEELER
GUNTERSVILLE
HALES BAR
CHICKAMAUGA
WATTS BAR
FORT LOUDOUN
height of gates above sea
815
745
635
556 3
418
375
300
0
PADUCAH
22 miles above mouth
207
259
275
349
431
471
530
602
650
KNOXVILLE
PROFILE OF THE TENNESSEE RIVER

FIGURE 2

FIGURE 3

Mission Statement - Division of Forestry, Fisheries, and Wildlife Development

Working with the people of the region and recognizing changing priorities and needs, the Division of Forestry, Fisheries, and Wildlife Development strives to improve the quality of life in the Tennessee Valley through research, development, protection, and management of terrestrial and aquatic systems and optimal use of the natural resources and other benefits these systems provide.

Specific Objectives for the Tennessee Valley

1. Secure protection and management of terrestrial and aquatic systems to assure a high order of resource productive potential, waste assimilative capacity, diversity of life, and biological resiliency.
2. Identify and protect rare and endangered biota and unique scenic areas.
3. Improve urban, suburban, and industrial environments by protecting and establishing appropriate elements of terrestrial and aquatic systems.
4. Increase public understanding of ecological concepts and active involvement in the protection, management, and use of aquatic and terrestrial resources.
5. Improve the appearance of forests, wild lands, and waters.
6. Improve and employ the concepts, rationale, and technologies needed to manage the land and water base for optimal outputs and use of resources and services, such as sport and food fishes, waterfowl and other aquatic birds and mammals, upland wildlife, timber, high-quality water, and recreation.
7. Capture the economic and social benefits from natural resources for the well-being of all the region's people with special attention to the needs of the disadvantaged.

include 40,400 acres subject to flooding at any time of the year for power head fluctuation and 278,600 acres below top gate levels which can be inundated wholly or in part at least once a year. Reservoir wetlands components receive high priority in fisheries management efforts since these are principal fisheries breeding zones and provide temporary to permanent food foraging areas. Our continuing activities include fishery resource surveys, ecological studies of young reservoir fishes, sport and commercial fisheries harvest surveys, tailwater trout food production studies, life history studies, and limnological assessment.

Additionally, to the extent possible based upon manpower and budgets, TVA fisheries activities are carried out on other Valley lakes and streams. An appreciation of the magnitude of the riverine segment is gained from review of Table 1, which summarizes total mileage of Tennessee Valley streams (nearly 42,000 river miles).

TABLE 1

Tessessee Valley Streams

Category	Miles	Percent Total Miles
Free-flowing	38,000	90
Open streams, regulated flow[1]	720	2
Streams in impoundments	3,150	8
	41,870	100

[1]Extend from one dam downstream to the normal full-pool backwater limit of next lake.

Waterfowl and Wetlands Wildlife

In 1938, TVA began setting aside portions of its reservoirs for wildlife management purposes. Today, of 192,000 acres designated in this manner, 161,000 acres are being managed by the Fish and Wildlife Service and State wildlife agencies predominately for migratory water-fowl (Table 2). Wetlands are an integral part of the management base at

TABLE 2

TVA Land and Water Used for Federal and State Wildlife Programs

June 30, 1974

		Acres		
Agency	Reservoir	Land	Water[a]	Total
U.S. Fish and Wildlife Service				
Tennessee National Refuge	Kentucky	10,105	40,725	50,830
Wheeler National Refuge	Wheeler	8,383	26,917	35,300
State of Alabama	Guntersville	5,038	19,962	25,000
	Pickwick	7,103	2,318	9,421
	Wheeler	2,519	6,965	9,484
State of Mississippi	Pickwick	1,375	222	1,597
State of Tennessee	Chickamauga	3,873	5,472	9,345
	Douglas	184	1,046	1,230
	Norris	26,750	799	27,549[b]
	Watts Bar	674	3,927	4,601
	Kentucky	230	10,946	11,176
	John Sevier SP	90	218	308
	Kingston SP	835	1,010	1,845
State of Kentucky	Kentucky	--	3,274	3,274
	Shawnee SP	1,100	--	1,100
Total		68,259	123,801	192,060[c]

[a]Includes both land and water below maximum shoreline contour, and the entire area is subject to permanent or periodic flooding.

[b]Includes two multipurpose recreation=conservation areas--Central Peninsula and Cove Creek Peninsula.

[c]Excludes some 150,000 acres in Land Between The Lakes wildlife management program.

these refuges and hunting areas. Current Valley waterfowl concentrations and public uses derived upon these areas are summarized in Table 3.

TVA's Land Between The Lakes (LBL), a 170,000-acre outdoor recreation-conservation education center located between Kentucky Lake and Lake Barkley (a Corps of Army Engineers reservoir), devotes considerable effort towards wetlands wildlife management, featuring migratory wintering waterfowl, Wood Ducks, resident Giant Canada Geese, Southern Bald Eagle, raccoon, muskrat, beaver, and others.

Concurrently with the initiation of LBL, the agency became more directly engaged in wildlife resource development Valley-wide. Today, its waterfowl-wetlands wildlife programs strive to reach any appropriate resource development area, working with landowners, other Federal agencies, state wildlife agencies, citizen conservation groups, and local governments.

Current activities include: resident Giant Canada Goose propagation and release, Wood Duck nest box projects, Wood Duck streamside breeding habitat surveys, brood telemetry studies, migratory waterfowl habitat surveillance and development, moist-site vegetation management, heron-egret colony protection, shore and marsh bird management, beaver management and control, furbearer marketing analysis and promotion, and wetlands mammal habitat development.

Wetlands surveys have focused on three areas: WoodDuck breeding habitat; a USGS-TVA effort to classify and map freshwater wetlands using remote sensing technology; and a test of inhouse capabilities to classify, measure, and evaluate wetland habitats using existing computer mapping technology, ERTS vegetation-hydrology data, soils maps, and any existing field information.

TABLE 3

Valley Waterfowl Resource

Fiscal Year 1974

Area	Midwinter Inventory			Food Production* -Acres-	Waterfowl Hunting Trips*	Waterfowl Harvested*	Other Trips**
	Ducks	Geese	Total				
Kentucky Reservoir	157,330	36,470	193,800	5,690	7,280	14,000	354,170
Land Between The Lakes	1,470	3,100	4,570	700	800	1,200	1,999,200
Bardley Reservoir+	53,800	6,300	60,100	2,890	2,660	3,040	13,755
Pickwick Reservoir	1,300	150	1,450	1,010	150	150	31,000
Wheeler Reservoir	46,800	27,850	74,650	7,310	8,155	4,960	428,400
Guntersville Reservoir	11,750	1,500	13,250	3,750	3,900	1,900	8,440
Chickamauga Reservoir	1,000	1,500	2,500	2,720	1,415	735	47,485
Watts Bar Reservoir	100	200	300	815	No data	No data	No data
Cherokee-Douglas Res.	2,300	0	2,300	50	1,400	No data	50,350
John Sevier-Upper Holston	300	0	300	Native aquatic plants	No data	No data	No data
Nolichucky Project-Davy Crockett Lake	600	0	600	40	0	0	No data
Total	276,750	77,070	353,820	24,975	25,760	25,985	2,932,800

* Tennessee Wildlife Resources Agency data, 1973.
** Upland game hunting, birding, picnicking, fishing, camping, etc., on waterfowl areas.
+ This Cumberland River reservoir included because of its relationship to LBL.

July 1974

Wood Duck Breeding Habitat Surveys are being conducted county by county using pilot-observers and observers in low-flying, fixed-wing aircraft. All streams encountered are mapped into three categories (good, fair, poor-none) based on easily recognized forest-human impact characters (Burbank, 1972). Valley-wide coverage will have been completed this year, and resurveys shall commence the following year in order to obtain five-year interval updating.

The USGS-TVA Wetlands Survey research effort is designed to classify and map freshwater wetlands using seasonal high altitude (50,000 feet) color IR photography, ERTS digital data, and low-altitude multispectral scanner data (Carter and Stevens, 1974). Two high-altitude NASA overflights have been completed and initial wetlands mapping begun using a tentative classification system patterned after Anderson, Hardy, and Roach (1972) but expanded to give more ecological detail (Carter and Burbank, 1975, in preparation).

Inhouse Wetlands Survey work is underway but not enough has been accomplished to evaluate outputs. Basically, we are combining current ERTS digitized ground cover-hydrologic data with digitized local wetlands soils characteristics to identify and locate general wetlands types (i.e., hardwoods-wetlands, conifer-wetlands, mixed-wetlands, old field-wetlands, and other [unimproved]-wetlands). If it proves adequate, it can furnish a quick and inexpensive method to document wetlands changes at very frequent intervals on a regional (county or larger) scale.

Land Analysis Systems

The Division conducts a number of land analysis surveys, of which wetlands and their resources are monitored as part of the total analysis effort. They include: a monitoring system to identify potential land-use conflicts; an analysis system for land, forest, and wildlife capability studies, a system for multiple land-use decision-making; and a model for land management planning and impact studies (Baxter, Cox, and Gregory, 1975). The following information has been summarized from the above citation.

The Forest and Wildland Monitoring System is used to monitor the status of natural resources in the Tennessee Valley region. Its components include: Key Facilities--existing or planned cultural features that may affect forest-wildland resources; Upland Ecosystems--designated, specific management lands, areas of ecological significance, rare, threatened, and endangered species or habitats, and locations of bare or erosive land; Wetlands Ecosystems--designated, specific management areas, areas of ecological significance, rare, threatened, and endangered species or habitats, and important fish-shellfish spawning areas; Other--education, aesthetic, or recreation components which may affect forest and wildlands resources.

The Forest Resource Analysis System deals with the collection and analysis of information about the forest resources of the Tennessee Valley (this includes wetlands forest types). Resurveys are made on a seven- to ten-year cycle. The objective of this system is to analyze the characteristics of the forest resource (over half the Valley is forested) so that its value and benefits can be maximized.

The Bioterrain Analysis system was developed to enable the analysis and display of spatial data to aid decision-making. Its objective is to provide the capability of rapid site-specific analysis of spatial land related data by using relatively simple and flexible computer systems at moderate cost.

The Land Management Decision System is a decision-making process designed for land holdings where site-specific tradeoffs and activities must be evaluated, particularly where multiple-use objectives must be met. In practice, the Decision System and the Bioterrain Analysis System are used together. The Land System enables managers to develop a comprehensive set of management activities for one area, while considering adjacent land characteristics and public inputs to the planning process. It is most appropriately used on large parcels of land (5,000 hectares or more). However, since private lands of Valley landowners more typically consist of small acreages, the WRAP System (Wildland Resource Allocation Procedure) was developed to furnish a similar multiresource management planning tool for these tracts (TVA, 1974).

The Regional Natural System Model simulates the impacts of predicted or proposed land-use change on the natural resources of the region. The objective is to develop and demonstrate the application of interdisciplinary systems analysis techniques to regional land-use modeling with particular emphasis on environmental impact assessment. TVA is participating in this effort with the Regional Environmental Systems Analysis group at the Oak Ridge National Laboratory (Tennessee) under sponsorship of the National Science Foundation RANN Program.

Needs--Current and Future

Inadequacies of the past can perhaps best describe current and future wetlands inventory and classification needs. Past efforts have been inadequate in terms of coverage, discreteness, classification continuity, and periodicity. The last point exemplifies one of the most apparent needs; namely, a system whereby, locally or nationally, wetlands can be resurveyed more quickly than at 20-year intervals or more.

For TVA, our only regional data source for wetlands presently comes from the information noted grossly on topographic quadrangle sheets (some as old as 1939). Although most significant bodies of wetlands in the Valley have been located and mapped, we have no system in force to deal with the dynamics of change, regionally.

Betson (1973), Head, Hydrological Research and Analysis Staff, Division of Water Management, has summarized succinctly TVA's view regarding this matter by stating:

> The type of natural dynamic wetland system that would not appear on conventional maps includes ephermerally wet sinkholes, shallow flat backwater areas resulting from seasonally high reservoir or lake stages, and lowlands subject to extended inundation during wet weather periods. . . . The type of dynamic wetland situation resulting from man's activities that could profitably be mapped would include construction of farm ponds, drainage, or filling of wetland areas, and the creation of wetlands resulting from construction activities.
>
> Conventional mapping simply lags too far behind to pick up some of these situations.

Obviously, a system of wetlands monitoring must be more dynamic and flexible than past efforts. As far as TVA's needs are concerned--regardless of the specific discipline involved--we must be able to identify quickly, accurately, and discretely (at times to the nearest hectare) the wetlands of the Tennessee Valley, in a classification format which accepts new technologies and is consistent in definition of ecological types.

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Discussion

Mr. Burgess: (Robert Burgess, Oak Ridge National Laboratory): Where does TVA do its mapping?

Mr. Burbank: We have within TVA a Division of Water Resources Management, and that Division in turn has a Maps and Surveys Branch. The offices are located in Chattanooga, Tennessee. They have a cartographic unit that can do many, many things. I am not a cartographer, but I do know that they do good work for us when we need it.

U.S. Environmental Protection Agency

by

Harold Kibby

The Environmental Protection Agency (EPA) has experienced nearly five years of rapid activity to implement various pollution control acts. During this period the Agency has viewed itself as primarily a pollution control agency. This has been necessary; however, it is now time to look ahead at the larger objective of maintaining instead of attaining adequate environmental quality. I do not mean to imply that we have already attained adequate environmental quality, but simply we need to begin now to do research and develop a monitoring system so that we will be able to maintain adequate environmental quality once it has been attained. By knowing the extent and kind of wetlands that are present in the United States, we have a good data base against which we can judge future environmental decisions. Further, part of this monitoring system must be the establishment of an adequate set of controls, possibly a series of wetland and ecosystem preserves. The basic wetland inventory can and should serve as a basis for the development of such control areas.

There are two very basic pieces of legislature, of major concern to EPA, for which information from the wetlands inventory and classification is needed. First, the Federal Water Pollution Control Act Amendments of 1972. Before getting into the requirements of the Act, let me say, at present there is some controversy as to how to define navigable waters of the United States. EPA favors a broad classification that includes many wetland areas. Other agencies in the Federal Government favor a much more restricted definition. The utility of the wetlands inventory to EPA depends to some extent as to how the courts and, more importantly, Congress in new legislation define navigable waters. For the purposes of our discussion today, I will assume that wetlands will be covered in the definition of navigable waters.

Basically, the Pollution Abatement Program that has been developed as a result of the Federal Water Pollution Control Act relies on two complementary approaches. One is to set water quality criteria and standards for specific bodies of water and to develop strategies for achieving desired levels of water quality through detailed planning procedures. The other approach is to set specific performance standards for all facilities which discharge pollutants into the Nation's water ways.

Under the first approach of establishing objective water quality and planning procedures, the Administrator of EPA publishes water quality criteria documents which summarize our scientific knowledge about the effects of pollutants upon human health and welfare; in particular the effects of pollutants upon "plankton, fish, shellfish, wildlife, plant-life, shorelines, beaches, esthetics and recreation." Also included is a discussion of the concentrating and dispersal mechanisms for pollutants and their by-products which occur through either physical, chemical or biological means, and "the effects of pollutants on biological community diversity, productivity, and stability, including information on the factors affecting rates of eutrophication and rates of organic and inorganic sedimentation for various types of receiving waters."

Other documents which must be prepared summarize our scientific knowledge on ways of restoring and maintaining the chemical, physical and biological integrity of all navigable waters, including coastal zone waters and the ocean. Further, the Agency must determine "the factors necessary for the protection and propogation of shellfish, fish, and wildlife and allow recreation activities both in and on the water for all classes and categories of receiving waters." These reports identify key pollutants and contain techniques for measuring and classifying water quality.

Up until now, I have discussed the Federal Water Pollution Control Act in general terms. However, there are also very specific sections of the Act that are relevant to the wetland inventories program.

Section 104 has some very specific language that is very applicable to our discussions today. Among other things, it says the Administrator of EPA shall:

(1) conduct research to study the "causes, effects, extent, prevention, reduction and elimination of pollution";

(2) probably the most relevant words in this section state, "in cooperation with the States and their political subdivisions, and other Federal agencies establish, equip and maintain a water quality surveillance system for the purpose of monitoring the quality of navigable waters and ground waters and the contiguous zone and the oceans. . . ."

In order to carry out the above mandates, the Administrator is authorized to collect "basic data on chemical, physical, and biological effects of varying water quality. . . ."

Further, this section provides that the Administrator shall ". . . continue comprehensive studies of the effects of pollution, including sedimentation in the estuaries and estuarine zones of the U.S. on fish and wildlife, on sport and commercial fishing, on recreation, on water supply, and on other beneficial purposes."

To summarize Section 104, it deals with research on ecological effects of pollutants and authorizes EPA to conduct such research. Certainly an inventory program could prove to be most useful.

Section 316 deals with and discusses thermal discharges. A wetlands inventory program could provide useful baseline information on assessing the effects of thermal discharges and, more importantly, allow us to see long-term biotic changes.

One potential environmental problem that is associated with wetlands is the disposal of solid wastes for the purpose of creating new land areas. This practice should, in the future, be regulated by Section 402. This section states that:

> "(c)(1) The Administrator shall promulgate guidelines for determining the degradation of the waters of the territorial seas, the contiguous zone, and the oceans, which shall include:
>
> > "(A) the effect of disposal of pollutants on human health or welfare, including but not limited to plankton, fish, shellfish, wildlife, shorelines, and beaches;
> >
> > "(B) the effect of disposal of pollutants on marine life including the transfer, concentration, and dispersal of pollutants or their byproducts through biological, physical, and chemical processes; changes in marine ecosystem diversity, productivity, and stability; and species and community population changes;"

Section 404 is one area of the Act that has received a lot of attention lately. Of all of the requirements placed on EPA this is one where the inventory program can probably be most useful. In fact, I see the wetlands inventory playing a major and integral role in the future development of policies designed to carry out Section 404.

Section 404 directs the Secretary of the Army to issue discharge permits for dredge and fill activities. However, the Administrator of EPA is authorized to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site whenever he determines that the discharge of such materials into a specified site will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas.

Let me, at this point, further expand my thoughts a little on Section 404. EPA and the Corps of Engineers have been trying to agree on a set of guidelines that can be applied to the issuing of a disposal permit. A series of testing protocols is being developed to analyze potential chemical effects of disposing of dredge and fill material. While there is some controversy over what individual test procedures should be included and how to interpret the results of these tests in a meaningful way, there is little or no controversy over the fact that probably far more damage is occurring to fish and wildlife resources from direct destruction of habitat than from chemical toxicants. This is one area where the national inventory of wetlands is particularly valuable.

The second piece of legislature that is of great importance to EPA, and that relates to the national wetland inventory program, is the National Environmental Policy Act of 1969 (NEPA). In this Act, Congress sets forth some basic guiding principles for all agencies, namely, it states that it is the policy of the Federal Government to "foster and promote the general welfare, create conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations." Section 102 of NEPA requires that an environmental impact statement be prepared setting forth the environmental effects of "major Federal actions significantly affecting the quality of man's environment." EPA, like all Federal Agencies, must prepare environmental impact statements (EIS). Further, EPA has the added special responsibility of reviewing the adequacy of other agencies' EIS's and commenting on environmental effects as set forth in the EIS. I do not want today to debate the acceptability of environmental effects or change because that is a social question that must be answered by society as a whole. The wisdom of the answers will depend upon society's values and its knowledge of biological, social and cultural consequences of the action. One major problem in making the necessary environmental trade-offs is that of acquiring adequate knowledge. In this case we are confronted with the problem of acquiring knowledge about potential environmental effects to one of man's valuable resources--in this case, wetlands. We cannot begin to fully analyze the effect of Federal actions on wetlands and adequately understand the trade-offs that are to be made without full knowledge of our wetlands resources. The national wetland inventory can contribute significant information that will aid in these decisions.

Before discussing the type of information that will be useful to EPA in a wetland classification system, let me first mention some of the causes of wetland deterioration as I see them. One of the most critical causes of wetland deterioration is direct destruction of wetland habitat. A dam eliminates much of the original habitat upstream for the length of the reservoir and downstream to the limit of severe waterflow modification. Levees lead to absolute obliteration of the wetland habitat of the "protected" floodplain. Canalization destroys the wetland habitat values of coastal marshlands and leads to severe erosion problems. Heavy siltation eliminates riffle and pool habitats. Mining spoils have totally destroyed aquatic and riparian systems. The list is long and can be well documented. Unquestionably, a vast number of acres of the native wetland systems of the Nation have been eliminated or so severely modified that they bear little resemblance to the original ecosystem types. Further, in many cases, little projects are just as big a problem as are large projects. These little projects, such as a local highway, a bridge, a drainage ditch, a pier, and so on, are pecking away at the Nation's wetlands and causing a large cumulative problem.

The second cause of wetland deterioration is alteration of the wetlands physical characteristics. Modification of flow rates and seasonal flow patterns, and particularly the elimination of peak flows, has greatly altered species compositions and standing crops in wetlands. Leaching spoil piles, saltwater encroachment, loss of nutrients and loss of beach nourishment have created chronic distress problems for many wetland systems.

The third cause of deterioration of wetlands may be termed chemical pollution. Floodplain construction leads to rapid runoff of surface water from a variety of areas, such as urban areas, industrial complexes, and transportation pavements. This runoff is combined with chemical contaminants associated with other human activities. Mining wastes produce chemical pollutants involving acids, metal sulfides and oxides, and radioactive materials. Dredging may release a variety of chemical pollutants from the sediments. Dams may create nitrogen gas supersaturation. While chemical pollution is important, I do not believe it to be the most important cause of wetland deterioration.

Now with this background on the relationship between EPA's programs and the wetland inventory and the summary of wetland deterioration, let me address what information could be gathered to make the new national wetland inventory most useful to EPA:

(1) Vegetation. A detailed description of the vegetation can tell us a lot about habitat types and the amount of any specific habitat that is available regionally. Such information is crucial before informed decisions can be made as to acceptable levels of environmental change. Even of more immediate concern, habitat types can provide very useful information about those species of fish, shellfish and wildlife that are expected. By knowing this information the EPA Administrator can make more informed decisions, under Section 404 of FWPCA, on the acceptability of a given dredge disposal site.

(2) Successional Stage. In order to have some predictive capability about potential future conditions, it would be most useful to know the successional stage of each wetland. For example, is the wetland evolving from a marsh to open water, as is the case in areas with subsidence, or is the wetland part of an active delta? Such knowledge is crucial for meaningful planning and environmental analysis.

(3) Water Quality. While salinity and acidity are two water quality parameters that appear to be very useful in classifying wetlands, it would be most advantageous to EPA if other water quality data could be collected at the same time. The relative "health" of a particular wetland might eventually be categorized or correlated to given water

quality conditions. It is hard to say what specific water quality measurements are needed on a national scale. Certainly, in industrial areas any known industrial effluents should be measured. In agricultural areas it would be desirable to know concentrations of various pesticides, etc. In pristine areas other parameters which would describe water chemistry would be useful. I believe that very little is known about how various chemical constituents affect wetlands. While not part of a classification scheme, detailed water quality estimates that are collected during the inventory can accomplish a great deal.

In summary, I believe that the wetlands inventory can be very useful to EPA in judging the acceptability of physical habitat destruction and that collection of extensive water quality data could prove to be most useful in helping EPA to analyze potential wetland effects of pollutant discharge.

U.S. Bureau of Land Management

by

Richard R. Olendorff
John E. Crawford
William A. Kennedy
J. David Almand

Wildlife Habitat on the National Resource Lands

The Bureau of Land Management (BLM) is charged with protecting, maintaining, and enhancing aquatic and terrestrial wildlife habitats on about 450 million acres collectively called the national resource lands (NRL). By acreage the BLM has the largest land management responsibility in the nation.

Virtually all of the NRL support wildlife with varying potentials for habitat protection, maintenance, and enhancement. In the ten contiguous Western States and Alaska where the BLM has large land holdings, the NRL include over 374 million acres identified as big game habitat, 391 million acres of small game habitat, and 30.5 million acres of waterfowl nesting and wintering grounds (Table 1). About 600 thousand acres of the waterfowl habitat are found on NRL outside of Alaska. Best estimates also show nearly 5 million surface acres of lakes, 331 thousand acres of reservoirs, and 258 thousand miles of streams on the NRL (Table 2). Thus, NRL wildlife and wetland habitats are of great extent and national importance.

For example, the economic value of the "harvested" wildlife resource on the NRL in 1973, including fishing, waterfowl hunting, and other wetland related activities, has been estimated at $350.7 million (Table 3). This is a conservative estimate, due to inflation, because it is derived from 1973 NRL recreation visitor-day and game harvest statistics

TABLE 1

Estimated Acres of Important Game and Waterfowl

Habitat on the NRL, 1974*

State	Big Game	Small Game	Waterfowl
Alaska	262,000,000	262,000,000	30,000,000
Arizona	7,898,000	11,442,000	2,500
California	5,187,000	10,442,000	1,314
Colorado	8,000,000	6,653,000	25,000
Idaho	9,333,600	11,440,600	140,600
Montana	7,000,000	5,077,000	162,500
Nevada	21,618,000	23,270,000	38,500
New Mexico	9,819,000	15,240,000	18,000
Oregon	10,770,000	12,579,000	83,800
Utah	17,575,000	18,926,000	37,000
Wyoming	15,013,000	14,021,000	90,000
Total	374,213,600	391,182,600	30,599,214

* Data from Bureau of Land Management (In Prep.)

TABLE 2

Estimated Miles or Acres of Existing Fishing Streams,

Lakes, and Reservoirs on the NRL, 1974*

State	Acres of Lakes	Acres of Reservoirs	Miles of Stream
Alaska	4,700,000	---	240,000
Arizona	1,616	26,975	378
California	56,137	22,428	520
Colorado	8,199	13,822	1,498
Idaho	134,598	92,134	3,275
Montana	578	44,189	688
Nevada	23,976	18,305	1,066
New Mexico	630	298	42
Oregon	5,719	81,209	7,226
Utah	683	15,121	2,046
Wyoming	11,145	16,303	1,535
Total	4,943,281	330,784	258,274

* Data from Bureau of Land Management (In Prep.)

TABLE 3

Economic Value of the "Harvested" Wildlife Resource on the NRL in 1973

Commodity	Value (Millions)
5,806,000 Hunter Days @ $10.52 ea.	$ 61.1
Meat Value of Game--30.3 Million lb. @ $1.00/lb.	30.3
6,593,000 Fisherman Days @ $6.30 ea.	41.5
Meat Value of Sport Fish--9.9 Million lb. @ $1.00/lb. (Assuming Average Daily Catch of 1.5 lb.)	9.9
Nonconsumptive Use--28,233,000 Camping, Picnicking, and Sightseeing Use Days @ $3.84/day. (See Text)	108.4
Meat Value of Commercial Fish @ $1.00/lb.	99.5
Total	$350.7

(Bureau of Land Management 1974) and 1970 figures for hunter and fisherman day values (Fish and Wildlife Service 1972).

The value of nonconsumptive use is based on the assumption that most camping, picnicking, and sightseeing on the NRL is (a) directly related to wildlife appreciation, or else (b) the quality of such outdoor experiences are significantly enhanced by the presence of wildlife. The value of $3.84 placed on a day of nonconsumptive use is based on the percentage (52.1%) of the 1970 average hunter and freshwater fisherman day value ($7.38) spent on food, lodging, transportation, and auxiliary equipment (Fish and Wildlife Service 1972). This excludes hunting equipment, guides, dogs, licenses, and privilege fees that a nonconsumptive user of wildlife on the NRL would not need to purchase.

Identification of Wetlands on the National Resource Lands

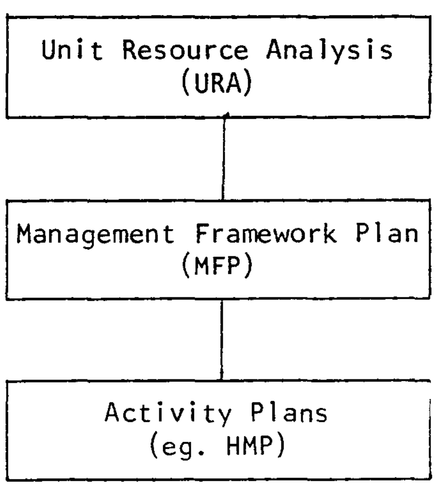
Significant objectives for wildlife are accomplished by the BLM through a thorough planning system (Figure 1) and subsequent implementation by 139 professional fisheries and wildlife habitat managers. The planning system is designed to provide an objective and standardized process for making land-use decisions in advance of on-the-ground actions. The functioning of this internal management tool requires that the Bureau's total program be divided into program activities, one of which is wildlife.

Wetland habitats are routinely identified during the planning process, particularly in the preparation of a document called the Unit Resource Analysis (URA). The Bureau has divided its land into about 650 geographic units on which land-use plans are made.

FIGURE 1

BLM Planning System, Basic Processes Involving

Wetland Management



A URA is prepared for each of these planning units to provide a comprehensive analysis of inventory data, resource problems, conditions, uses, production, quality, capabilities, and management potentials. Each URA includes all available water resource information on Bureau-administered lands and on adjacent lands that might affect management of the NRL. Water resources identified in URA's include lakes, live streams, springs, wells, swamps, marshes, ground water, aquifers, reservoirs, water control structures, irrigation canals, permanent stream gaging stations, snow courses, glaciers, and ice fields. Tables, overlays, and narrative descriptions are prepared to illustrate or discuss all water resources, including such characteristics as drainage patterns, water yield, major recharge areas, unused water resources, storage capacity, and present consumptive and nonconsumptive uses. These data can then be correlated with tables, overlays, and narratives explaining other resources, such as wildlife, livestock forage, timber, and recreational potential.

Information compiled in a URA is later combined with a Social-Economic Profile and a Regional Analysis of the planning unit to develop a Management Framework Plan (MFP). This long-range document provides a framework of localized multiple-use coordination among the various resource program activities. It establishes objectives and constraints for each resource and support activity.

From these objectives and constraints evolve individual Activity Plans. In the case of wildlife habitat, Terrestrial and Aquatic Habitat Management Plans (HMPs) are written to provide a firm basis for on-the-ground enhancement. The BLM currently has 152 HMPs in various stages of preparation and implementation in the contiguous Western States.

Forty-four are aquatic HMPs involving wetlands of many kinds. Projects include fencing riparian habitat and upland meadows, development of waterfowl habitat, improvement of pool/riffle ratios in streams, and many other types of habitat management. Several examples follow.

The Blanca Wildlife Habitat Area

This 5,390-acre (8.4 square-mile) area, nine miles northeast of Alamosa, Colorado, is being enhanced primarily as waterfowl habitat, although the plan is to close at least 40 percent of the area to hunting at all times. This will allow continuous use by nesting and migrating waterfowl, shorebirds, and raptors. Greater Sandhill Cranes, which are considered endangered as a nesting species in Colorado, may also use the area during spring and fall migrations.

The major management technique is the development of artesian wells and other sources of water to create ponds in which nesting islands are being enhanced and (where needed) artificial nesting structures will be built. In addition, grain crops will be planted as supplemental feed; a livestock grazing system which protects the planned wildlife habitat will be developed; and application will be made to withdraw and classify the area to guard against appropriation under the general mining laws and agricultural land laws.

San Simon Cienega Wildlife Habitat Area

This 27,721-acre (43.3 square-mile) area along the Arizona-New Mexico border between Tucson and Las Cruces is one of the few remaining areas in the United States capable of supporting the Mexican Duck (Anas diazi). Continued loss of waterfowl habitat due to drainage of marshes, channelization of the Rio Grande, and other agricultural practices has resulted in the Mexican Duck's present status as an endangered species.

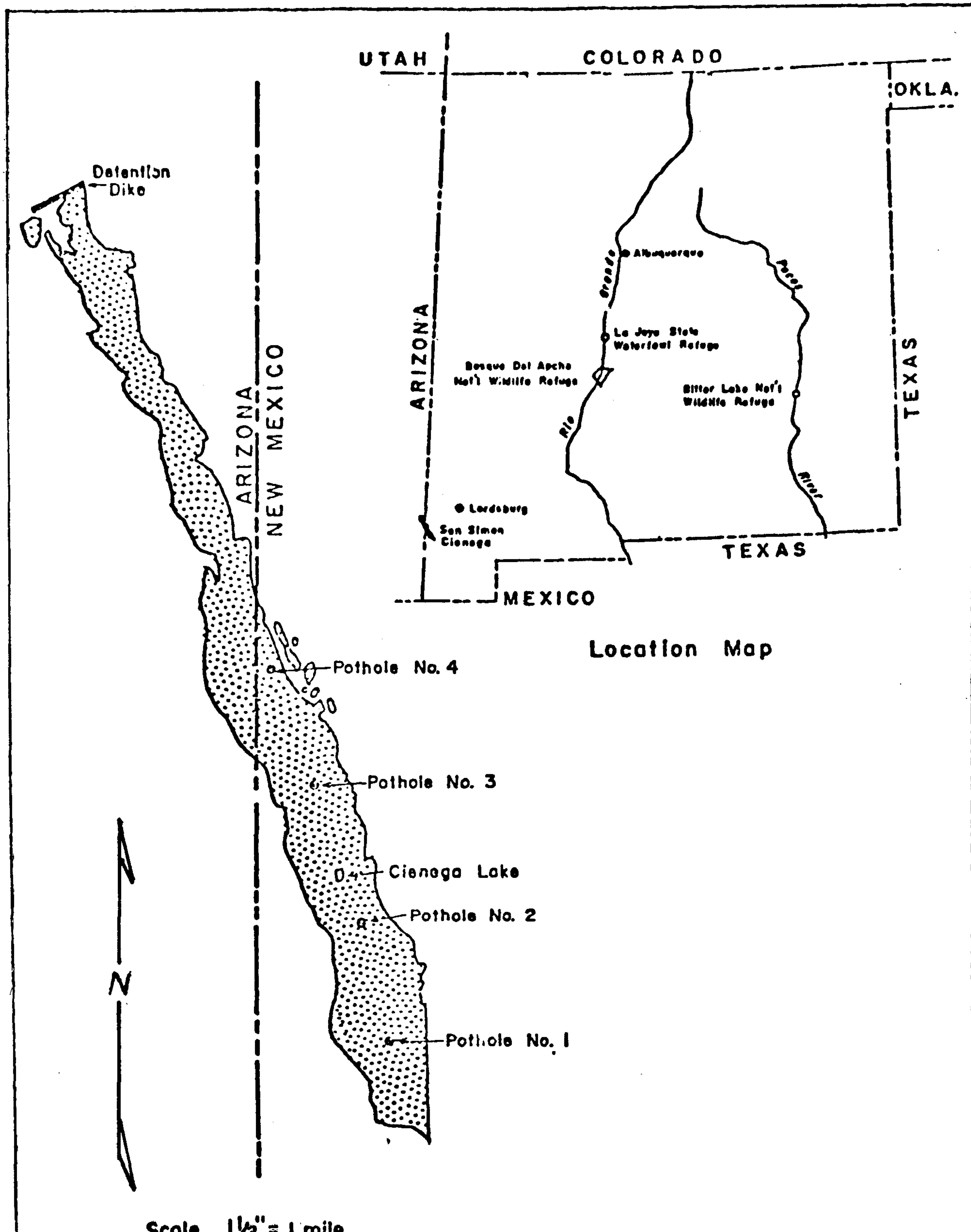


Fig. 2. San Simon Cienega and location in relation to State of New Mexico.

Of particular importance was the cessation of flow in San Simon Creek in 1952, a probable result of three years of pumping of subsurface water for irrigation.

About 200 acres of this area--a series of key ponds and associated marshes--has been withdrawn for protection of Mexican Duck habitat. Management efforts include well and pipeline developments; pond remodeling; small dam construction; cover and food seedings; and fencing to exclude livestock grazing.

Mexican Duck production at San Simon Cienega increased from zero in 1967 to about 20 in 1969 following release of initial brood stock. The population has since declined in the absence of additional transplants to what still may be a viable number. The limiting factor appears to be the number of water developments. Thus, a technical review of this project will be undertaken this month (July 1975) to help plan future management strategies.

In addition to aiding the Mexican Duck, the San Simon Cienega is important to wintering waterfowl and many nongame species. The chance of seeing such peripheral species as the Masked Duck or the Zone-tailed Hawk has made the area nationally significant for bird watching. Several universities use the Cienega for field trips as well as a study area.

Elephant Butte Marsh

An HMP is presently being implemented for this New Mexican waterfowl-shorebird area through close cooperation with the New Mexico Department of Game and Fish, and the Bureau of Reclamation. The objectives of the Elephant Butte Marsh HMP are to provide nesting habitat for 60 breeding pairs of Mexican Ducks, to maintain rookeries of the Double-crested Cormorant (a rare breeding bird in New Mexico), and to provide potholes, nesting boxes, food, etc., for both nesting and migratory water birds.

Already there is a full closure of the area (including a buffer zone) to public use. A fence is being constructed to exclude livestock grazing on the most critical acreages. Recently, the Bureau of Reclamation agreed to maintain the water level in Elephant Butte Reservoir at critical times of the year. The BLM is currently attempting to obtain unused water rights from the City of Albuquerque.

Montana Duck Factories

Nearly 8,000 stock ponds have been developed by the BLM in eastern Montana and portions of the Dakotas. Within a few years of construction, most of these ponds attract breeding pairs of Mallards, Pintails, Teal, Gadwalls, and American Widgeons: the blue ribbon ducks of the Central Flyway. Canada Geese now nest on stock ponds as small as two surface acres in this area if suitable nest sites are available.

This is one example where the BLM has provided wetland benefits beyond the initial purpose of livestock water. Guidelines have been developed through a joint effort by personnel from Montana State University, the Montana Fish and Game Department, and BLM range conservationists, wildlife biologists, engineers, and contract supervisors. Emphasis is being placed on guidelines involving island construction and shoreline protection and manipulation. Future pond construction on the NRL--now averaging nearly 240 ponds per year in the eastern two-thirds of Montana--will provide the maximum amount of waterfowl habitat on small water areas while simultaneously providing a program compatible with other uses.

The Opportunities Ahead

Though the BLM's accomplishments to preserve wetlands are noteworthy, many opportunities remain unexplored. Historically, riparian habitats and other wetlands have not been classified and inventoried in this Bureau, or any other to the extent necessary. This is due to a great number of reasons (e.g., public apathy in setting priorities on land use; lack of thorough multiple-use policies regarding wetlands, etc.). As with wildlife, however, wetlands on the NRL are getting a progressively fairer shake.

The BLM is no longer the steward of 451 million acres of land nobody wants. Everyone wants it now: on behalf of the American public; on behalf of special interest groups; or on behalf of individuals. The attitudes, ideals, and values that surround American's interest in land are changing. And the BLM is changing accordingly. The Bureau, as does the public, knows that the NRL are not just left over real estate. The climate is right in the BLM to implement a good wetland classification and inventory system. We welcome this opportunity to participate in its development and are particularly anxious to implement a good system that is practical for the field biologist to use.

National Marine Fisheries Service

by

Dale R. Evans*

We in the National Marine Fisheries Service (NMFS) appreciate very much the opportunity to be present and participate in this workshop. In our view, the launching of a new wetlands inventory to update and expand the Fish and Wildlife Service (FWS) Circular 39, published in 1956 as "Wetlands of the United States," is a most important and welcome event. It involves many complex technical problems which this conference must address.

I would like to outline very briefly certain considerations that appear quite important to us if the full benefit and usefulness of the proposed wetlands inventory are to be realized.

Relationship to Circular 39

Many things have changed since publication of Circular 39, in terms of improved technology, better scientific understanding of wetland ecosystems, and heightened public appreciation of the importance and the vulnerability of wetlands to damage. Circular 39 made a major contribution to the development of this public awareness by establishing a quantitative baseline for critical wetland habitat against which partial measures of its loss and deterioration have been possible. As I do not need to tell this audience, the ability to demonstrate factually and quantitatively, the full scope and trend direction of an environmental problem of this nature is simultaneously both difficult and indispensable. Therefore, as

* Paper presented by Robert L. Schueler for Dale R. Evans.

this workshop seeks to improve upon and transcend the previous inventory, I would most strongly urge that the new inventory be structured to link with the previous one so as to demonstrate changes and the trend of the changes. Specifically, changes in wetlands size, in composition, or in importance should be capable of being statistically compared to the baseline of Circular 39 to document any losses that have occurred.

Although the earlier inventory used wetland types in a classification that may require modification today, the data on which the types were based should be adequate for comparison with whatever new classification system is developed. Regardless of the other uses to which the new wetlands inventory may be put, if it does not rapidly give an up-to-date quantifiable report on where we are in terms of our wetlands resources since the last time the job was attempted, it will be severely criticized by those interested in wetlands preservation, conservation, and enhancement. The criticism would be justifiable. The wetlands conservation constituency, if I may use the term, is entitled to know, at least in rough outline, how rapidly the resource base is being lost. They are entitled to know whether ten years of public interest and concern have brought about any changes in rate of loss or enhancement, and where such changes have occurred. While not without technical problems, producing these relatively unsophisticated data should not unduly tax the capabilities of the new inventory. The important thing is to program this objective into the total effort from the beginning as a high priority item.

User Needs

We would agree, I am sure, that the proposed inventory should not be an academic exercise conducted for its own sake. Rather, it should be planned and conducted to produce information usable to those concerned with the conservation of these critical wetland habitats. The study should be fully coordinated with all concerned State and Federal resource agencies and conservation groups. As a potential user of the information that will be produced by the inventory, NMFS would like to indicate some of our needs as we see them.

For the inventory to be highly useful, it must be both general enough to cover broad geographical areas and specific enough to include local conditions. The material should contain the basic habitat information needed by State and Federal biologists to evaluate proposed construction and development permits and other planned alterations affecting wetlands. Desired information includes vegetative types, marsh acreage, productivity, biomass (plant and animal), the presence (and effects) of pollution, tidal range and currents, shoreline erosion, as well as use of the area by fish, shellfish, birds, and wildlife.

Examples of other useful information include identification of commercial and residential development pressures, regional planning goals involving the area, existing and proposed power plant siting plans, and the presence of marine or estuarine sanctuaries or other special-use areas identified in the State's Coastal Zone Management Program. Further, there is a need for the inventory to provide a base for making wetlands policy assessments. Examples of this need are: a) How adequately does a coastal state's proposed or approved Coastal Zone Management Program protect wetlands? b) What are the implications of recent court decisions extending Corps of Engineers' jurisdiction to non-navigable waters? c) How do wetlands-related fish and wildlife fit in the context of the Water Resources Council's Principles and Standards with regard to the sometimes conflicting objectives of economic development and environmental quality? A particular need of NOAA/NMFS is information on the adjacent open water habitat in the coastal zone. Ecologically, this habitat is inseparable from the coastal wetlands as now defined, at least in the case of estuarine and marine fish. It should not be excluded by an unduly narrow definition of the term "wetlands."

Potential NOAA/NMFS Technical Contribution

In the forthcoming wetlands inventory we expect that full consideration will be given to utilizing the technological advances that have been developed in recent years in the fields of mapping, satellite reconnaissance, sophisticated high resolution photography, other types of remote sensing, and automatic data analysis and processing. In the marine and coastal zone areas, we believe that the concentration and availability of this type of expertise, equipment and capability in NOAA is largely unmatched in the Nation. We have reviewed the draft document, "Tentative Classification for Wetlands of the United States," which was provided as a working paper for this session and note that this aspect, particularly remote sensing, is frequently mentioned. Hopefully during this workshop we can get a better grasp of the degree and manner in which this capability could make the most useful contribution. We are certain that appropriate representatives of NOAA would be pleased to discuss this in as much detail as you desire.

What is a Realistic Goal for the New Wetlands Inventory?

I have already broadly outlined some of the information that NOAA/NMFS would find most helpful as a user of the results of this inventory. Our desires in this regard may well be shared by other data users and decisionmakers whose interests affect the protection of wetlands and adjacent open water habitats in the coastal zone. These desires obviously transcend the scope of the inventory as presently contemplated--at least as outlined in the draft, "Tentative Classification for Wetlands of the United States." As in Circular 39, the orientation seems to emphasize waterfowl habitat, with the classification and inventorying techniques largely relying on vegetation. Such considerations as, value to fish and wildlife, habitat quality, and reflection of man-induced environmental alterations (either actual or potential) are not covered to any significant extent. We recognize, of course, that there are very real constraints of funding and manpower and that limits have to be set. Nevertheless, the new wetlands inventory should not be merely a classification exercise, and the fullest possible consideration should be given to accommodation of all user needs within these restraints.

In this connection, I have two major suggestions to offer:

1) Expansion of the Littoral Water class significantly seaward of the present limit of 30 feet below extreme low water. This would require modification of the present definition of "wetland." It would, however, greatly enhance the usefulness of the inventory from the marine fisheries' standpoint by inclusion of a habitat block very intimately related to the wetland areas now covered in your classification, and subject to many of the same stresses and impacts from man's activities. The technical problems of classifying and inventorying this "adjacent water" habitat should be much simpler than for classes already covered. NOAA/NMFS expertise might be useful in such an effort.

2) Selective expansion of kinds of data collected, using existing, or additional, subdivisions of the physiographic framework. In this manner,

organized collection of additional data could be initiated in increments without necessarily exceeding the real constraints that we all recognize. Selection of particular physiographic regions, or parts thereof, for more extensive compilation of user oriented inventory information could be based on (a) location and extent of readily available date, and (b) the vulnerability of the area to change and the consequent need for the information in a decision-making context.

NOAA/NMFS will be pleased to work with the FWS Wetlands Inventory staff to explore these suggestions further.

Discussion

Mr. Sullivan: (Carl Sullivan, Sport Fishing Institute, Washington, D.C.): Bob, the National Marine Fisheries Service is now completing the National Marine Fisheries Plan or National Plan for Marine Fisheries. What relationship do you see between that NMFS national plan and this National Wetlands Inventory?

Mr. Schueler: The question was, what connection is there between the National Fisheries Plan which is coming out shortly and the National Wetlands Inventory that we are discussing today? To my knowledge, there is no specific mention of the National Wetland Inventory in the draft of the National Fisheries Plan. However, the whole area of environmental assessment gets quite a play in the National Fisheries Plan. In that sense, it is secondarily connected. There is no specific mention of the National Wetland Inventory at the present time, and that can be attributed to the fact that we didn't know much about the plans for the Inventory. Although there have been some informal discussions between John (Montanari) and myself, this Workshop is our first official interface with the National Wetland Inventory.

Mr. Montanari: You mentioned that you would like to see the definition of the limit extended beyond 30 feet. What would be your guess as to how far out the limit should be extended? Last night Jack McCormick told me that with a 30-foot limit we are going to go all over hell. He would like to have a shallower limit; you would like to have it deeper.

Mr. Schueler: I look at it this way, John. My appearance on this podium is to outline the problem. The purpose of the workshop is to get into the details. We realize what dropping this kind of "clunker" does to the whole problem, and we also recognize the constraints. We must recognize that a lot of fish go out from the emergent vegetation quite a distance beyond the 30-foot depth, and return. It seems to us that this is a problem that must be addressed, but we do not have any specific suggestions to make at the present time.

By putting the consensus of knowledgeable wisdom together, we could play around with the concept of a variable belt. For obvious reasons, the belt off the coast of Maine would vary from that off the Gulf coast. This could be relatively simple. As we see it, you are not getting into refined contentions between vegetative types and some of the inland problems you face.

Mr. Cowardin: If you were to change the definition and move the line out from 30 feet, do you think that one class would be reasonable and sufficient, or do you think that the permanent water should be broken down into one or more classes? In your point of view, would one be sufficient?

Mr. Schueler: At the moment, if I had my choice between one or nothing, I would take one. But I think as we get into the technical discussions in the Workshop and later, other considerations associated with groupings may come up--bottom type, for example.

I have nothing specific to suggest insofar as groupings are concerned. I would say that because of physical and financial limitations we would have to adjust it to the framework that has already been laid down. I wouldn't think there could be a great many classes; perhaps one would be enough. However, you might want to look at it differently if you are comparing the Georgia to the Mississippi coast. That is as far as I am prepared to speak to this issue at this time.

Mr. Mason: (Herbert Mason, Berkeley, California): I would like to mention that the San Francisco Bay Conservation and Development Commission, on the other side of the spectrum, has set the limit at 100 feet from the shoreline. You cannot do anything without their permission; that distance has been legally established. They feel that you could do very great damage to the environmental relations on the shoreline if you change present conditions out to the 100-foot limit.

Mr. Schueler: I must say, Mr. Mason, I couldn't agree with you more. This is the reason we brought this aspect out.

Mr. Garcia: (John Garcia, University of Washington): I am interested in that you want to expand the definition of wetlands to include a habitat type that is important to fisheries. There is also a shoreline type, rocky shores and cliffs, that really isn't included in this definition, but it does represent a water edge interface. Do you feel that this interface should also be included?

Mr. Schueler: I am aware of how hard it was to arrive at this definition of wetlands, and the difficulties involved in changing it. As far as I am concerned, you could even consider a separate, permanent water category to take care of our needs. I think that was done in the last Inventory. That doesn't solve the more narrow problem with regard to the interface you have described.

As we reviewed the working document for this Workshop, several problems came to mind, particularly some associated with the West Coast. For example, where does Coos Bay or San Francisco Bay fit into a physiographic region? We are not familiar with the location of the boundary lines of the physiographic regions chosen. I suppose they may include the actual San Francisco Bay area or the Coos Bay area and the type of situation you have described. That is a technical question which I guess will be explored tomorrow when we break up into regional sessions.

The point I want to make is that we do recognize the problems that going seaward creates. If it is too much of a problem to totally change the definition of a wetland, maybe you could just make another category recognizing the rather distinct difference between this type of habitat that is so important to us and what is classically referred to as wetland. They do interact, particularly insofar as we are concerned.

Mr. Sullivan: I would like to suggest that the existence of kelp beds, which sometimes occur in more than 30 feet of water, might be one criteria to consider inasmuch as they are a distinct type of biological community. The sea otter, one of our rare and endangered species, is associated with these kelp beds along the California coast. I don't know how far beyond 30 feet the kelp beds go, but in some instances they are found in water that is 30 feet in depth.

Mr. Schueler: I am sure they do. You are right about their importance.

Mr. Teebo: (Lee Teebo, Environmental Protection Agency, Region IV): I would like to ask John (Montanari) if the group considered using light transmission as a defining parameter for the seaward boundary.

Mr. Montanari: I would refer that to Lew (Cowardin).

Mr. Cowardin: Yes, we definitely considered using light transmission. I think it would be a good parameter. The problem we have with it is that it is so variable because of varying turbidity. It is also variable within time. The main reason that we ended up with just a given depth--which we aren't too happy with--was for simplicity. Did I answer your question?

Mr. Teebo: Yes, I think so. I thought perhaps that was the case. I still think that it might make at least one good defining parameter.

Mr. Cowardin: We certainly would like to consider it and get all the help that we can with respect to its possible use. While I am up here I have one comment for the gentleman from the State of Washington (Mr. Garcia). Actually, as the classification is now structured, the bases of cliffs would be included. If you had a rock cliff within the tidal regimes that we have defined, whether they are vegetated or not, they would be included in the classification. Also, the presence of submerged aquatic vegetation overrides the depth. Depth is a factor only where vegetation does not occur. So the kelp beds, as the classification now exists, would also be included in the definition of wetland.

Mr. Garcia: Regardless?

Mr. Cowardin: Correct.

Mr. Schueler: If I could expand on just one point, we recognize the value and importance of having something standard across the whole country. We think the general configuration of the proposed classification system is quite worthwhile, despite the points we have made about expanding it. I would like to reiterate that there should be provided an opoortunity for selective expansion of the kinds of data collected, using existing, or additional, subdivisions of the physiographic framework. With the whole system linked together by a common classification scheme, you could pull out certain vulnerable areas and collect the additional data required for making sound decisions; do it selectively, and thereby stay within the constraints. That might be something we could talk about once we get into a little more detail. Thank you very much.

U.S. Fish and Wildlife Service

by

Jerry L. Stegman

One of the most rapidly disappearing components of the total earth ecosystem is the gradation between the land and water, which today is known in some ecological circles as wetlands. As greater knowledge about wetlands is gained through research, science becomes further convinced of the essential hydrological, chemical, and biological roles wetlands fulfill in the total earth ecosystem. Regardless of how subtle and obscure these roles may be to the casual observer, they nonetheless exist and exert an influence on a vast array of commonly accepted natural phenomenon ranging from floods, to animal populations, to general welfare of man.

Unfortunately, over the history of man's expansion, wetlands have not been understood for their true value, but instead have been viewed as wastelands that must be "improved" for the betterment of mankind. The general American creed during the first 150 years of our country was that our vast natural resources were virtually unlimited and should be exploited for the betterment of country and for personal gain. By the middle of the 19th Century, unoccupied public domain was diminished to the point that greedy eyes were turned toward swamp and overflow lands. The Swamp Lands Acts of 1849, 1850, and 1860 granted vast areas of wetlands to 15 states in an attempt to encourage reclamation. Swamplands were retained by the original 13 states and Texas, thus leaving 19 states in the Continental U.S. where public domain wetlands were never ceded by the Federal Government. Out of an estimated original total of 127 million acres of wetlands, a minimum loss of 45 million acres had been sustained by the mid-1950s. The carnage has continued to the present time, although accurate data are not available to specify the current score.

For some time, scientists have been accruing information to demonstrate the overall value of wetlands and need for their preservation. Only in recent years has the public begun to recognize and appreciate that wetland ecosystems are of vital importance in satisfying human needs as well as essential environmental roles. Far beyond their necessity for the survival and well-being of countless plants and animals native to the Continental United States, wetlands play essential roles in many natural functions vital to man. For example, they retard the flow of water from the land, moderate flood flows and help purify water by absorbing silt and nutrients that would otherwise degrade domestic water supplies, irrigation reservoirs, estuaries and other waters. Wetlands play a significant role in maintaining the recharging underground water aquifers and buffer shorelines against storm tides and erosion. Hardwood timber production depends on wetland ecosystems in some areas, as do a wide variety of other flora and fauna.

A great preponderance of all wetlands also provide recreational and esthetic values beyond calculation. Their importance to the perpetuation of both sport and commercial marine fisheries is undisputed--up to 90 percent of all marine finfish and shellfish depend upon coastal marshes and estuaries during some portion of their life cycles. Likewise, freshwater marshes are equally critical to many species inhabiting inland waters. Wetlands also provide vital habitat for a variety of other wildlife, including many furbearers, a multitude of shorebirds, and most of the wading species. These many values have become well enough known and documented that a growing segment of the general public support their preservation over destruction for other public or private purposes or gain. But continuing comprehensive studies are needed to better understand how wetlands function so that further public edification can be accomplished and wetlands can be more effectively managed.

Wetland Inventories

In the early 1900s, growing interest in reclamation of wetlands led to the first attempt at a national wetland inventory. In 1906, the Congress authorized the Department of Agriculture to develop data on the extent, character, and agricultural potential of remaining wetlands of the Nation. A questionnaire was sent to one or more persons in each county east of the 115th Meridian in an attempt to supplement or verify existing data. Eight of the western public-land States were excluded, as were all coastal tidewater lands. This inventory was limited primarily to identification of potential reclaimable wetlands and as a consequence was incomplete.

A second national inventory was conducted in 1922 by the Bureau of Agricultural Economics of the U.S. Department of Agriculture. It was based on data furnished by soil survey reports of the U.S. Bureau of Public Roads, topographic maps of the U.S. Geological Survey, various State reports, and the 1920 census of drainage. This inventory was the most complete nationwide survey of wetlands ever conducted and still remains the basis for many reclaimable wetland estimates.

The third, and latest national wetland inventory, was published in 1956 by the U.S. Fish and Wildlife Service as Circular 39, Wetlands of the United States. Unlike the first two inventories, which were geared toward identification of reclaimable wetlands, the latter survey was intended to classify and inventory remaining wetlands and evaluate their relative importance to waterfowl, and to a lesser degree other wildlife. It was financed largely by funds derived from sales of Federal Duck Stamps with the intent to aid in the establishment of more comprehensive land-use programs and policies, thereby preserving our diminishing wetlands.

Over the intervening years, considerable use has been made of Circular 39 by a variety of Federal and State agencies, universities, and private conservation groups. It has gained acceptance among the Federal establishment to the point that it is used as the inventory and classification standard by the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and Soil Conservation Service, and forms the basis of a wide spectrum of Federal regulations and policies dealing with the preservation of wetlands. It is also used as the classification basis for wetland preservation in such Federal legislation as the Water Bank Act, and the so-called Reuss Amendment to the annual Agricultural Appropriations Act. In addition, it is utilized in numerous State policies and regulations as the accepted standard of wetland classification and inventory.

Uses of Wetland Inventory Data

The greatest single application of wetland inventory data over the past 20 years has been related to the evaluation and planning of Federal water development projects or private projects requiring Federal permits. This effort has been carried out under authority granted to the U.S. Fish and Wildlife Service and the States under the Fish and Wildlife

Coordination Act and the Watershed Protection and Flood Protection Act. The type of project evaluations which often require wetland inventory data include reservoirs, navigation channels, levees, diversions, hurricane protection dikes, channelization and irrigation projects of the Corps of Engineers, Bureau of Reclamation and Soil Conservation Service. Private projects accomplished under special permits or licenses issued by the Corps of Engineers, Federal Power Commission, Nuclear Regulatory Commission, Forest Service, and Bureau of Land Management, also frequently require wetland inventory data for analysis.

Probably the most common use made of the wetland data today involves permits issued by the Corps of Engineers under authority of Section 10 of the River and Harbors Act of 1899 (covering construction in navigable waters of the United States) and Section 404 of the Federal Water Pollution Control Act amendments of 1972 (for deposition of solid materials in navigable waters). These permits generally apply to coastal or estuarine areas where in past years vast acreages of public wetlands and waters have been destroyed or damaged by uncontrolled private construction activities. The numbers of these permits have grown at a rapid rate in recent years, as have the counter-activities of the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and State fish and wildlife agencies to control or limit destruction of valuable wetlands. In virtually every case wetland inventory data are of some use in evaluating and reporting on projects of this type.

A relatively recent use for wetland inventory data falls in the area of prosecution of illegal drainage or construction activities carried out in public wetlands without proper Federal permits. Over the past five years, the number of prosecutions of such illegal acts has risen dramatically. In many cases, wetland inventory data provide important evidence to document exact habitat conditions prior to the illegal construction and, therefore, play an important role in court settlements and judgements. In addition, wetland inventories utilizing aerial photography, could well serve as an aid to current Federal and State surveillance efforts to detect and stop illegal construction activities.

Wetland inventory data are likewise used as an aid to acquisition of migratory bird habitat. Over the years the Fish and Wildlife Service has used funds from Duck Stamp sales, the Wetland Loan Act of 1961 and direct appropriations to purchase or lease in excess of 8.2 million acres. In addition, State agencies have acquired or leased over 6.2 million acres. In future years, these efforts are expected to continue and thereby expand the need for reliable wetland inventory data. Also, relatively new preservation programs under the Water Bank Act and the Coastal Zone Management Act should increase the need for such data.

The most general, and in some ways most important, use of wetland inventory data is associated with periodically determining remaining acreages and types of wetlands and drainage trends. These data are needed to correlate with declining wildlife populations, increased flood runoff, lowered water tables and other related environmental declines. With these hard facts in hand, private citizens, planners and law makers can be more easily convinced of the general value of wetlands and the need to preserve them for future generations.

It would be difficult to reliably determine the degree of utilization made of wetland data by the various users. However, based on the relative numbers of personnel, project studies, and funds involved, it is obvious that the greatest majority of use (perhaps over 80-90 percent) relates to evaluation of water development projects and habitat preservation and management. Therefore, it is imperative that any wetland classification and inventory system adopted should be designed to meet these primary needs.

Figures 1 through 4 illustrate the types of construction works which require wetland inventory data for evaluation.

Types of Inventory Data Needed

In late 1974, a questionnaire was circulated to all Fish and Wildlife Service Regional Offices and key research personnel to ascertain their needs for wetland classification and inventory data. The results of that questionnaire and the opinions of a broad spectrum of operational personnel fall into two general categories of consideration: 1) adequacy of the classification system and inventory methods employed in Circular 39, Wetlands of the United States; and 2) what types of data should any new inventory include.

Although opinions vary considerably, there seem to be certain threads of consistency in the arguments on Circular 39 which merit serious consideration.

1. Circular 39 is well entrenched in current law, regulations, policies, and usage to the point that its discontinuation would create serious problems in coordination of Federal and State water development programs and wetland preservation efforts.
2. Circular 39 deals primarily with waterfowl habitat, and as such does not adequately relate to other animal and environmental values.
3. Circular 39 basic data (maps, acreages, etc.) are not organized and stored so that easy extractions or compilations can be made.

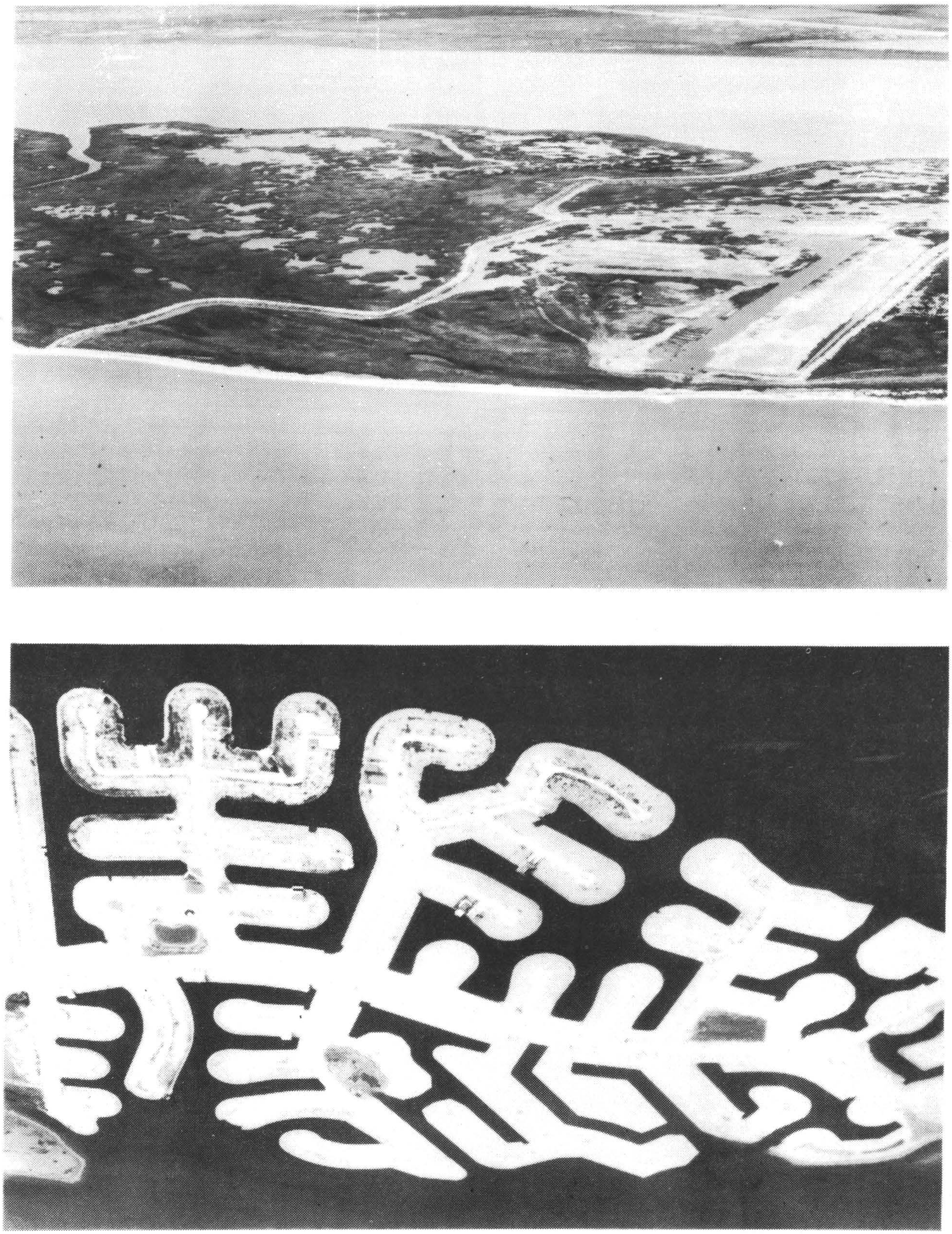


Figure 1. Coastal marsh destruction for housing development.
(Before and after) - NMFS photo.

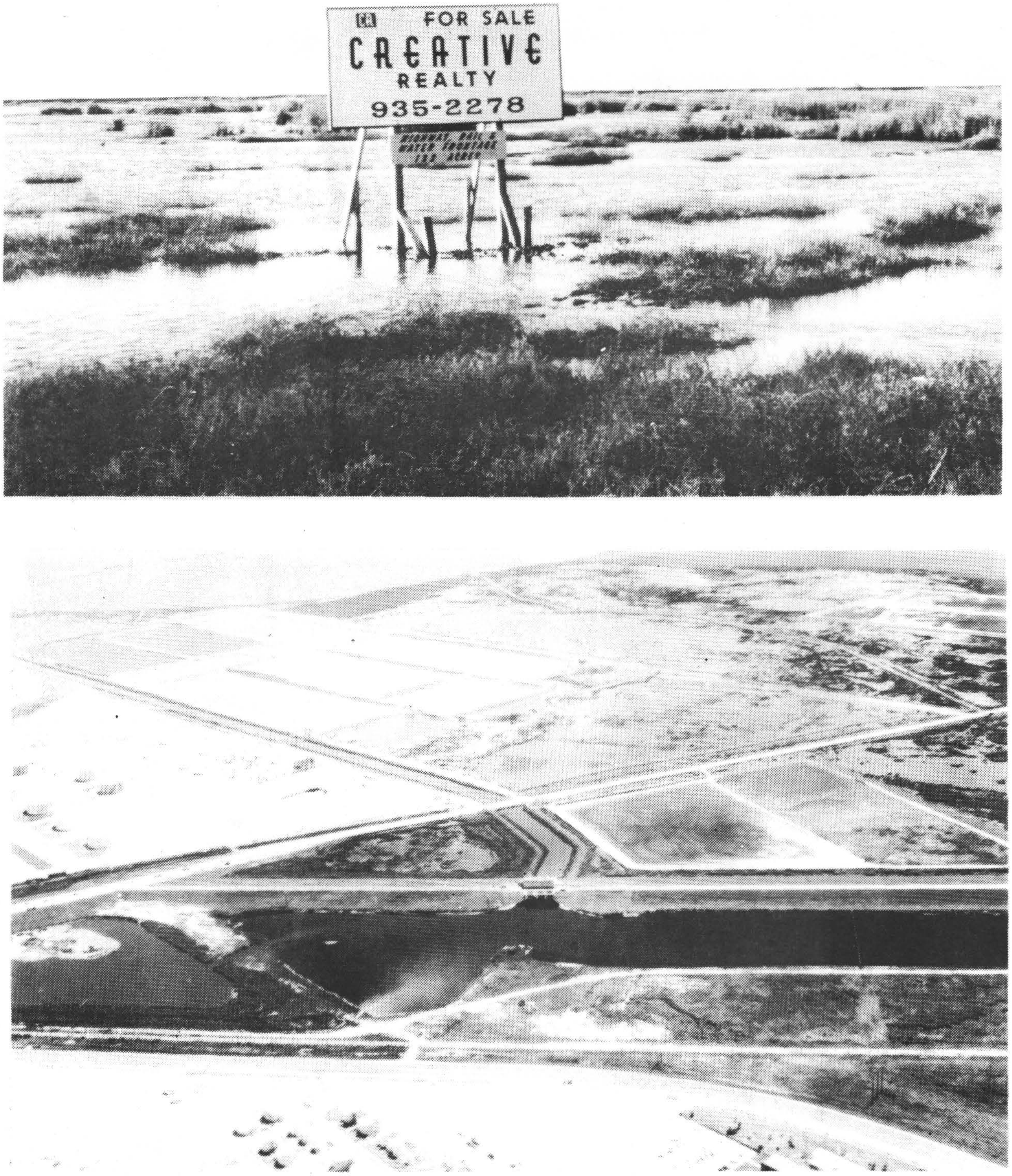


Figure 2. Coastal marsh destruction for industrial development - FWS photo.

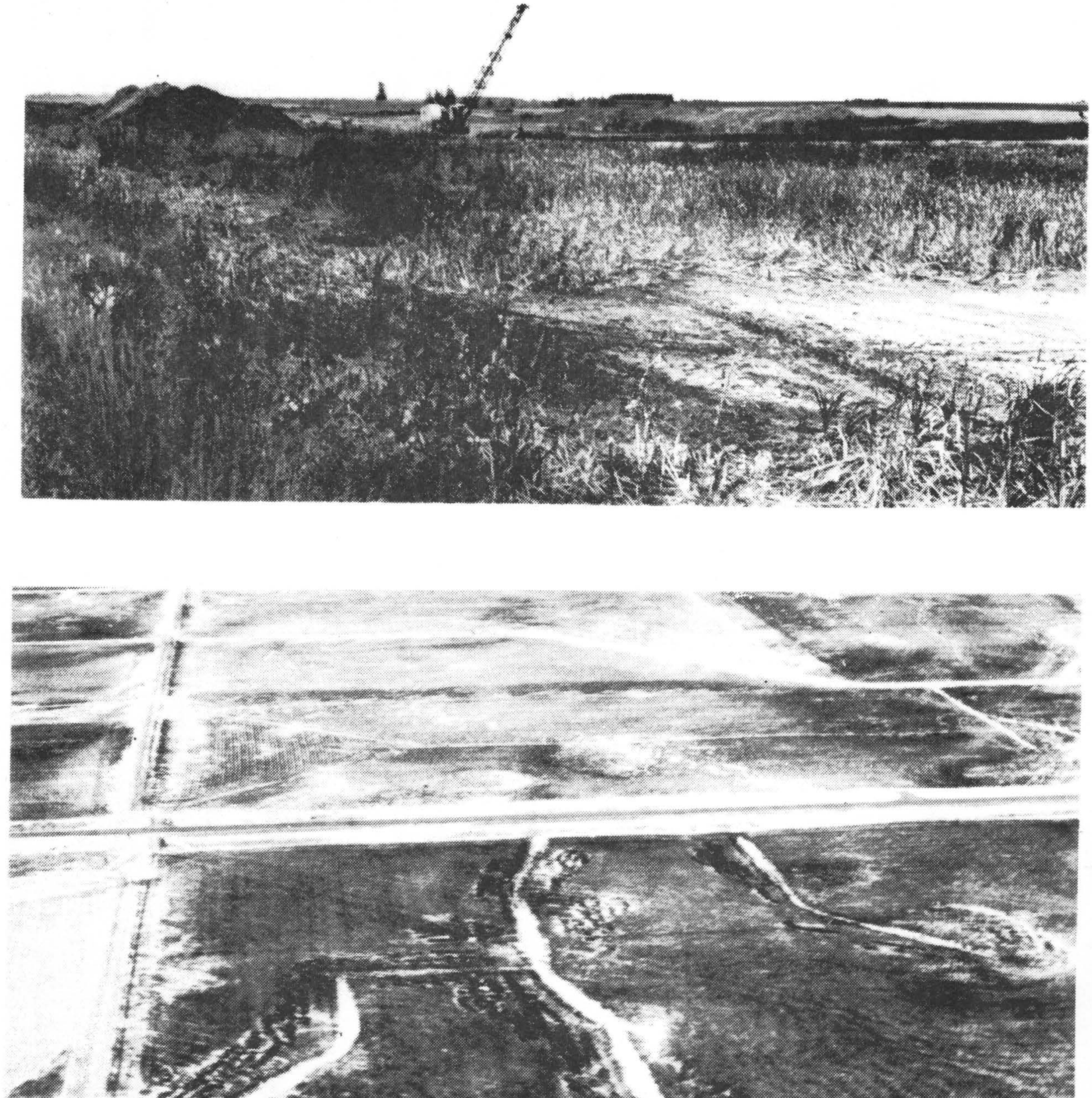


Figure 3. Drainage of prairie potholes by highway construction - FWS photo.

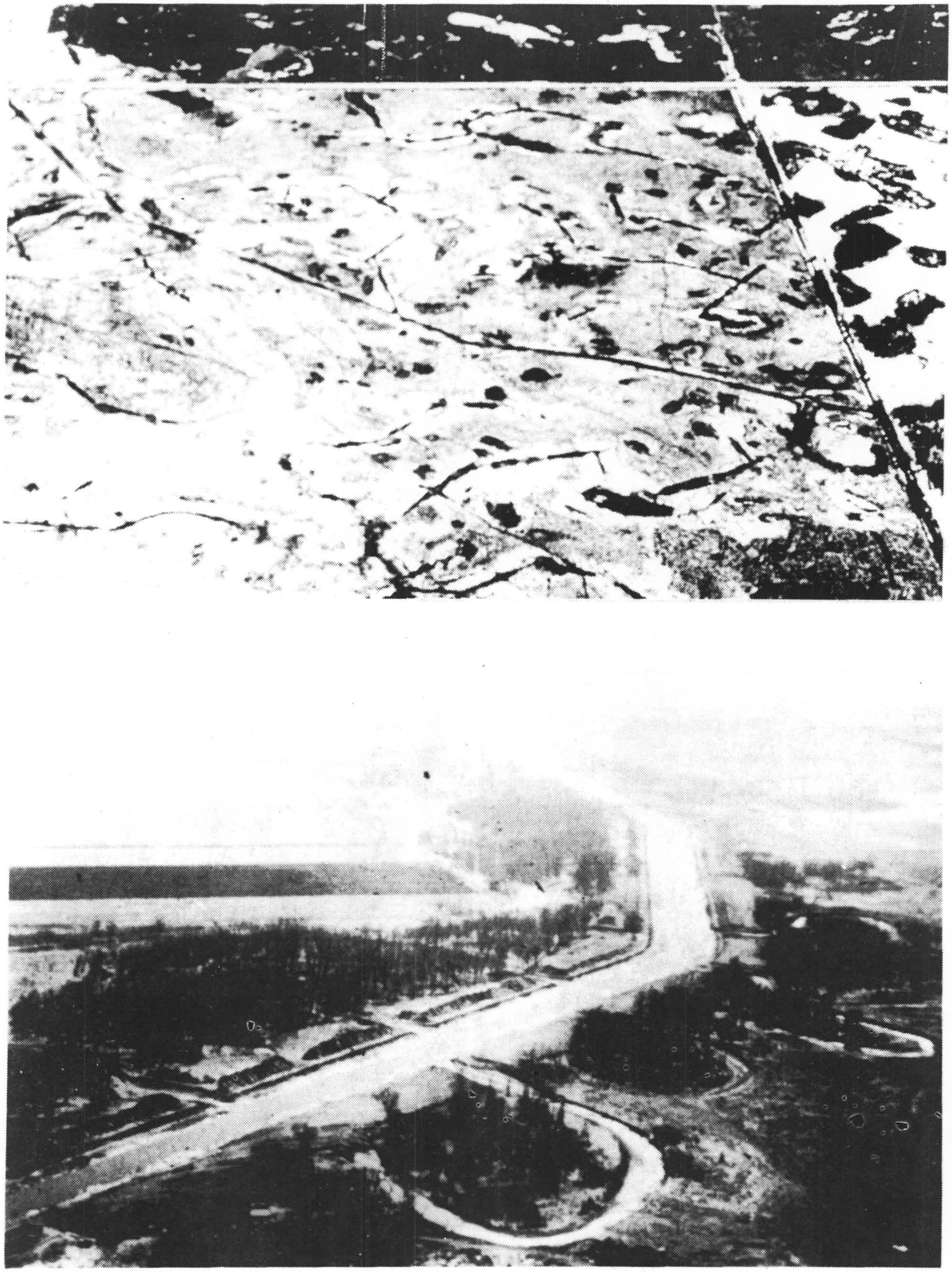


Figure 4. Destruction of wetland habitat by channelization - FWS photo.

4. The classification system in Circular 39 is not specific enough to meet research or regional needs.

The major uses of wetland inventory data are associated with efforts to protect, manage or conduct research on existing wetland areas. As a result, major data needs relate to the evaluation, planning and reporting of water-related construction works; with the acquisition and management of wetland areas; and with research carried out to better understand what factors contribute to the existence of wetlands and the many values they have to man, wild creatures and the total ecosystem. No total consensus will ever exist on precisely what parameters should be included in any wetland inventory. However, some of the most frequently expressed opinions among FWS management biologists indicate that where possible, any new inventory should be:

1. Relatively simple and easy to understand so that it can be utilized by a broad spectrum of biologists, planners and laymen. Such a system should delineate in a precise manner easily distinguishable or recognized wetland types. It should be based on stable long-term factors of basin configuration, vegetation, water conditions, soil types, water chemistry, etc., which are not subject to short-term or seasonal variations.
2. Designed so that more specific or definitive sub-inventories can be conducted and added to the general system to broaden its coverage.
3. Designed so that periodic re-inventories (on a minimum five-year interval) can be made with acceptable precision and cost. Critical areas could well be inventoried every one to 3 years, as needed.

4. Designed so that as new data are obtained, they can be added to the system, thereby providing the most current information available.
5. Designed with statistical sampling areas to be used periodically to update data and determine overall system reliability.
6. Designed to reflect relative value of individual wetlands for broad groupings of animals (waterfowl, finfish, shellfish, etc.) and physical functions (water purification, erosion control, aquifer recharge, etc.).
7. Designed so that data on wetland types, acreages, ownership, resource values, watershed characteristics, etc., can be stored and rapidly retrieved for the nation, flyway, State, County, drainage basin or specific limited area, including map printouts of specified areas. A grid-coding by geographic coordinates should be employed for easy identification of wetland areas and to permit rapid recall of latest data.

These information needs will require utilization of modern methods of satellite and/or aerial photography, multi-spectral scanning and computer analysis, storage and retrieval of data.

Regardless of what classification system is used, a single system cannot meet the total needs of all users. Therefore, we recommend the adoption of a general system most applicable for the majority of users with more specific sub-systems applied to localized or more limited applications as needed. For example, the general type of data needed to determine periodic totals of wetlands by type, drainage trends and correlation with animal populations or environmental conditions may be satisfactorily obtained from a general five-year interval inventory obtainable by gross methods such as satellite photography. The utilization of the Circular 39 classification system for this purpose will insure simplicity, continuation of wetland typing and acceptance by current users. The general results of this inventory should be printed in a public version similar to Circular 39. The backup data should be computer stored so that specific data and maps could be extracted as needed. More-detailed and frequent inventories could be conducted on identified critical areas (prairie pothole areas, coastal zones, Mississippi River Valley, etc.) on an as-needed basis. Individual state inventories would fall in this category. The system should be designed so that this type of supplemental inventory would utilize a refinement of the same classification system and the resulting data could be used to up-date the more general five-year inventory.

Discussion

Mr. Sullivan: (Sport Fishing Institute, Washington, D.C.): I have a question that is directed to your agency as well as any of the other major Federal land-holding agencies such as the Park Service, the Forest Service, and the Bureau of Land Management. Within the last year, the National Resources Council of America developed a survey of the inholdings in these Federal lands. These inholdings consist of many, many millions of acres. Every year we are purchasing some of these acres with some of the proceeds from the Land and Water Conservation Fund. Is the Fish and Wildlife Service, is the Park Service, is the Forest Service studying the wetlands in these inholdings so that they are factors involved in purchase negotiations? Which inholdings are purchased with the funds as they become available?

Mr. Stegman: To my knowledge, no. Our acquisition program within the Fish and Wildlife Service is directed toward wetland production areas and that sort of thing. As far as inholdings in existing areas of the type you are referring to, I don't know.

Mr. Stegman: (continued)

Our acquisition program is sometimes geared toward habitat for a certain species we are interested in, particularly an endangered species. But as far as wetland inholding approach is concerned, I don't know of one. Somebody else from the Service may, or from some of the other Federal agencies you mentioned.

Mr. McCormick:

(Jack McCormick & Associates, Inc., Pennsylvania): Maybe it is unfair to ask you this question because it is a general one, but under the Endangered Species Act of 1973 (Section 7) all Federal agencies are required to implement the Act. It also broadens the endangered species category by including the second class, or threatened species. Then it also takes the endangerment down to the smallest political unit, which may be a county or municipality. (Witness the proposed regulations on the American alligator). How does this fit in, particularly with critical areas in Section 7? Can't this be included as a protective device for wetlands?

Mr. Stegman:

It probably could. I think the problem that is being wrestled with right now, and that has not as yet been resolved, is how do you define critical habitat? Until you do that, which is even harder to do than trying to come up with a wetland classification system that will satisfy everybody's needs, I don't know exactly how you go into the next step.

Mr. McCormick:

I think the Fish and Wildlife Service and the National Marine Fisheries Service published a definition of critical habitat in the Federal Register on the 21st of April. It is very general, but it is so general as to be very good.

Mr. Stegman:

You go from there and get into the specifics for a given species, and I am sure it is going to be quite interesting. I think you have a good point, but I wouldn't even hazard a guess as to how it will be approached in the final analysis. I think that probably somewhere in this inventory, ideally in the open-ended flexibility that I alluded to, there would be thought given as to how you plug in endangered species data.

I think that is the real problem that we are all wrestling with. How do we leave ourselves open-ended enough so that we can, 5 or 10 years from now, leave our options open, so to speak. I think that is the beauty of a generalized approach. We may find five years from now that what we think is true of wetlands today is entirely fallacious in some areas, and we may wish we didn't have the restraints that a more specific approach will place on us. As I have said, I am a generalist, so I feel that way about most things.

Mr. Robinson: (Lee Robinson, National Park Service, Washington, D.C.): In your presentation you brought up something on coding locations. I have seen everything from river mile to section and township, to longitude and latitude. Do you know of any effort being made to accept one of those as standard rather than having different ones for every derivation there is?

Mr. Stegman: No, I really don't. I think you will find that some systems lend themselves to certain types of habitats and not to others. For instance, the old Federal Water Pollution Control Administration had a system you may be familiar with for coding streams. It was a computer-based type of system that would supposedly allow you to extract data from any stream segment in the United States. Based on my experience, it was a good system. It probably had no applicability whatsoever to other types of wetlands.

I do think that whenever a biologist goes into the field to evaluate a project, he will want to make a search for whatever data might be available related to the specific location in which the project is located. Some type of system must be devised to enable him to extract those data. I'm afraid I can't solve such problems; I can just bring them up.

Mr. Montanari: What system is used in LUDA (Land Use Data Analysis)?

Ms. Carter: I think it is UTM grids.

Mr. Montanari: All right, that is what I think we would like to use. That is one of the reasons we have had such an interest in the Geological Survey's LUDA program. They have a software system for locating parcels of land-use across the country. I think the system--I may be mistaken--was developed by the University of Saskatchewan. If we can mesh this system with the National Wetland Inventory, we should be able to locate wetlands geographically. Hopefully, it will also be possible for us to plug our classification system into the LUDA program. If that does prove to be feasible, we will then be able to get various types of relevant upland information by pushing the right buttons; at least to the extent that they have been classified in the LUDA program.

Ms. Carter: We have people here who can explain the UTM grids if you want to pursue that issue after this session.

Mr. Jahn: (Larry Jahn, Wildlife Management Institute): Jerry, I don't mean to pin you to the wall, but we are talking about different systems of aerial photography, etc. For all of the different physiographic provinces the concept of minimum size is of major importance. How small a unit are you going to inventory? Forty acres is the minimum size the Geological Survey intends to inventory. We need something smaller than that. What is the minimum size you have in mind for the two types of periodic inventories: the intensive inventory every one to three years, and the more general inventory every five or more years?

Mr. Stegman: Well, I am not really too familiar with the various types of hardware that might be available and the practical aspects of their use. Just from a manager's standpoint, I think there is a need for the two types of inventories I referred to. The one could be on a 40-acre basis which would have little functional use, but it would reveal trends in wetland habitats. For that type of an inventory, a five- or ten-year interval might be adequate. That is similar to what we have with Circular 39 now, except that you cannot extract the data very satisfactorily. If you give that type of information to the man in the field who has the everyday problem of purchasing a wetland or evaluating a project, it is absolutely worthless to him. He then takes the Circular 39 system, or whatever regional system he feels is better, and goes out and does his own classification and inventory. This then brings up the question as to how practical it really is to attempt to do an inventory for him on a case by case basis. It is probably not practical to attempt a fine scale inventory on a national or even a regional basis. I am really not familiar enough with the hardware to make a final judgment on that problem.

Regardless of whether we can do it or not, the man in the field finds himself in some cases being confronted with the problem of having to identify areas as small as a quarter of an acre in size. I don't think I have answered your question, but what I am trying to get across is that it may not be practical to do a national inventory on the scale that is necessary for the evaluation of projects. You may have to resort to some kind of statistical approach to detect and evaluate general trends in wetland habitats, and then use spot checks to get smaller scale data needed to evaluate specific areas.

Mr. Jahn: Right. All of the speakers have indicated the limitations of the different methods. You have brought out the interesting point that it is the users' needs that should be paramount in deciding which method should be applied.

Mr. Stegman: If you turn your back on the users' needs, you might as well go home and let somebody put out a nice paper on inventory and classification. It will join those other nice papers in the literature that are absolutely worthless to the man in the field. If you are not going to do this inventory for the man in the field, you are going to waste a lot of money.

Mr. Johannsen: (Chris J. Johannsen, University of Missouri): I would like to pursue that "user-need" point just a bit further. Last night Al Hirsch listed about 10 products that the Fish and Wildlife Service saw coming out of this inventory. One of these was referred to as habitat values. Could you elaborate on that? What type of habitat values are you talking about? Are you thinking specifically about the habitat evaluation system the Service has been playing with, or are you thinking of a new set of habitat values focusing specifically upon wetlands?

Mr. Stegman: You are opening up a real "can or worms." Inasmuch as you are from Missouri, I assume you are familiar with Salky Daniel's input into the habitat evaluation system. There are all kinds of ways of determining habitat values. Here again, I think there are dangers in getting too specific. For example, considering fish and wildlife values only you could be so specific as to evaluate on the basis of individual species, and we may have to do so in the case of endangered species. However, if you go too far beyond the broad approach, I think you are going to lose the functional applicability of many of these values. For instance, you might evaluate a wetland for waterfowl, or for forbearers, etc. The more specific you get, the more complicated the problem becomes. Being specific has advantages, but I think it is better to reserve detailed research to specific types of wetlands and try to correlate those findings to wetlands in general.

In evaluating wetlands, we must never stop with just fish and wildlife values. We also must go into the other values such as flood control, groundwater storage, etc. Such values are probably more significant to the individual citizen than fish and wildlife values. We are not in this to convince each other that wetlands have value; we are in it to convince those who want to convert wetlands to some other so-called higher use.

Mr. Johannsen: Specifically, do you think the terrestrial habitat evaluation procedure that the Fish and Wildlife Service is now proposing fits into this wetland inventory scheme?

Mr. Stegman: I would say that it should be the other way around. Just by way of fast review, the system that he (Mr. Johannsen) is referring to is one being developed by the Fish and Wildlife Service, state fish and game agencies, and some private conservation groups in response to a recommendation made by a national coordinating committee for water resource projects. I am not sure as to the exact title of the committee. This was an outgrowth of some regional workshops held in about 1970. The workshops were geared toward identifying the shortcomings of the Fish and Wildlife Service, state fish and game agencies, and private conservation groups with respect to their input to Federal water development project planning and development. The workshops resulted in the formulation of a national committee that was to set strategy or identify problems that should be addressed during each subsequent year. In about 1974, one of the recommendations of that committee was that the various organizations mentioned earlier should cooperatively develop a standardized habitat evaluation system. That system has been developed in a very general form, and it has been tested in the field. At the present time it is being studied in a series of workshops being held in various sections of the country. So far, I think about three workshops have been held, and another is scheduled for Portland in August. Following that, I think workshops are scheduled for Minneapolis and Boston.

That evaluation system is well on the way. I expect that it will get some type of sanction by the regional associations of fish and game commissioners, the Fish and Wildlife Service, the National Marine Fisheries Service, and possibly others. It is a fact of life, it has been developed, and it is being used. I think that rather than ask how it fits into the wetland inventory we are talking about here, we should ask how this inventory can fit into this evaluation system. The evaluation system is so general that I think that the wetland inventory could fit into it very easily.

U.S. Office of Coastal Zone Management

by

Edward T. LaRoe

NOAA's Office of Coastal Zone Management (OCZM) administers two programs which relate to wetlands protection and management: the Estuarine Sanctuary Program, authorized by the Federal Coastal Zone Management Act (CZMA) of 1972 (PL 92-583) and the Marine Sanctuary Program created by Title III of the Marine Research, Protection and Sanctuary Act, also of 1972 (PL 92-532). I will briefly describe these two programs, their current status, and then suggest some areas where we could use your assistance.

Before I begin, I might add that OCZM is not directly involved in any wetlands inventory or classification efforts. However, in our administration of the overall coastal zone management program--wherein we award grants to coastal states to develop and implement management programs for their coasts--we do encourage and fund such efforts by the states themselves. We would hope, for example, that in the development of their management programs the individual states would identify, inventory and classify their coastal wetlands and develop means to protect and preserve them. In view of the diverse systems used to date, we do recognize the need for a standard approach. In this sense we are indirectly involved in such efforts. In the long run, I hope this will have a significant impact on the status of coastal wetlands in our nation, and in fact, this will probably be the most significant impact that our office might have.

Turning to the sanctuary programs, where we are directly involved, I would like to discuss the Estuarine Sanctuary Program first. Section 312 of the Coastal Zone Management Act established a program to provide 50% matching grants to states in order to permit them to acquire, develop, and operate estuarine areas for use as estuarine sanctuaries. The primary objective of this program is to provide a representative sample of natural estuarine areas for long-term scientific and educational use. The sanctuaries are to serve as natural field laboratories, and will be managed and utilized as research natural areas. That is, the primary management objective will be to retain the sanctuary ecosystem in as near natural state as possible. Other uses--such as low intensity recreation--might be permitted so long as they do not interfere with this primary management objective.

Sanctuaries established under this program have the dual purpose of first, providing selected undisturbed areas so that examples of a variety of natural estuaries will always remain available for ecological research, and second, so that natural areas will be available for use as a control against which the impacts of man's activities in other areas can be assessed. These sanctuaries are to be used primarily for long-term scientific and educational purposes. It is hoped that they will produce information essential to coastal zone management decisionmaking.

I might emphasize a few major attributes of the estuarine sanctuary program. First, it is a grant program, with the primary responsibility for initiating sanctuary proposals and applications, as well as ownership and management responsibilities, lying at the State level. It is not a program where the Federal Office of Coastal Zone Management actively goes out and seeks appropriate sites.

Second, it is designed to protect a representative series of natural estuarine ecosystems. This has several ramifications: we are clearly focused on estuarine systems--a body of water partially enclosed by land. As a general rule, these estuaries should contain seawater measurably diluted by fresh-water from inland runoff, although the estuarine sanctuary program would also include hypersaline lagoons as well as estuarine-like areas in the Great Lakes, so that the classic components of estuarine systems are not essential criteria.

It is important to recognize the estuarine focus of the program: the emphasis on the water body. This sanctuary program is not a wetlands--a marshlands--acquisition program, although where marshes are a part of the estuarine ecosystem, they should be included.

Although focusing on the estuary, the program also emphasizes the ecosystem. As such, estuarine sanctuaries should include the estuary proper; marshlands, intertidal areas, and transitional zones; and the uplands to the extent that they all interact and are a part of the same ecological unit. Experience has shown that we can't adequately protect the estuary without all of these components of the ecosystem.

The program stresses representative areas rather than unique sites. In order to ensure that the full variety of ecological types of estuaries will be adequately represented, we have utilized a classification system based on biogeographic provinces. These provinces reflect major geographic, hydrographic, and biologic characteristics. The system used--with eleven major provinces around the coasts of the United States--is similar to that developed during the National Estuarine Pollution Study (1969) and the Woods Hole Coastal Zone Workshop (1972). I might point out that this does not purport to be a wetlands classification, but an estuarine one. After recognizing significant subcategories within these provinces, we feel that a minimum of 18 sanctuaries will be needed to provide the full representation desired.

Finally, the areas selected should be as natural--that is, undisturbed by man--as possible, and should be managed to retain that characteristic. Management of estuarine sanctuaries should distinguish between the coastal laboratory and the sanctuary concepts. The former might be thought as manipulative areas, parallel to the experimental ecological reserves concept proposed by the Federal Committee on Ecological Reserves and others. Sanctuaries, on the other hand, will not normally be open to manipulative research, and would approximate the FCER's research natural areas concept.

To date, two estuarine sanctuaries have been established, and we are actively processing two more.

It is unfortunate that the names are so similar, for the Marine Sanctuary Program differs markedly from the Estuarine Sanctuary Program. To begin with, it is a far more flexible tool. The objectives are far broader. Marine Sanctuaries may be designated to preserve, restore, or enhance conservation, recreation, ecologic, or aesthetic values or resources.

We have identified several general types of Marine Sanctuaries in line with these objectives. For example, we could perceive establishing a marine sanctuary as a species preserve, to protect a given species; as a habitat preserve, to protect an ecosystem or geographic area; as scientific research or education areas, either natural or manipulative; or to protect or provide recreational use and aesthetic values. After defining the specific purpose for a proposed marine sanctuary, the regulations for each sanctuary will be designed and individually tailored to achieve that purpose. Great latitude exists in designing the regulations, which could, for example, prohibit certain activities or discharges, set catch limits or protect certain species, and control access and use of the area generally. The Marine Sanctuary Program is one of broad potential.

It differs from the estuarine sanctuary program in other ways, too. It is essentially a Federal program, where designation of a marine sanctuary is actually made by the Federal government, although when it would be located in a State's waters the governor has veto power over designation. Although designation is a Federal action, proposals can be nominated by virtually any agency, individual, or organization.

The Marine Sanctuary Authority covers all coastal and offshore waters of the United States, inland to the extent of tidal ebb and flow, and the Great Lakes. However, unlike the Estuarine Sanctuary Program, there is no authority to acquire lands for marine sanctuaries.

To date, one marine sanctuary has been established, and we are about to release an environmental impact statement on a second.

Finally, let me briefly highlight three areas where we could use your assistance: First, we need assistance in the identification of sites. Wetlands inventory efforts will be of great assistance to State coastal zone management planners, who need help in identifying estuarine sanctuary sites. Such information will also benefit--ensure the soundness of--the overall State coastal zone management programs. In addition, the Federal Office of Coastal Zone Management could directly utilize assistance and information in identifying appropriate marine sanctuary sites. A thorough inventory would help us choose appropriate sites, and would provide a sound base for others to select and offer nominations. Second, we need assistance in determining priorities. This takes two forms: With the limited funds and resources available in the Marine Sanctuary Program, we need to have a systematic basis for selecting the most important nominations for processing. We would be interested in a classification system which might provide that, one which would enable us to select the most important habitats, ecosystems and objectives for early emphasis.

In the Estuarine Sanctuary Program, we need assistance both in choosing among sites--competitive sites--in the same biogeographic provinces, and in determining the overall suitability of sites.

Finally, we need assistance in use of these areas. To a certain extent these sanctuaries will serve a useful function if they are simply protected and allowed to remain natural. They will, for example, provide benefits related to maintaining genetic diversity, breeding stocks, and simply examples of what such areas once were like as others are altered by man. But they really should be used by scientists and educators. For work requiring natural systems, for control purposes, or for providing baseline data, I would hope that these sanctuaries might be utilized as standards. Properly used, they can provide a very beneficial service.

Discussion

Mr. McErlean: (Andrew McErlean, Environmental Protection Agency): I am very curious about the estuarine sanctuaries program. As I understand it, the Office of Coastal Zone Management has some $9 million allocated for 27 coastal states for planning. What is the funding picture for this estuarine sanctuaries program? Could you elaborate on that?

Mr. LaRoe: At the moment we have a single appropriation of $4 million. We have expended roughly two-thirds of that. Authorization has been given for an additional $18 million. I am not sure how realistic it is that that will be released. We are anticipating $6 million a year for the next three fiscal years.

Mr. McErlean: Am I to understand by that that you were able to buy an estuary for $4 million?

Mr. LaRoe: First, Federal dollars make up only 50 percent of the funds; they must be matched by State funds or private donations. But, yes, we have acquired parts of an estuary, never an entire estuary, for sanctuaries. The first estuarine sanctuary was established in Coos Bay and includes roughly 4,000 acres. The projected total cost--State and Federal--for this sanctuary is approaching $3.6 million. Just recently the second one was set up which involves the entire southern end of Sapelo Island and Duplin River watershed.

Mr. McErlean: I am curious. I would hope that some attention would be given to Chesapeake Bay which purports to be one of the best studied estuaries in the world. I am very curious as to what you think $4 million, or something of that order, will do to preserve a representative study estuary in the Chesapeake system.

Mr. LaRoe: We are in the midst of communication with the State of Maryland, which is the only state bordering Chesapeake Bay that has indicated in writing that it is pursuing an estuarine sanctuary application. We feel that there are a number of inventories already existing that should enable the State and our office to select, for the purposes of the program, one site representing the ecosystems found in the Bay.

Mr. McErelean: I guess the really fundamental question is whether or not there is sufficient funding to do something significant with this, or is this going to be scientific tokenism in the broadest sense?

Mr. LaRoe: We would favor one large site in Chesapeake Bay, rather than a number of smaller ones. Although perhaps lacking the diversity of a number of small sanctuaries, a single large site would enable a greater approximation of a single ecosystem, and would be more defensible in the face of future development. There is no way we could do anything to preserve Chesapeake Bay as a whole. However, it is not our objective to provide a large-scale open-space, refuge, or parkland acquisition program. We are attempting to provide a nationwide system--perhaps 18--of representative natural estuarine areas. I believe we can do this. I personally feel that this is significant. We may disagree.

Mr. Sullivan: According to what you have said, the coastal states are required to do a wetlands inventory as a part of their coastal zone management plan. That will obviously have to come before 1980 when John (Montanari) speaks of the national inventory being prepared. Now, my question is, are the states going to do this state by state with their own criteria? Are they going to adopt the classification scheme we are discussing here or are they going to wait until this inventory is done and plug that into their state by state plans when it is completed?

Mr. LaRoe: The states are required to identify "areas of particular concern." We, in our regulations, would include wetlands as one category of such areas. What has happened to date is that every state has interpreted this in its own fashion and gone about the study and inventory in its own fashion.

For the purposes of our program, they have three years to develop a coastal zone management plan. That means that they would complete their plans before the results of the National Wetland Inventory are available. To the extent that some kind of standard or system could be produced here, I would hope that the states would utilize it. But their work will have to be completed before the final product of this effort will be available.

Mr. Springer: (Paul Springer, Fish and Wildlife Service): You have identified two of the estuarine sanctuaries. Could you give us the marine sanctuaries and also the acreage of the various areas that either have been acquired or are being considered?

Mr. LaRoe: As I said, in the Coos Bay estuarine sanctuary we have about 4,000 acres, of which I think roughly 900 acres are water and the remainder are made up of intertidal areas and uplands. At Sapelo Island we are talking about a total sanctuary of about 8,000 acres.

The first marine sanctuary was designated for archeological or historic reasons. It was the site of the Monitor's sinking off the coast of North Carolina. I don't know the acreage, but the site is a circle one mile in diameter.

The second marine sanctuary, one that will be covered by a soon to be released environmental impact statement, would be a larger area off of Pennekamp Coral Reefs State Park in Florida. Essentially it is for the purpose of extending the Park's authority beyond State-owned waters into Federal waters. It would provide better regulation of the coral ecosystem by extending to deeper waters the protection of rules and regulations similar to those that the state now provides for its coral reefs.

Mr. Springer: How much more protection?

Mr. LaRoe: We are coming out with a draft Environmental Impact Statement (EIS). I suspect that our regulations will be modified as a result of the EIS process. We would prohibit the taking of coral and the collection of certain kinds of invertebrates. There is some disagreement about how much protection should be provided from fishing, particularly commercial fishing and commercial lobster harvesting. As yet, I don't know whether fishing and harvesting will be prohibited or permitted under some kind of restrictions or regulations. In addition I think it would provide another tool the state could use to control the effects of mainland dredge and fill upon the coral reef.

Mr. Springer: What is the size of the area invoked?

Mr. LaRoe: I do not know the acreage of the area. It runs the full length of the Pennekamp Coral Reef State Park and goes offshore from the State's jurisdiction to the 60-fathom or the 60-foot contour; I am not sure which. It is on the order of miles in length and width.[1]

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[1] Editorial note added in press: The Key Largo (Pennekamp) Coral Reef Marine Sanctuary is about 100 square miles in extent, and parallels the State Park, extending seaward to the 300 ft. contour. ETL

Mr. Purkerson: (Lee Purkerson, National Park Service): Did you say 60 rather than 300-foot contour?

Mr. LaRoe: Maybe it is 300 feet. That is 60 fathoms. I don't know, Lee. I have been out of the office for two weeks. There was a great deal of uncertainty as to what the final regulations as promoted in the EIS would be. I expect, as I said, that there will be changes based on comments received on the draft EIS.

Mr. Garcia: Who will police the sanctuary programs?

Mr. LaRoe: The estuarine sanctuary programs will be policed by the states. They are eligible for matching grants to assist them in the policing and management of the sanctuaries. In the marine sanctuary program there are no monies available for administration of the program; we are doing it with borrowed funds. Theoretically, we have the responsibility for policing them; however, we do not wish to get involved in the management of these areas. We do not have the ships, boats, or manpower to do that. In the case of the Monitor Marine Sanctuary, the Coast Guard was willing to provide the policing. In the case of the Pennekamp Coral Reef Marine Sanctuary, it will probably be a mixture with the Coast Guard having the actual arrest powers and the state doing the day-to-day management and enforcement. There is possibly some problem in giving the arrest and enforcement powers to the state; we are having a legal discussion over that.

Canadian Wildlife Service

by

N.G. Perret

Assessments of waterfowl habitat have been carried out in Canada for many years to meet waterfowl research and survey needs. However, they were not made in a uniform or systematic manner and were not carried out in all regions. As a result, we had a fragmentary picture of the extent and value of our waterfowl habitat. It was not until an agricultural program was launched to improve the level of earnings of agricultural enterprises in Canada, that we had the opportunity and funds to piece together the full picture of waterfowl habitat and to examine its relationship to other uses of land.

The agricultural program began with a series of studies across Canada to determine the causes of depressed farm earnings and to recommend methods of improving the situation. It soon became apparent that many factors were involved and that often agricultural activities were being carried out on land not suited for that purpose. The findings demonstrated the need to look at the settled part of Canada and determine the capability of the land to support different kinds of agricultural activities. Also demonstrated by those findings was the need to examine alternative uses of land and to determine the capability of the land to support them. Therefore, it was decided that a multiple resource capability inventory was required and in 1963 the Canada Land Inventory was established.

The Inventory is primarily a systematic survey and mapping of approximately 1,000,000 square miles of land. In addition to determining capability of the land for agriculture, forestry, wildlife, recreation and sport fish, information on present land-use, and climatic and socio-economic data were compiled and mapped. The Inventory was designed to provide data in a useable form for land-use planning at the regional, provincial and federal levels. It was undertaken as a cooperative program involving federal and provincial government agencies, universities and private organizations. The program was organized, coordinated and paid for by the federal government under the Agricultural Rehabilitation and Development Act of 1961.

A critical part of the Canada Land Inventory was the development of a geographic information system. It provides for storage of all land inventory data, present land-use and climatological data and various kinds of social, economic and political data on the human population. The computer system was designed to accept normal input data as well as area, line or point data from maps of various scales. Once entered into the computer the data may be grouped, compared or analyzed on a geographical or numerical basis. The output from the computer may be in map or numerical form.

The agricultural inventory commenced first because capability could be determined in many areas of Canada from existing soil and climatic data. While that work was going on experts in the other sectors were devising methods of categorizing land capability in their fields. In the wildlife sector we attempted to develop a classification system that would include all species of wildlife. We soon realized that it was not feasible and the wildlife sector was then restricted to two main groups of species common to almost all regions of Canada. They are ungulates, which are the responsibility of the provincial governments, and waterfowl, which by treaty are the responsibility of the federal government. The classification system used was the same for both groups with slight modifications because of different environmental requirements.

It may be well at this time to define the word "capability" since it underlies the classification used in all sectors of the Inventory. Capability is the inherent potential of land to produce a sustained yield of a specific crop or group of crops. It infers good management practices that are feasible and practical within the framework of present day technology and economics.

Capability is expressed in a seven-class system running from 1 for lands with high capability to 7 for lands with low capability. All environmental factors are considered when a capability class is assigned to a unit of land. The class boundary is determined by physical characteristics of the land and the class level by the degree of limitation and, to a lesser extent, by the kind of limitation that affects the land unit.

Land capability for waterfowl was similarly rated in 7 classes but because of the migratory habits of waterfowl, four special classes were added to indicate those areas which are important during migratory periods. Three of the special classes indicate areas suited to production but also used for resting during migration, and one, special class (3M), signifies wetlands unsuitable for production but important during migration.

With the exception of Class 1 and special Class 3M, the classes were divided into subclasses according to the nature of the limitations that determined the class level. The following subclasses were used to denote significant limiting factors that may affect either the waterfowl or the ability of the land to produce suitable habitat conditions.

A - Aridity - The limitation is an arid condition of the land, or susceptibility of the land to periodic droughts resulting in low water levels or premature drying of marshes during breeding or brood raising seasons.

B - Free-flowing water - The limitation is usually due to fast or excess water flow which inhibits development of marsh habitat along stream edges. It may be due also to a lack of flow through low-lying land which may result in poor quality habitat.

C - Climate - The limitation is a combination of adverse climatic factors which act to reduce favourable habitat or the production and survival of waterfowl.

F - Fertility - The limitation indicates insufficient nutrients in the soil and water for optimum plant growth.

G - Land Form - The limitation is poor distribution or interspersion of marshes or basins and uplands needed for optimum production of waterfowl.

I - Inundation - The limiting factor is excess water level fluctuation, or tidal action, which adversely affects habitat or the nesting success of waterfowl.

J - Reduced Marsh edge - The limitation is the absence of or degree of development of marsh conditions along the edge of water areas.

M - Soil Moisture - The limitation is poor water holding capacity of the soils which adversely affects the formation and permanency of water areas.

N - Adverse soil and water characteristics - The limitation may be due to excessive salinity, alkalinity, acidity, a lack of essential trace elements, or an abundance of toxic elements which affects the development of plant and animal communities essential for waterfowl production.

R - Soil depth - The limitation is the restriction of the rooting zone by bedrock or other impervious layers which affects the development of plant communities.

T - Adverse Topography - The limitation is the steepness or flatness of the land which may affect the development or permanency of wetlands.

Z - Water Depth - The limitation is excessively deep or shallow water which affects development of waterfowl habitat.

In the waterfowl classification the term "land" refers to both land and water. The unit of classification may be a land unit with its component wetlands forming a complex, or it may be an individual marsh or wetland if its size or importance warrants separation from the surrounding land, or if it has a different capability from the surrounding land. Thus the waterfowl inventory is not a wetlands inventory as such, but an assessment of the capability of land. The capability class, with its associated subclasses is an expression of the environmental factors that control the numbers of waterfowl a unit of land can produce or support.

Land capability information was collected from a variety of sources, the most important of which were aerial photographs, soil surveys, surficial geology reports and maps, national waterfowl population surveys and ground reconnaissances. Data were gathered and assessed, class boundaries were drawn on 1:50,000 scale topographic maps and a preliminary classification was assigned to each land unit. A field reconnaissance of the map area was then carried out and class boundaries and classifications were confirmed or changed. The map was revised and submitted to the Geo-information sector of the Inventory for processing and storage in a computer.

The detailed 1:50,000 scale maps were reduced and consolidated on a 1:250,000 scale map. On those maps, areas that were too small to be shown as separate land units were combined with others and a "complexed" symbol was used to indicate the association of habitat units. Maps for each sector are being published in colour at that scale for sale at a nominal cost. They are very popular with the public as well as planners and senior officials of government concerned with broad land planning.

After the popularity and usefulness of the 1:250,000 scale maps was well established it was decided that for educational purposes and for decision making at the highest level, slightly simplified maps at the scale of 1:1,000,000 would be published for each sector. Those maps, each covering a province, are now being published in colour and are being made available to administrators and the public.

Is the waterfowl capability classification valid and are the data that were collected and assessed the best data to use in determining capability? How is the inventory being used now and how will it be used in the future? Those are some of the questions usually asked whenever the waterfowl capability inventory is discussed. Therefore, I would like to address myself to them for the time remaining to me.

Those of us that were involved in waterfowl capability inventory are convinced that the classification system is valid and is excellent for the purpose for which it was designed. Initially not everyone agreed with us mainly because the classification was so closely associated with soils, landforms and other physical features of the land and we were criticized for not determining use by waterfowl before assigning a class and subclasses to a unit of land. However that resistance has diminished considerably and more and more waterfowl biologists and research scientists are now using the classification system and capability maps in their programs.

A few studies have been undertaken to determine the validity of the waterfowl capability inventory. One study carried out in the Prairie Provinces is of particular interest. In that study waterfowl breeding pair and brood counts obtained in the national waterfowl surveys were tabulated and compared by capability class. The data showed conclusively that there was a significant difference in the numbers of breeding pairs and broods per square mile between the capability classes. The results of that study were very encouraging because in at least one major waterfowl producing area, the classification system and the way it was applied was reflected in waterfowl use. We think that the inventory was carried out equally as well in most of the other regions of Canada but if we find errors or misjudgments in classification, the mechanism exists for correcting or updating the data.

The waterfowl capability data and maps have been used extensively by the Canadian Wildlife Service in planning for waterfowl research and development. The habitat acquisition and development program, for example, depends very heavily on the inventory maps for establishing priorities and providing the justification necessary to obtain funds for acquisition and development of important wetlands. Waterfowl capability maps at the 1:1,000,000 scale are used to make policy decisions and to plan overall programs for a particular province. The 1:250,000 maps provide an overview of large areas in which important waterfowl habitat can be readily identified. The 1:50,000 scale maps may then be drawn upon for the detailed information. Maps of that larger scale are used to compare the value of particular wetlands for other uses such as agriculture and determine if the best use for those lands is waterfowl. From these analyses we are able to plan for an orderly program of wetland management.

We have been involved, as members of interdisciplinary teams, in the analysis of land capability for specific regions of Canada. The process is one of overlaying capability maps of the various sectors and determining the best or primary use of the land. All sectors are given equal weight and the sector with the highest class rating is considered the best or most suitable user of the land. When an area has two or more equal capabilities other criteria are introduced to determine best use. The results, published as a coloured map at a scale of 1:250,000, is not a plan for land uses, but an indicator of feasible capability patterns based on a comparison of physical data. It provides a quick visual reference to land capabilities in a region for broad land resource planning. The land capability analysis maps are important to us not only because we contributed to their production but also because they show waterfowl as a legitimate user of land equal to agriculture, forestry and recreation.

A research and mapping project now underway will identify those lands across Canada which are considered critical for such uses as agriculture, waterfowl, other wildlife, forestry, recreation, urban growth and energy production. The emphasis is on lands which are most productive, have the highest capability, or are most endangered. The study will examine the interrelated nature of land uses and conflicts. The product, which we hope will be available late next year, will be a multi-scale, extensively annotated map-folio publication, tentatively entitled, "Canada's Critical Lands."

The completion of input to the geographic information system of the land capability and land-use data collected through the Canada Land Inventory is now in sight. We will soon be able to direct a much greater effort than in the past to the kinds of analyses for which the system was designed. We will be able to examine more closely the impacts of social and economic trends and of government policies and programs on the waterfowl resource and plan for its protection and continued existence. Thus the Canada Land Inventory has been an important program for waterfowl management in Canada and its importance will increase as waterfowl managers and land-use planners learn to use land capability data more effectively.

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Discussion

Mr. Cowardin: Nolan, I have one question. Not on Adams and Soltai--perhaps that is not the classification for all of Canada--but the paper that Zoltai and others published in 1975 based upon the 1973 Forest Soils meeting. In that paper it is stated that it is the classification system for Canada and that the system was designed to tie into the Canada Land Use Inventory. I visualized it as being similar to the relationship between the United States soil taxonomy and the soil capability classification; the soil capability classification being similar to your land use classification. Could you comment on that?

Mr. Perret: The paper you are talking about was really another version of the Adams and Zoltai paper. It still refers to the biophysical inventory which has not been conducted, and which is not likely to be conducted. We just can't get the money for it. We think it is a good idea to do a biophysical inventory, but we have not been able to get it through.

The subcommittee of the National Committee on Forest Land establishing in 1970 was not given a mandate to prepare a classification of wetlands of Canada. The purpose of the committee was to resolve the forester's problem of how to put a line through a lake or around a lake.

Mr. Heinselman: (University of Minnesota): I was remotely connected with that effort. I first heard about it back in 1971, but I never had a chance to follow up on it. I am wondering if it really was the same effort. I was contacted about an effort by Zoltai, Staneck and others to focus on the classification of organic terrain. I guess that is a little narrower than wetlands; it is really peatlands. Is this the same thing that ultimately led to the Adams and Zoltai paper?

Mr. Perret: Yes, it is. It was to classify the forest regions which were primarily the organic soils.

Mr. Heinselman: Incidentally, I have not seen the final products, but I have seen some preliminary portions of it. Are you satisfied with the classification as it stands for organic terrain, or what we could call peatland?

Mr. Perret: I think so. We had nothing against it. As waterfowl managers it doesn't really serve our purposes, because we really don't care whether a goose is on a fen-bog or a bog-fen. The fact that the goose is there and breeding is more important to us than what it is actually sitting on, or what it is using.

Mr. Mavery: (University of Maryland): Did I understand you to say that important waterfowl areas were not the same as important agricultural areas? I thought the pothole area was heavily farmed.

Mr. Perret: I will change that. I didn't really mean to give that impression. Take the Minnedosa country for example. It is classified as Class II for agriculture, 40 per cent of it with a slight limitation due to water. Sixty percent of the area was Class II and 40 percent was Class VI because of water. Now that is reasonably low in agriculture. The Class VI, or the 40 percent, is actually the waterfowl part. That area for us is primarily Class II; some of it is Class I. So that is an important area for us, and it is an important area for agriculture as well.

One of our problems in the pothole country now is not drainage, but knocking down of the habitat on the uplands. Now, if they don't drain any more wetlands, but continue to remove all of the upland cover, the area will not produce a duck. So we have to look at more than just water; the uplands are a very important part of the wetland picture.

Mr. Garcia: Again, you promote a classification system based on the utility to waterfowl. In this survey I think we have a number of users that have interests other than waterfowl. Couldn't we have more than one classification system and have them overlap?

Mr. Perret: Yes, we could. We are biased, because ours was for waterfowl. Some Provinces actually classified everything for all of the game species within the Province. Surprisingly enough, because physical features were the basis for the lines that we drew on maps, the boundaries didn't change significantly when you went from ungulates to Ruffed Grouse.

SESSION B. STATE AGENCIES AND PRIVATE ORGANIZATIONS

Overview of State Sponsored Wetland Programs

by

Jon Kusler and Barbara Bedford
University of Wisconsin, Madison

The following tentative conclusions are derived from a survey of definition, data-gathering and implementation phases of state wetland programs. (See attached table). The survey is part of a broader investigation of state "critical area" programs (including wetlands, flood plains, coastal areas, shoreland, etc.) now underway by the University of Wisconsin Institute for Environmental Studies with funds from the University of Wisconsin Sea Grant program and the National Science Foundation.

Conclusions Concerning State Programs

1. Classification and data-gathering efforts of state wetlands programs have usually been "implementation-tool" oriented and designed to facilitate wetland protection through land use regulation or acquisition. Wetland acquisition has traditionally been a component of broader fish and wildlife, park protection, park acquisition and open space protection programs at state and local levels and at least six states have adopted statutes specifically oriented to wetland acquisition. The use of land use regulations for wetland protection has been recently stressed through the adoption of thirteen coastal and five state inland regulatory programs specifically directed to wetlands. In addition, wetland protection has become a component of broader state and local

shoreland zoning efforts in at least five states, flood plain regulation programs in several states, special coastal zone regulatory programs in at least seven states, and comprehensive "critical area" regulatory efforts in Florida.

2. Statutes establishing state wetland programs have not, in most instances, mandated sophisticated classification systems or data-gathering efforts. Most statutes only use single word descriptions for the types of areas (swamps, etc.) subject to state programs; but some regulatory statutes more specifically define wetlands based upon characteristic vegetation types, high water elevations (coastal programs) or soils (the Connecticut program). Only Maryland, Rhode Island, Connecticut, Massachusetts and New York establish detailed data-gathering requirements including the large scale mapping of wetlands. Only Virginia requires the state agency to develop more specific classifications.

3. State programs have also not, with exceptions such as New York and Maryland, developed detailed classification systems during administrative phases of programs and there is some question whether detailed classifications based purely upon resource characteristics are the most pressing need. Most classification approaches have been rather simplistic and have stressed biological, topographic and hydrological factors. But implementation-oriented programs have also implicitly or explicitly considered existing uses, land ownership, development pressures, sensitivity and land values in assigning data-gathering priorities, establishing use standards, and undertaking acquisition. In other words, broader social and economic considerations have often been considered a

primary concern in attempts to analyze and designate wetlands. Data-gathering efforts for definition purposes have usually been undertaken on a priority basis for areas with special values or development pressures. Data-gathering efforts have been based primarily upon air photos with field checks, and have, with little exception, involved the preparation of maps at a scale of 1/24,000 or larger.

4. Political, legal and administrative (as opposed to purely scientific) considerations have played major roles in existing classification and data-gathering efforts. Although identification of wetland species is important for scientific and educational purposes, regulatory data-gathering programs have often stressed flood hazards in wetlands, relation of wetlands to flood storage, function of wetlands to pollution control, soils limitations for structures and on-site waste disposal and other parameters related to health and safety. Health and safety considerations are often more politically and legally palatable than ecological arguments, particularly where tight regulations essentially prohibit private use of land. For regulatory purposes, wetland mapping at a scale of 1/24,000 is generally considered essential (particularly for inland areas) to provide certain boundary lines. Methods for defining the high water mark are required for efforts emphasizing the mark as a wetland boundary. Detailed wetland evaluation and data-gathering for environmental impact analysis and evaluation of individual development proposals are often considered the most crucial phases of analysis and data-gathering and the weakest link in existing programs. High resolution air photos, topographic maps, and field investigations are often considered essential to investigate the impact of particular proposed uses within or adjacent to wetlands. Time series photos are considered useful

for monitoring and enforcement of programs.

Recommendations for a Federal Data Classification System/Data Gathering Effort

1. A Federal effort should address (to the extent possible) all phases of State wetland program formulation and implementation and should not be limited to assistance in initial, broadscale mapping of areas based upon biological, hydrological and topographic factors. Regulatory and acquisition needs should be stressed since virtually all programs look to these techniques for implementation.

2. A hierarchy of classification systems and data-gathering efforts is needed to respond to varied needs. The present proposed Federal classification system related primarily to resource parameters may suffice at the highest level, but other classification schemes related to existing State statutes and programs, land ownership, sensitivity, existing uses, and State preferences will be required at lower levels. Analytical approaches emphasizing wetland function, and identifying areas in need of immediate protection should be stressed.

Similarly, a generalized national inventory of wetlands at relatively large map scale may suffice for certain national policy-setting and planning, but more detailed maps and photos (e.g., 1/24,000 and larger) are essential for regulatory definition, administration, and enforcement. In addition, the utility of mapping the country as a whole at one scale is highly questionable since the topography, diversity in wetland types, and development pressures are highly varied (e.g., Arizona vs. Rhode Island). Statistical sampling techniques might be more economically used to provide statewide or regional wetland profiles than generalized, blanket data-gathering.

3. Assuming that the federal government cannot undertake detailed classification and wetland mapping for the country as a whole, priority areas (such as wetlands of national significance and wetlands in urbanizing areas) should be mapped at large scale and the federal government should (1) prepare "how to do it" guidebooks and manuals to assist states in more detailed wetland analysis classification and mapping (for regulatory and acquisition purposes); (2) disseminate to the states high resolution air photos, (perhaps) color/color infra red with seasonal coverage (for at least one year) and periodic updating to facilitate wetland analysis, permit-processing and enforcement; (3) provide grants-in-aid to assist State efforts; and (4) establish workshops and training sessions to train state and local personnel in field surveys and air photo interpretation for more detailed wetland analysis, E.I.S. analysis, and program administration.

4. Finally, a national wetland data-gathering effort should address the broader political and educational aspects of wetland management through the preparation and widespread dissemination of: (a) films, (b) reports, (c) books and other materials which describe and illustrate wetlands values and limitations including the diversity and beauty of wetlands. Such "sensitizing" materials are now essentially lacking and could provide important legislative, citizen and landowner support for the adoption and implementation of programs.

TABLE I

PROFILE OF SELECTED STATE WETLAND REGULATORY AND ACQUISITION PROGRAMS *

CODE

CW = Coastal Wetland Act
IW = Inland Wetland Act
CZ = Coastal Zone Act with Wetland Language
S = Shoreland Zoning Act (Lake & Stream Shore)
P = Regulatory Permit System
O = Regulatory Order System
A = Statutory Acquisition Program

STATE	NATURE OF PROGRAM					IMPLEMENTATION				CLASSIFICATION							DATA GATHERING IN DEFINITION PHASE			COMMENT
	CW	IW	CZ	S	Other	P	O	A	Other	Simple Description/ Physical Feature	Tidal Action/Water	Vegetation Species List	Physical Measurement	Elevation	Political/Cultural Boundaries	Soils	Data Required**	Data Source***	Scale if Applicable***	
Alabama			X			X				X							Identification of boundaries, inventory,& evaluation	Air photos	Specifics undecided	
Ark.				Natural area				X		X							Maintain a registry or inventory	Field survey		
Calif.			X			X					X		X				Map delineating boundaries by regions			
S.F. Bay	X					X				X	X		X	X						
Conn.	X	X				X		X		X CW	X CW	X CW		X CW		X IW	Inventory & show boundaries	Field survey (c) Soils maps (I)	1"=200' (C) 1"=132' (I)	
Del.			X												X					
Florida			X		Aquatic Preserves	X		X		X										
Georgia	X					X					X	X		X		X	Only enforcement inspections	Field survey & frequent air photos for enforcement	Varied	
Louis.			X		Study Plan															
Maine	X			X		X	X			X (Criteria recently amended)	X						None specified	Air photos (B&W) & field survey	1"=2 mi, or 1"=1340'	Inventory by Dept. of Inland Fish & Game
Maryland	X					X	X			State & private wetlands distinguished	X	X					Inventory & delineate boundaries	Air photos & field survey	1"=200' 1:24,000	New inventory will classify by vegetation type & rank as to relative value
Mass.	X	X				X	X	X Cons Com.		X	X	X	X				None specified except for Cons. Comm. Inventory	Air photos & field survey	Varied. 1"=600' 1"=200'	Some cities & towns have undertaken their own delineation
Mich.				X	Zone plan								X				Study, inventory marshes, environmental areas			Program not yet in force because of lack of funds and staff
Minn.				X	Zone plan			X Wild life lands					X				None specified			Field surveys in connection w/ designation of public waters plus many studies by F&WS
Miss.	X					X				X	X	X Not specified but used		X Not specified but used			Evaluate and show distribution	Color IR photos	?	One inventory complete; another under contract w/ Geol. Survey underway
N.H.	X	X				X				X	X	X		X			None specified by act	Air photos (B&W) Field survey for regulation		
N.J.	X					X	X			X	X	X		X			Inventory & map. Define boundaries	Color IR air photos	1"=200'	
N.Y.	X	X				X	X?	X		X	X	X					Inventory & set boundaries	Air photos	1"=200' (coastal) 1:24,000 (inland)	Different inventory for coastal & freshwater wetlands. Freshwater data gathering effort unique
N.C.	X		X			X	X			X	X	X						Low-level air photos used for enforcement		Inventory underway in cooperation w/ Geol. Survey. Testing several wetlands
Oregon	X	X?	X															Air photos (B&W & color) & field survey	1"=1000'	
R.I.	X	X				X				X	X	X	X	X		X	Designate coastal wetlands	Air photos & field survey	1:12,000 & 1:6,000	Study of guidelines & evaluation ongoing
Texas			X								X				X		Inventory, mark boundaries			
VA	X					X					X	X		X	X		Inventory & evaluate	Field survey	1:24,000	For evaluative purposes the wetlands were broken into 12 veg. types and ranked by functions and values
Wash.				X						X			X				Inventory	Air photos field survey	Varied 1:12,000 1:24,000	
Wisc.				X									X					Field survey		

* Prepared by Barbara Bedford
** Statutory Requirement
*** Implementation Phases

Wetlands Activities in New York State and Their Relation to a National Wetlands Inventory

by

Herbert Doig*

Wetlands are in the forefront of environmental concerns which have been identified by the New York State Department of Environmental Conservation. Our current involvement has been built upon a long history of programs conducted by the Bureau of Wildlife aimed at wetlands protection, preservation and research.

Current Wetland Program

Over 30,000 acres of high quality wetland habitat have been purchased by the State and placed under the administrative control of the Bureau of Wildlife. The Bureau is charged with the proper maintenance and management of these wetlands, and valuable wetland and waterfowl research has been conducted on these areas. The areas are open to many forms of public use. They furnish recreational opportunities for many thousands of waterfowl hunters during the fall.

We are presently acquiring 30,000 additional acres of the best freshwater wetlands habitat in the State using $5 million supplied by the 1972 Environmental Quality Bond Act and supplemented by Pittman-Robertson and Bureau of Outdoor Recreation funds. We are also purchasing up to 5,000 acres of tidal wetlands on Long Island with an appropriation of $18 million from the 1972 Bond Act. The present policy of the Bureau of Wildlife is to protect by public ownership or effective land use restriction all major remaining wetland complexes in order to preserve these critical habitats for their wildlife and other associated values.

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* Paper presented by Porter B. Reed, Jr. and Eric Fried

Four million dollars was set aside in the 1972 Bond Act for wetland restoration and enhancement. Projects have been started on both municipal and state-owned wetlands.

For many years, wetlands associated with navigable waters (except those on Long Island) have had some protection under our Stream Protection Law. Legislative protection was given to marine wetlands by the passage of the Tidal Wetlands Act of 1973, which provided for a tidal wetlands inventory, a moratorium on alteration during the inventory period, and regulation of future activities on tidal wetlands. A Freshwater Wetlands Act recently has been passed by both houses of the New York State Legislature and will soon be signed into law as part of our Governor's environmental package. The Freshwater Wetlands Act will employ the current wetlands inventory being conducted by the Bureau of Wildlife as its regulatory mechanism. Major provisions of the Act include the protection of all wetlands 12.4 acres and larger; a blanket exemption from regulation for agricultural practices; a moratorium on development in protected wetlands while the Department completes the official freshwater wetlands maps and devises suitable rules and regulations for the establishment of a permit system and land use controls; and a method for giving the first round of regulatory powers over wetlands to local governments, subject to review and guidelines by the Department of Environmental Conservation.

Future Wetland Inventory Needs

One need we in New York must address is to update our current inventory. The statewide freshwater wetlands inventory which we are now conducting is based upon aerial photography taken in 1968. A second inventory will give us a means of determining the amount and rate at which wetlands have been lost in the interval between the two inventories and will document the specific activities which contributed to this loss. The proposed national wetlands inventory could meet this need if it is completed soon enough and the data collection system is comparable with New York's wetlands inventory data (although it may not be realistic to hope for comparability). Data on wetlands extinction rates and causes, for instance, would be used to determine the significance of the exemption of agricultural practices from regulation in our Freshwater Wetlands Act. Comparative data from the two inventories would also give us information on the types and locations of wetlands most vulnerable to destructive activities. This information would help the Department to more accurately frame land use controls to protect highly vulnerable wetlands or to protectively zone areas where valuable wetlands have been lost in large numbers or at a rapid rate.

A revised national wetlands classification, consisting of precisely defined subdivisions, also will be useful to the authors of environmental impact statements and to land use planners as a source of background material and in the justification of generalized ecological position statements.

Current Wetland Inventory

The Bureau of Wildlife is currently conducting an inventory of all the freshwater wetlands of New York State down to one-half acre in size. A description of the inventory is given by Fried (1973). This inventory is anticipated to be completed by January 1, 1978, if funding levels remain constant. New York State is also conducting by contract to a private firm an inventory of all tidal wetlands in the State down to one acre in size. Harmon (1975) describes the tidal wetlands inventory and its use in implementing the Tidal Wetlands Act of 1973. The tidal wetlands inventory will be completed by the late fall of 1975.

Relation of Wetlands Classification to Inventory

We, in New York, support the attempt to revise the Circular 39 federal wetland classification. A detailed description of the variety of wetlands will be useful in developing an organized approach to wetland concepts, for instance, in ecology classes, in training biologists, and in giving planners and administrators a "feel" for wetlands. We are apprehensive, however, about classification in general and the proposed classification in particular as the basis of a wetlands inventory. We are also concerned about several other aspects of the inventory planning as we understand them. Some of the grounds for our apprehension are as follows:

1. An inventory should rely on measurements, not on classifications.

    (a) The classification proposed requires that measurements be taken, but if the measurements themselves are useful descriptors of wetlands, there is no need for the arbitrary lumping and splitting and willful loss of precision involved in classifying. By relying on classifying, the proposed system does not reflect the fact that wetlands are the intersections of a number of continua-geological, topographical, chemical, hydrological, botanical, etc.

    (b) An inventory based on measurement will be more flexible than one relying on classification. All future uses, foreseen and unforeseen, of an inventory based on a predetermined classification will be constrained within the particular scheme used. But if we have the measurements, we can at any time evolve any classification we desire to fit any particular need.

(c) A resource inventory must be keyed to a rigorous objective measurement of characteristics amenable to remote sensing materials and techniques. Objective measurements employed in the data gathering phase will impart a standardization to the entire inventory. This is an especially important consideration when a nationwide resource inventory is contemplated.

2. The purposes of an inventory will define the desired products. The desired products will define (within financial capacities) the methods, including the classification, if any, to be used. Unfortunately, the material presented to date has not identified the purposes of the national inventory.

3. Information should be organized and suitable for analysis by automatic data processing methods. The computerized analysis of resource inventory data further places a condition on the inventory that all data relating to location, lineal and aerial measurements, and other characteristics be recorded in an organized, numeric fashion.

4. Classification designed for an inventory must be tied to remote sensing capabilities if it is to be more than a theoretical exercise. Statements are made in the remote sensing portions of the class descriptions (especially wet meadow, swamp, and

fen) to the effect that these classes are either difficult to detect by tested remote sensing techniques or inseparable from other proposed classes.

Incidentally, we ourselves have had problems with the identification by remote sensing techniques of the bog class (one of the few instances in which we attempted to go from covertypes to a wetland "class"). A bog is typically composed of three vegetative types--a herbaceous sedge mat, a low ericaceous shrub component, and a higher coniferous tree zone. The major problem from a remote sensor's viewpoint is that the sedge mat is in many cases indistinquishable from the fen and wet meadow images and the shrub and tree components are visually identical to other images placed in the swamp class.

5. The proposed system implies that a wetland is a disjointed entity usually composed of only one wetland class. This concept might apply to smaller (one acre) wetlands having uniform topographic features, water regime, and soil characteristics, but larger wetland systems for the most part do not follow this rule and are often composed of several wetland "classes."

6. The classification proliferates terminology that will be cumbersome at best to the biologist and meaningless to everyone else. The analogy to biological taxonomy--which is based on genetic relationships--is misleading.

7. The system is unnecessarily apologetic about the use of vegetation to define wetlands. There is nothing wrong with the notion that "an aquatic plant is a plant that is in my book."

Recognizing that wetlands are one segment in a continuum between deep water and dry land, and that despite this a definition of wetlands is necessary, setting the outer (wet and dry) limits of wetlands will be arbitrary. Composing the list of plants that will define wetlands is the process by which those arbitrary limits are set. The job is a descriptive one, not an exercise in abstract logic.

We recommend using vegetative covertypes, according to the most refined distinctions that can be made with available techniques, as the best integrater of various factors. Vegetative cover-typing makes no claim to generalized categorization. It is rigorous in that it simply records what is visible from the air at the finest level of distinction feasible. Covertyping can then be used for classification if and when that is needed.

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Discussion

Mr. Montanari: Mr. Reed, I have one comment. You said you are using black and white 1:24,000 photography and you are mapping on 7-1/2 minute quad sheets down to one-half acre. At a scale of 1:100,000, the dot delineating 5 acres is probably the same size as your half-acre dot at the 1:24,000 scale.

Mr. Reed: It is essentially the smallest area that we can delineate on a 1:24,000 U.S. G.S. topographic quad and still have something within the circle. It was established as a practical size limitation. Let me say one more thing. I have had a number of people, especially legislators, come to me and ask why we are mapping down to the half-acre size. The thing that I feel I have to get across to them is that really, all of us, especially in the acquisition and management kinds of agencies, tend to believe that bigger areas are easier to administer, bigness and goodness are often combined. In New York State we feel, especially with the kinds of uses we have in mind for this inventory, that small wetlands may in the total complex be as, or more, important than the larger wetlands.

I think that is what Nolan was getting at with regard to the pothole areas. These types of areas must be identified and taken into consideration. If we just do a blanket kind of an inventory and identify all wetlands, 10 acres and greater, I really wonder if we are serving and carrying out the mandate to protect and preserve wetlands.

Unidentified Participant: What resources and manpower were you able to draw on in conducting your surveys? Just how did you go about getting the job done?

Mr. Reed: I almost hate to answer that, because it is kind of embarrassing. Essentially, it was a "nickle and dime" operation. We started in 1972 and tried to do it by means of a contract with Cornell University. They have a resource information laboratory and we thought that for as little as $30,000 we could do a one-year study that would give us all the information we needed.

As all inventories go, and I predict the National one will too, ours has sort of grown like topsey. We are now coming to the realization that to do the mapping of the wetlands of New York State down to a half-acre in size will probably require somewhere in the neighborhood of $300,000 and a period of five years. I hope that answers your question.

Unidentified Participant: The $300,000 cannot include the cost of your own personnel though, can it?

Mr. Reed: That includes everything. I think the important point to be recognized is that it doesn't take a lot of money to do a wetlands inventory. Well, $300,000 is a lot of money, but we are not talking about millions of dollars to do a very specific inventory. I think one of the important things to keep in mind with regard to our inventory is the fact that we are going on the basis of only what the air photo interpreters can see. We are not taking into consideration all sorts of other water characteristics. I think that when you do that you immediately are faced with the problem of having to do large scale field checking. That is where you get yourself into tremendous costs.

We know what can be done with the remote sensing techniques we now have, and I would compose the National Wetland Inventory around what we know can be done to obtain the answers to our questions. I think the Inventory will essentially work itself out in the wash after that.

Unidentified Participant: I have been under the impression that they went back and looked at some of the areas they had previously observed and found that there had been a dynamic change in acreage in a given area of wetland and, in some cases, they have more wetland now than they did the first time they looked at it.

Mr. Reed: I don't think this means that new wetlands were created; I think it relates to the precision of the inventory. The one that you are referring to, as the one they went back to, is the 1968 LUNAR inventory. It was a land use and natural resources inventory that was done in New York State around the late sixties using 1968 photography. We chose the 1968 photography because it was the only systematic coverage of the State. This is one of the things that disturbs me about the Fish and Wildlife Service tying itself to the LUDA inventory.

If you look at the classification of wetlands, they are designated as wooded and nonwooded. I am afraid we need more precise definitions and delineations of wetlands than that. This is exactly what happened in the LUNAR inventory. The wetland classification was very generalized, similar to the classification that is being proposed for the LUDA program, and what we are doing is making a much finer interpretation of the photographs. On this basis, you cannot help but get more wetland acreage. A random sampling of our data sheets indicates that wetlands in the State may be 5 percent of the land area. Wetlands compose a lot more of New York State than we had thought, and I suspect that will be the case on a national scale too.

Mr. Kosco: (U.S. Geological Survey): How far down the road in the inventory do you find the U.S.G.S. 1:24,000 scale map can be carried without any additional effort from yourself?

Mr. Reed: I hate to answer that question with Virginia Carter right here; however, I don't think she made those original maps. I think it is a good point, because many people are doing wetland inventories by essentially outlining the marsh symbols, the wooded and open areas as they are indicated on the maps. We tried to find out what the U.S.G.S.

photo interpreters used as their guidelines in identifying marshes and wetlands. We were unable to get a clear-cut answer from them.

We are finding that in most cases there is agreement, at least in basic location, between their marsh symbols and what we draw. What really disturbs me is to see marsh symbols and then our aerial photo interpreters tell me they don't see a wetland there, and field checks indicate that the photo interpreters are right. The disagreement is not due to succession either; the wetland wasn't there initially. I think we are identifying a lot more wetland areas, because we are spending a reasonable amount of time studying the aerial photographs. It takes us about five days to look at 45 photos that make up one 1:24,000 quad. That is what it takes in terms of manpower, and we spend a lot of time at it.

Texas Wetlands -- Classification, Inventory, and Mapping

by

Harold D. Irby

Texas' wealth of wetlands include: extensive shallow estuaries; a variety of coastal marshes and flats; numerous lakes, reservoirs, rivers, and streams; swamps; playa lakes; and seemingly countless farm ponds and stock tanks of various sizes. Accurate ecological information of value to the many wetland users and squads of planners is piecemeal and stored at various locations where retrieval is unwieldy if not impossible. The basic knowledge of what types of wetlands of what sizes at what locations is simply not now known.

The Wildlife Division of the Texas Parks and Wildlife Department has embarked on a program to map the vegetative types of the entire state. The program is directed by Dr. Craig McMahan, Carl Frentress, and Roy Frye, and is augmented by biologists and others in the field traïned in the mapping system. The objective is to produce ground cover type maps compatible with the needs of wildlife management in Texas. This includes long-range planning. By knowing accurately the identity, quality, and location of various wildlife habitats and impinging factors, planners and managers may begin to propose rational alternatives to minimize losses of habitat brought about by industrialization, urbanization, water development projects, and other land uses.

The advent of remote sensing technology has opened new means of classifying and evaluating the environment for natural resource planners and managers. Current trends indicate a rapidly expanding field of remote sensing technology which has application to wildlife management, especially in habitat mapping.

The Texas Parks and Wildlife Department is conducting a comprehensive vegetational type mapping inventory for the entire state utilizing remotely sensed data in digital form obtained from the LANDSAT - 1 (Earth Resources Technology Satellite) and processed through capabilities of computer-assisted analyses. The classification output will be multilevel in that natural areas will be classified more intensively than urban or agricultural areas. The final maps will show detailed plant association patterns and generalized agricultural and urban patterns. Based on wildlife management needs the plant association level (descriptive in floristic-physiognomic terms) should be most practical for application of the classification products. Supportive information previously gathered from other vegetative studies, information provided by district biologists, examination of aerial photography, LANDSAT imagery, and topographic maps will be used to familiarize the analysts with the general floristic and physiognomic characteristics of the expected vegetation.

Every pixel in the scene will be classified to provide the analyst with later options related to varied scale. That is, if every pixel is classified then the scene can be portrayed on the basis of every pixel (approximately 1:24,000 scale), every second pixel (approximately 1:62,000 scale), etc., according to the desires of the analyst or user. This will provide for expected as well as yet unrecognized uses of the classification results. No lengthy results, evaluations or decision-making steps are associated with this. The classification will be stored on magnetic tape rendering these results available for practically unlimited temporal usage.

The final results of the classification process will be checked for accuracy prior to the cartographic conversion. Suspected classification errors will be compared to ground truth information derived from aerial photographs or on-site field inspections and corrected.

The analysis for pattern recognition will be completed and subsequent tasks will deal with cartographic aspects. The computer printout "maps" alone are limited in application. Therefore, the results displayed on the printouts must be rendered into more practical map form. Techniques for producing desirable map products are being explored and tested for operational utility.

Generally, these cartographic approaches involve sophisticated electronically oriented procedures involving computer-controlled display screens that yield colored photographic prints of classified scenes. These methods are under experimentation by the Remote Sensing Center, Texas A&M University and Johnson Space Center, Houston, Texas. Output in the form of colored photographic mosaics from image display screens are unexpected.

The final products will be base maps in 1:126,000 scale with the ground cover classes in color codes. Illustrated narratives of legends will provide descriptive information for each of the classes portrayed. Also, the base maps will contain most of the information present in county highway maps presented in the same scale. This information would include such features as roads, urban areas, stream courses, etc. Inclusion of this information from the highway maps is essential to lending orientation attributes to the base maps.

Tentative physiognomic classes for wetlands are: marsh, brush swamp, parkland swamp, wooded swamp, forested swamp (young and mature), water, spoil, dunes, and other.

Up to now only ranch and farmlands have been classified and mapped. Our schedule calls for the lower Texas coastal wetlands to be classified in the near future. I hope that this workshop will have met its challenge of producing an acceptable wetland classification system which we may adopt.

Discussion

Mr. Sullivan Harold, I read that in Galveston County, because of extensive use of ground waters, that a problem of subsidence has been created; maybe up to a foot or more. Is that creating new wetlands?

Mr. Irby: Yes, it is not just in Galveston. It covers quite a large area, and it is making wetlands out of some front lawns near Baytown, Texas.

Mr. Sullivan: Is that directly traced to the use of ground water for irrigation and domestic water?

Mr. Irby: There is quite a bit of debate about that, but we are having the subsidence taking place throughout the whole coastal area and it may or may not be attributable to ground water use. Maybe that marsh land just dried up.

One thing I am reminded of here, and I hope we get into this in our sessions tomorrow, is some of the classification terms being used. I notice that it is suggested that we use the term meadow for tidal areas. I would hate to be the first guy to go down to a fur trapper in Southeast Texas and ask him how many rats he is going to take off of his meadow this year. I know that one of the first things that is going to happen is that I am going to land on my little rear end in that soft meadow. Maybe we can put something in quotes--"shallow marsh--or something like that.

The State of Washington

by

David W. Jamison

The State of Washington has for several years been aware of the lack of information on its Wetlands, information which is necessary for sound management decisions. Until recently the State has not had a focal point in law that would direct its attention and resources to filling this data gap. However, with the passage of the Shoreline Management Act in 1971, there came into being a statewide program of land use in the critical area of the land/water interface.

Assisted by federal funding under the Coastal Zone Management Act of 1972, State efforts have expanded dramatically. To date these efforts have been uncoordinated and based on perceptions of the data gaps by a variety of interest groups.

The current research in Washington on Wetlands is shown in Table I.

Baseline Studies Program

The Legislature requested through RCW 43.21A.405-420 that the Department of Ecology establish "a continuing, comprehensive program of systematic baseline studies for the waters of the state" that aid in the maintenance of water quality standards as well as address the specific problems associated with oil contamination of marine ecosystem.

The goals of the program are:

A. Determine the economic value of natural resources, human structures, and human activities that would be damaged by an oil spill.

B. Identify specific areas of the marine waters of Washington that exhibit a high risk of being damaged by an oil spill or oil pollution.

C. Suggest criteria for the siting of oil facilities and oil transport activities that would minimize risk up to the natural resources, human structures, and activities within the state.

The Program objectives which were developed to meet these goals are:

1. Determine the magnitude and location of present and potential oil contamination of the marine waters of Washington.
2. Determine the economic value of man-made structures and man's activities that would be damaged by oil pollution in the marine and estuarine waters of Washington.
3. Determine and list the significant biological resources of the marine and estuarine waters of Washington.
4. Determine the economic value of significant biological resources that would be affected by oil pollution in the marine and estuarine waters of Washington.
5. Determine the types, distribution and abundance of major habitats in the marine and estuarine waters of Washington.
6. Document the distribution and abundance of biological resources and relevant oceanographic parameters in intertidal and shallow subtidal habitats.
7. Determine how and the degree to which the significant biological resources of the marine and estuarine waters of Washington would be affected by oil pollution.

8. Develop the capability of predicting the movement of oil discharged upon the water surface.
9. Determine the distribution and abundance of intertidal and shallow subtidal population of significant biological resources that serve as major sources of recruitment for adjacent areas.

This effort has been underway for the past year and a half in Northern Puget Sound. Beginning in January 1976, funds from the MESA program of NOAA will be used to extend the study to the Strait of Juan de Fuca. To date, approximately $900,000 has been committed to this study from both state and federal sources.

Items five and six relate to the distribution of wetland types in the intertidal zone in Northern Puget Sound.

<u>The Grays Harbor Dredging Impact Study</u>

The purpose of the dredging study is to provide decision makers with objective information concerning the following:

1. The sediment dynamics of Grays Harbor and comparable areas.
2. The effects of disturbed sediments upon the significant biological resources and water quality.
3. The effects of altered habitats on the significant biological resources.
4. Alternatives for sediment management in Grays Harbor and comparable areas.

Besides providing activities and site-specific data on dredging in Grays Harbor, the data will be useful with respect to other problems in

Grays Harbor County. In addition the data can be used in assessing the impact of dredging in other areas of Washington.

The Dredging Impact Study focuses in both the negative aspects of dredging such as potential degradation of water quality and the positive aspects such as the creation of spoil islands for enhancement of bird nesting opportunities and general recreational activities.

This study has been underway for the past year and a half and has expended $378,000 provided by the Army Corps of Engineers (Seattle District).

Item three establishes the wetland types of Grays Harbor.

Remote Sensing Project

Several state agencies are participating in a cooperative Land Resources Inventory Demonstration project being funded jointly by NASA, the U.S. Department of the Interior and the Pacific Northwest Regional Commission. The purpose of the program is to show potential users from the state and local agencies in Washington, Oregon, and Idaho the role that LANDSAT earth satellite information is playing in natural resource planning and management. The overall goal of the project is to provide users from a variety of resources planning and management agencies within the three states with the experience in extracting and using information derived primarily from LANDSAT multispectral data and, to a lesser extent, from other remote sensing data sources such as high-altitude aircraft. Office of Community Development is coordinating Washington state agency participation in the project. Two key participants are Department of Natural Resources and Department of Ecology. DNR is studying the use of LANDSAT technology in relation to its existing geographically referenced information system. DOE is studying the project from the standpoint of the following objectives:

1. an evaluation of inorganic turbidity distribution from local rivers to document surface current patterns in Puget Sound;
2. an evaluation of the ability of LANDSAT to identify beach and shallow water habitat types; and
3. an evaluation of the ability of LANDSAT to locate human construction activities and new construction in the near shore area.

Tidal Marshes of Jefferson County

This study was undertaken by a County with a sizable number of small marshes on saltwater. Their objective was to provide the County with a description of the processes that occur in and because of tidal marshes, and to evaluate the importance of the tidal marshes in the County.

From a review of the literature and field data an analysis on the Counties marshes was made. Formation, physical characteristics, colonization, succession, and productivity were all discussed and illustrated. In addition each marsh was illustrated and described. A matrix for marsh value determination was developed.

The study was completed in June 1975, and is available from the Jefferson County Planning Department.

Wetlands Analysis Study

This study was sponsored by the Department of Ecology under Coastal Zone Management funding. Its purpose is to develop and defend a wetlands definition and classification scheme applicable to Washington Coastal Zone.

Biological, geological, hydrological and legal definitions were helped in arriving at the final definition. Questionnaires and interviews with hundreds of able individuals and interest groups were utilized in finalizing the definition and classification scheme.

Survey of Skagit and Grant County Wetlands

Both projects were funded by the Department of Ecology to update and expand on a test basis the 1954 survey of Wetlands of Washington by the U.S. Fish and Wildlife Service. The objective of the studies is to provide comparative information between years on the status of Washington wetlands by following comparable methods and a classification scheme as used in the 1954 survey. However, new elements were to be incorporated into the study if possible.

The results to date are a detailed classification scheme which expands on the 1954 survey but does not materially alter it. High altitude aerial photography was utilized providing more cost effective data acquisition.

The projects are being done by the University of Washington and Washington State University. Present funding is from the Washington Department of Agriculture and will continue until June of 1976.

Summary

The results of these studies are currently under consideration as a part of a total review of the existing status of data available for making Coastal Zone Management decisions. Further work in the Wetlands of Washington will be based on this review and status of the proposed National Wetlands Survey.

Table 1

Current Wetlands and Studies in Washington

Title:	Oil Baseline Study
Sponsor:	Department of Ecology
Objective:	Inventory habitat types and associated organisms
Status:	Ongoing
Title:	Grays Harbor Dredging Study
Sponsor:	Corps of Engineers
Objective:	Develop data for planning of spoil disposal
Status:	Completed January 1976
Title:	The Tidal Marshes of Jefferson County, Washington
Sponsor:	Jefferson County
Objective:	Describe and map marshes in county
Status:	Completed June 1975
Title:	Survey of Skagit County Wetlands and their value as wildlife habitat
Sponsor:	Department of Ecology
Objective:	Analysis of Skagit County Wetlands
Status:	Phase I completed June 1975
Title:	Pacific N.W. Regional Commission Remote Sensing Demonstration Project
Sponsor:	Pacific N.W. Regional Commission
Objective:	Provide experience to potential remote sensing data users
Status:	Ongoing
Title:	Wetlands Analysis Study
Sponsor:	Department of Ecology
Objective:	Analyze and classify (but not inventory) Washington's wetlands
Status:	Completed January 1976
Title:	Analysis of Grant County Wetlands
Sponsor:	Department of Ecology
Objective:	Analysis of Grant County Wetlands
Status:	Phase I completed June 1975

The Nature Conservancy

by

Robert M. Chipley

Introduction

At the Nature Conservancy, our interest in wetlands inventory is part of our interest in inventories of all ecosystem types. Taking the broadest view, what is endangered is not merely a single class of ecosystems, such as wetlands, but biological diversity itself. We feel that what is needed, therefore, is a comprehensive approach to preserve not only many examples of a single class of ecosystems, but at least a few examples of every ecosystem type. This represents an approach where the qualitative takes priority to the quantitative; thus, rather than saving the tenth example of the tidal creek in Mississippi, we would prefer to concentrate our efforts on saving the first and perhaps only remaining example of the Beech-Magnolia Forest in the state. We wish to avoid the syndrome whereby some habitat types are preserved redundantly while others are not preserved at all. What we are looking for, therefore, are representative examples of wetland types; we leave the job of preserving wetlands in the large to others. In our view, it is better to lose a fraction of the wetlands rather than the last representative of some other important ecosystem type. If we are ever to embark on a program of correcting the gross insults done to the environment, we must have a representative set of ecological materials with which to work. Unless we have been systematic and thorough in our preservation efforts, we will look for these materials in vain.

The Nature Conservancy's Approach

The Nature Conservancy has long been the leading private organization dedicated to the preservation of ecological diversity. Its staff and members have been involved in every significant ecological inventory undertaken in the United States. We have authored a comprehensive study for the Interior Department entitled The Preservation of Natural Diversity: A Survey and Recommendations. We have also actively protected through outright acquisition over 1,300 ecologically significant tracts of land totaling more than 750,000 acres in 48 states, Canada, and The Caribbean. Much of this has been accomplished in cooperation with federal, state, and local governmental bodies. We consider the State Heritage Program to be the next logical step in increasing our collective effectiveness.

The State Heritage Program

If we are truly dedicated to preserving the full array of natural diversity, we must accumulate, organize, and utilize a great deal of ecological and other information, in order to identify the ecologically significant remnant land areas and to allocate the resources necessary for their perpetuation. For this purpose, The Nature Conservancy has developed its State Heritage Program. Through this program, a multidisciplinary task force works cooperatively with state governments, institutions, and the general public in the creation of appropriate inventory and planning processes.

A State Heritage Program is initiated, funded, and implemented by the state government. The Nature Conservancy is prepared to assist at all stages, and normally works with the state under contract during the early stages of designing and setting up the program. By the end of this contract period (normally one year), the state should have at its disposal a continuous process of ecological inventory, data management, and preservation/protection planning for the preservation of ecological diversity.

The Classification System

The first major task of the program is to create a classification system of the elements of diversity which exist in the state. As defined by the program, an element is a natural or cultural feature of particular interest, either because it is unique or endangered within the state or nationally (such as the Red-cockaded Woodpecker), or because it represents an important type (such as the Mixed Mesophytic Forest). The purpose of the classification system is to identify, define, and catalog these elements by class. This structure forms the basis for the orderly gathering of information during the inventory phase of the program.

Initially the classification system will involve a hierarchical ordering of plant communities and aquatic types, and a listing of special species (including those which are endangered, threatened, rare, endemic, peripheral, or otherwise of particular concern and interest). The system may be expanded to include geological, historical, archeological, and other classes of elements. In addition, as further information becomes available, new elements may be added under each class, and some existing elements may be redefined, broadened, or subdivided. The classification system is created with reference to existing national and regional classifications, through searches of the literature, and by consultation with scientists both in and outside the state.

The Inventory Process

The inventory phase of the State Heritage Program involves a set of procedures for generating leads to element occurrences, conducting inventories of these occurrences, and handling the resultant information. Leads will come from the results of other past and current inventories, literature searches, consultation with knowledgeable individuals, and remote sensing.

Each element occurrence will require a certain minimum of information, including verification to type, precise geographic coordinates, ownership, and protection status. As actual field visits to the localities are made, information about quality, disturbance, threat, and the biological and physical components of the element in question is collected. Data-gathering procedures and formats have been designed for each of the different classes of elements, so that standardized and comparable information can be recorded about each occurrence. This will allow the system-user to pick the best and most viable example of the element in which he is interested.

This system of inventory has notable advantages over most past inventories. First, unlike past inventories, which had limited objectives and were of limited duration, the inventory phase of the State Heritage Program is intended to be an ongoing, constantly updated process. Second, this system is element-oriented rather than site-oriented. Since each site is unique in its component elements, an attempt to compare one site with another is an attempt to compare unlike entities. This leads to subjective and to some extent arbitrary scoring methods in ranking these areas. Because of its size and pristine qualities, a site containing several more common community types may outrank a site containing the last damaged remnant of a rare type. The greatest advantage of the element-by-element approach is that it represents a rigorous accounting procedure to ensure not only that the best examples of each element are clearly identifiable, but that no element is overlooked.

Element Data Management Program

The Element Data Management Program has been designed to handle, on an element-by-element basis, the information generated during the inventory process.

The Element Data Management Program is a set of integrated PL/1 routines designed for the construction, management and retrieval of data in an element file data base. It is designed for use on the IBM 360 or 370 series computer and requires a PL/1 F-level compiler. The secondary storage medium will consist primarily of disk as well as tape devices. The element file presently consists of several classes including plant communities, aquatic types, and species of special concern. Within each class a number of different element types, corresponding to units in the classification system, can be incorporated. For example, "Mixed Mesophytic Forest" would be considered an element type, subset of the plant community class. Each element type may in turn presently contain up to 99 mutually independent occurrences. In the cited example, every occurrence of the Mixed Mesophytic Forest would be sequentially stored under the element heading "Mixed Mesophytic Forest."

Actual information retrieved may be as limited or complete as the system-user desires. He may request merely the name of the element and the number of occurrences reported in the inventory. He may request these items plus the county, geographical coordinates, protection status and ownership of each occurrence. Or he may request the entire printout on an occurrence of the element, including information on quality, disturbance, threat, and the entire results of the field visit to the locality. Thus, information is retrieved on the basis of user-supplied need and criteria.

A second capability of the system is to generate computer-plotted maps depicting the spatial arrangement of the data. Latitude and longitude coordinate pairs, the name of the element and other data are punched onto cards and interfaced with a Fortran IV program. This program builds a file suitable for use as input to a CalComp plotter. The plotter will plot single map areas showing point data; line data, such as river boundaries; polygons, such as state boundaries; or any combination of these. Maps may be obtained either on standard plotter paper or on mylar, which may then be overlayed on a data-rich base map.

The Element Data Management Program is a user-oriented, flexible information management system which should be of use to scientists, analysts and policy-makers involved in the study and preservation of the environment.

Analytical Capabilities

The assembled components of the inventory process of the State Heritage Program constitute a simple but powerful system which should have these four analytical capabilities:

1. To determine criticality of element types- the system will be capable of showing the ambient rarity of any given ecological type or component (i.e., those elements with the fewest reported occurrences may be presumed to be rarest in the state landscape). Ambient rarity is an indicator of the relative criticality of individual elements, and as

the information base is enriched, this type of index will become more and more accurate.

2. To determine protection status- the system will also be able to show which of the elements are under-represented in existing protected areas. Combined with the rarity index, this will give an even clearer picture of endangerment and criticality of whole element types.

3. To determine criticality of examples of selected elements- the system will enable us to compare objectively the reported occurrences of a single element, and thus permit the assessment of the relative quality of occurrences of any particular element type. This element-by-element approach allows us to compare "apples to apples," so to speak, which will both simplify the process and make the results far less subjective. This approach will also permit us to apply criteria to real data rather than being forced to use abstract measures and arbitrary rating systems in order to rationalize characteristics of dissimilar areas.

4. To determine criticality of ensembles- the system will then enable us to attack the question of relative significance of whole "sites" by mapping the element occurrences and identifying the existence of multi-element ensembles. An inherent difficulty with sites has been to define appropriate boundary conditions. The Heritage system gets around this problem by combining the natural boundaries of various element occurrences to define proposed legal boundaries for the establishment of selected sites as natural area reserves.

Protection Process

A fundamental product of the Heritage Program is an adequate protection process. Without adequate legal, administrative and financial tools and capabilities, no state can effectively preserve the elements of its natural diversity which other parts of the program are designed to identify and locate. It should be noted that in the process of designing an adequate protection process it will be necessary to generate certain other products for the state. These will primarily serve to assist in delivery of the main protection product, but they may have independent uses since they will supply the state with certain concrete information it may use in a number of ways, depending on its need. Thus, in order to decide on an effective manner of protecting ecologically significant areas, it is necessary to have an intelligent grasp of the full range of mechanisms which might be used and are being used elsewhere to achieve this purpose. The advantages and disadvantages of these mechanisms must also be ascertained so that perspective and background for particular implementation recommendations will be present. Similarly, once a good grasp of possible mechanisms for the protection of ecologically significant land has been achieved, it is necessary to canvass and to evaluate existing mechanisms within the program state.

Examples of proposals which may be made as a result of this process include:

1. Legislative recommendations- the creation of an effective and unambiguous natural area law; a conservation easement law.

2. Administrative recommendations- the creation of a state natural areas system and the form it should take; management criteria; restriction of development in critical conservation areas; more effective use of the zoning power for conservation.

3. Financial recommendations- statutory exemption from real estate and benefit taxes for conservation organizations acquiring ecologically

significant areas; creation of acquisition funds through real estate transfer taxes or other special taxes; changes in the inheritance tax; the passage of special bond issues for acquisition and maintenance of important ecosystems.

Obviously the number and content of the proposals will vary with the individual state, and it cannot be said at the outset which program will be recommended for any state. It is expected that a variety of alternative mechanisms will be proposed and the merits of particular alternatives identified. Some general attempt will be made to take account of political realities in the state, but this will not necessarily be determinative in recommending a protection program which would effectively preserve ecologically significant portions of the state.

Application

The State Heritage Program focuses on maintaining ecological diversity by identifying priorities for ecological preservation. As the process continues, however, and the data system becomes more enriched, the system will serve other uses as well. The comparative methodology by which the relative criticality of various natural lands is identified and documented will be of great utility to land-use planners. By mapping the collected data, we can provide the information which can be used in remote sensing research to find the signatures for particular ecological elements. This would contribute greatly to blanket inventory and simultaneously provide the feedback mechanism to generate further leads to element occurrences. This system has obvious applications to land-use planning, both by identifying areas which could be designated as environmentally critical and by spatially displaying ecological information in relation to other land-use parameters such as agriculture, corridors, and urban districts.

Another application will be in the field of environmental impact assessment, long hindered by a lack of state, regional, or national perspective. The criticality or significance of any individual site (or alterations to the site) cannot be judged by reference to that site alone. If, however, comparable data exists on many sites, systems, or features within the state, one can gain the perspective necessary for estimating the relative significance of any single site. The Heritage system provides the structure and methodology for collecting the standardized data by which such comparisons and evaluations can be made.

The Conservancy's program is not intended to block development, but rather to enable ecological considerations to become a part of the overall process by which land use is determined. Planning at any level should begin with an inventory of natural systems, followed by analyzing needs for open space, recreational amenities, housing, transportation, and so forth. Buildings and roads need not be constructed on fragile natural areas; such structures are "shiftable and replaceable" and can be planned to accommodate and complement the natural landscape. Construction should not be at the expense of obliterating the natural landscape; we must minimize the adverse impact on the environment. By implementing a Heritage Program, the state can gain the information to upgrade its planning processes and thereby balance the equation between natural systems and developmental needs.

Our Classification and Inventory Needs

As remarked in the tentative classification document prepared for this meeting, it may be advisable to defer classification until after inventory or mapping. Unfortunately, the destruction of our environment does not pause while we take all the preliminary steps necessary to come up with the best classification possible. We prefer an interim classification produced at the earliest possible date to a deferred, more polished system. We need a structure with many types already defined, but flexible enough to allow the addition of new types and the modification of old.

Our primary purpose in devising or adopting a classification is not to have the means by which to make generalizations about communities, nor even to study them. Rather, we wish to use a classification system as a checklist for preserving as much biotic diversity as we can. Therefore, our need is for a classification system that will capture the full spectrum of wetland and other ecosystem diversity in well-defined, consistently recognizable units.

Since one of the central goals of our program is to be able to make judgments about the relative quality of ecosystem examples, we, therefore, need an inventory that will not only identify the community to type and delineate its boundaries, but will also supply the data necessary to compare one occurrence of this community type against another occurrence of the same type. This includes information on quality, disturbance, threat, and biotic and physical components. Since we wish to concentrate our efforts on community occurrences not already dedicated to a program of preservation, we must also have information about the ownership and protection status of the areas inventoried.

What we need most is the widespread adoption of standardized techniques and formats so that the results of inventories done by public and private agencies are compatible in the greatest degree possible. We look forward to cooperating with all such agencies and groups in attaining this goal.

Wildlife Management Institute

by

Keith W. Harmon

Introduction

The Wildlife Management Institute appreciates the opportunity to participate in this National Wetland Classification and Inventory Workshop. It is appropriate that a resource as important as wetlands be accorded this attention.

Before commenting on the subject of the workshop, an observation seems essential. Wetland programs have been and are being carried out for one reason--to protect and maintain the broad spectrum of values associated with aquatic areas that are important to people. Increasing numbers of citizens are giving values other than waterfowl consideration. Benefits, such as groundwater recharge, flood water retention, nutrient recycyling, etc., are being recognized more widely. This is essential to help people understand the needs for maintaining important aquatic areas. Actual accomplishments in the field must be advanced through sound wetland classification systems and inventories.

The Institute's comments are not intended to provide details for a national classification system or inventory. Rather, they are conceptual--a base from which this workshop can proceed.

Wetland Inventory

An inventory that is as accurate as technologically feasible is essential. Any planning effort should start with an inventory of the resource base. This has too often not been the case regarding wetlands. Information from an accurate inventory must be available to develop a comprehensive land and water use plan or program. Likewise, wetland inventory data are essential to identify and evaluate alternatives for proposed development projects.

In part, the accuracy and detail of a national wetland inventory will be dictated by manpower and funds. In those cases where wetlands are large and well defined, such as coastal marshes and bottomland hardwoods, the costs per unit of return may be relatively low. In the prairies where marshes average an acre or two in size, the costs may be high. In the first case, satellite or high altitude photography may make the inventory relatively easy. In the second, a biologist counting dots on a USDA aerial photo may be required.

In either case, the inventory needs to be of sufficient detail and accuracy to provide a base to adequately preserve wetlands--legally and financially--in all land and water use programs.

Some speculation relative to the detail needed in a national wetland inventory seems appropriate. Land-use planning legislation has yet to pass in Congress. Although the progress has been disappointing, there is little doubt that land-use planning will come. One concept in land-use is that of critical areas. Here wetlands are a natural candidate. But unless the nation's wetlands have been identified, land-use planning will proceed with that resource given less than adequate attention.

Even in the absence of federal legislation, land-use planning is proceeding on a piece-meal basis. Current federal expenditures are budgeted at three to four billion dollars annually for water resource development. For fiscal year 1975 the Corps requested funds for 217 on-going projects, seven new starts, and planning for an additional 91 projects. Add to this a host of Bureau of Reclamation projects and nearly 2,000 small watershed projects and it becomes obvious that many people are involved in planning to use resources.

Many of these projects involve wetlands. But, too often state and federal fish and wildlife agencies do not participate in the early stages of planning because the wetland base is not known then. As the months--even years--pass while the wetland resource is being inventoried, engineering features become more firmly entrenched in the plan and potential economic windfalls are looked forward to with greater anticipation by local sponsors. Finally, with the inventory in hand, those concerned with wetland protection can only act as adversaries with the resource lost or at best mitigated.

It, therefore, seems evident that a national inventory be of sufficient detail that the data can be used in land- and water-use planning at all levels of government. The degree of refinement may vary by geographical province. Thus, it seems logical to consider the planning units of agencies that have an impact on the wetland resource. This would be watersheds in the case of the SCS, river basins in the case of River Basin Commissions, etc.

Wetland Classification

In developing a classification system or refining one presently being used, the foremost question is, "What is the system suppose to accomplish?" Is it to be used by researchers for detailed study of wetland ecosystems or is it to be used by many others dealing with landowners, sportsmen, legislators, and construction agencies? The answer is obvious. It is these people, collectively, who hold the key to wetland maintenance. The information generated through a national wetland inventory system must be useable long after the inventory has been completed.

This begs the question, "What is needed in the way of a wetland classification system?" First of all, employees of state and federal fish and wildlife agencies, as well as other resource agencies, must be able to apply the system accurately with minimum difficulty. Equally important, it must be understandable to the public--particularly landowners and organizations such as the National Association of Soil Conservation Districts and its 2,000 affiliated county SCD's. In essence, this means a classification system designed to maintain wetlands not especially to conduct detailed research.

There presently exists a nationally applied wetland classification system found in the U.S. Department of the Interior's Circular 39. In existence for over two decades, it is the standard reference.

In anticipation of this workshop, I purposely talked to a number of state and federal field personnel who have experience in the use of Circular 39. These front-line troops have used this system to check thousands of drainage referrals under P.L. 87-732, in continuous contact with other agencies, and in dealing with landowners. Almost without exception, these people state that Circular 39 is an effective and workable tool. It may not be perfect, it may not fit the detailed needs of the research biologist, but it works in the field for maintaining wetlands.

Circular 39 also is established in both law and policy. It is found in the Reuss Amendment, the Referral Law (P.L. 87-732), and the Watershed

Protection Handbook. In these cases, wetland Types 1 through 5 are covered. Of significance, is the SCS's Conservation Planning Memorandum 15 dated 5 May 1975 that deals with wetland Types 1 through 20. Any decision to modify this wetland classification system must be made with full knowledge of its current legal recognition.

Probably more important than the legal aspect is the process of re-education that would be involved in changing classification systems. Progress has been made--slowly--with Circular 39. In recent years, it has become common to hear personnel of construction agencies, soil conservation districts, and, yes, even some landowners refer to Type 3 wetlands. It seems imprudent to set aside such an accomplishment unless absolutely necessary.

One subject to be explored at this workshop is the relationship between wetlands and uplands. Although important in any management scheme, there are inherent pitfalls relative to wetland inventories and classifications. Circular 39 does not deal with this relationship. However, the system developed by Stewart and Kantrud for the prairies does. They emphasize this relationship by designating certain wetlands as tillage ponds. In a semi-arid area any wetland type in any given year could be so classified. Subsequent and pending publications dealing with tillage ponds stress their lack of value to waterfowl. Certain agencies in North Dakota are looking at tillage ponds as trade-off areas in drainage projects. The ingredient missing of course is the potential of that basin when normal water is present.

Circular 39 is helpful because it recognizes the importance of wetland basins and the changes experienced as water levels respond to drought and flood. It forces the classifier to recognize the long range potential of each wetland rather than its status in a given year. This important concept must be retained.

Although Circular 39 is a workable tool in the field, it can no doubt be refined and still retain its legal and policy integrity. For example, the text could better discuss the use of aids, such as topography and basin shape, to help determine what the wetland type would become over the long-haul. It could more clearly emphasize that wetlands are dynamic systems and are subject to change.

In summary: 1) The inventory should be accurate and detailed enough to make significant contributions and impacts in all phases of resource planning at all levels of government and private decision making and 2) the classification system should, above all, be designed for practical use at the field level and be understandable by a wide cross-section of individuals, organizations, and agencies.

Institute of Ecology

by

W. Brian Bedford

Introduction

The adequacy of field research facilities for experimental and manipulative studies and the level of support available for such resources have been focal points of concern for perceptive scientists and federal agency personnel involved with the environmental sciences and closely allied activities. In the fall of 1973, The Institute of Ecology (TIE) began to implement a study that would serve as the basis for recommendations concerning the establishment and support of a comprehensive network of biological resources for ecological research. Deliberations resulted in a grant request to the National Science Foundation for support of the Experimental Ecological Reserves (EER) project, and the study was funded and initiated in June 1974. As with most TIE efforts, the EER project is interinstitutional in nature and involves the direct participation of approximately thirty university and federal ecologists.

The major tasks of the project are:

1. To develop a classification system that will be used to delineate the major natural and modified ecosystems.
2. To develop criteria for and to conduct an analysis of existing research sites to determine their extent, quality and distribution.
3. To evaluate administrative and support requirements for a network of experimental ecological reserves.

The objectives of these tasks are to identify the costs and benefits of such a system and to prepare recommendations regarding its establishment, support and administration. The need for experimental ecological research areas will be examined as well as their current and expected future, long-term use. Current practices will be critically evaluated with a view toward how the effective use of such areas could be better coordinated, and recommendations will be made on the development of the existing field sites and for the staff and support facilities required. This effort will provide the National Science Foundation with a documented estimate of the requirements needed to support and facilitate field research in the United States.

Since the present workshop is directly concerned with classification systems, I will not dwell on the rationale and overall objectives of the EER study but will present an overview of our progress towards the development of a classification system. At present this system is in draft form, and we welcome constructive criticism.

The Classification Task Group was charged with developing a classification of natural and man-modified landscape types encompassing the major ecosystems, including both terrestrial and aquatic components, of the United States, Puerto Rico and the Virgin Islands. The purpose of this classification system is to provide a framework, or universe, of important types of ecosystems against which the adequacy of a proposed system of EERs can be measured. Essentially, it is to be an inventory of types of ecosystems which should be represented by EERs. These reserves are viewed as components of a comprehensive system designed to facilitate ecological research, with the reserves representing protected areas of major ecosystem types and being dedicated to experimental research.

It is planned that the proposed classification, in addition to serving its designed purpose as a tool to identify and describe the components of an EER network, will be reasonably compatible with other familiar, widely used classifications and will have criteria of definition appropriate to the scientific and emperical purposes to which it may be put.

Major Classification Categories

In this classification, the marine coastal ecosystems are treated as a distinct category, although it is recognized that they are inextricably linked with terrestrial ecosystems and that coastal areas, particularly the areas influenced by tidal water regimes, must be both studied and managed as ecological units. Thus, the coastal ecosystem classification, though a separate category, will be treated as interfacing with the regional areas outlined in the terrestrial category bordering a particular coast. The similarity of coastal areas of the Great Lakes to marine coasts suggests that, though neither tidal nor saline, they should be treated in a similar way.

Lakes (other than the Great Lakes), ponds and running waters were also treated as a separate category with the premise that these, or portions of them in the case of extensive river basins, would be treated as units within the context supplied by the classification of terrestrial ecosystems. This seemed suitable because the regional environmental characteristics of the area in which the water body lies would be suggested by the terrestrial classification and the familiar realization of the effect of the watershed on the water bodies occurring within it. This is notably true in the case of running waters where a large fraction of the organic material is derived from external (allocthonous) sources from the surrounding terrestrial ecosystems.

In addition, a category of ecosystems initiated and maintained by man is distinguished with the assumption that the elements of this category could be integrated, like aquatic systems, into its larger regional element. Thus the major classification units are as follows:

Terrestrial Ecosystems - to include areas commonly designated as wet lands; e.g., bogs, marshes and swamps.

Coastal Aquatic Systems

Inland Aquatic Systems

Cultural Ecosystems - human initiated and maintained ecosystems; e.g., pastures, agricultural and urban-industrial areas.

The second level of hierarchy is based on major climatic zones which recognize the influence of climate in the evolution and distribution of these ecosystems in these zones. It was decided to follow Brown & Lowe (1974) in recognizing three climatic zones:

1) Arctic-Boreal; 2) Temperate; 3) Tropical-Subtropical

Since such a distinction is tautological in the case of tundra systems, the arctic-boreal climatic zone subdivision is applied to alpine treeless ecosystems which may occur wherever mountains are high enough. The term tundra is sometimes applied to treeless alpine areas in North America which have varying degrees of floristic and vegetational similarity to the Arctic Tundra. It does not seem appropriate to alpine areas generally (e.g., those of Hawaii) and is here restricted to the Arctic Tundra.

The familiar major vegetation types widely recognized by ecologists provided the third level of classification:

1. Arctic and Alpine Treeless Ecosystems (most familiarly tundra)
2. Forest Ecosystems
3. Woodland Ecosystems
4. Shrubland Ecosystems
5. Herbaceous Ecosystems
6. Desert Ecosystems

These, with the exception of desert, are based on physiognomy (general appearance) of the major component of the vegetation. Desert, which includes diverse physiognomic types of plants, is characterized by relatively sparce vegetative cover, a very considerable fraction (ca. 2/3) of the ground being bare.

The above vegetational classes follow familiar ecological usage and substantially equivalent to the Formation Classes of the system proposed by the UNESCO Committee on Classification and Mapping (cf. Mueller-Dombois and Ellenberg, p. 636) except that Arctic and Alpine Treeless Ecosystems would be incorporated as a subclass of the "Dwarf Scrub and Related Ecosystems" of the UNESCO system. They also are similar to the Formations of Brown and Lowe (1974) except for marsh, which is here incorporated in herbaceous ecosystem. The well-known map of Kuchler (1964), based on a nonhierarchical system, has similar categories but includes desert with shrub ecosystems and does not recognize a woodland category. The term Formation, as used in the UNESCO Classification, seems appropriate to the units recognized here and is used for the third level terrestrial categories.

It may be well to note, parenthetically, that the term ecosystem, as used herein, is applied to areas recognized by vegetation, climate or habitat. In varying degrees, animal components were indicated but the classification proposed does not purport to be based on all components usually recognized as essential to ecosystems. Integration of all such components into this, or any other classification, has yet to be done. It is an essential follow up to the preliminary draft, however, since it is obvious that the presence or absence of animal species will be an important aspect of selecting areas for inclusion in the EER program. In some instances the habits of important animal populations may be decisive in determining the size or nature of the EER (e.g., the caribou and other wide-ranging animals which cross even the large-scale physiognomic unit boundaries recognized in our terrestrial categories).

The terrestrial units recognized in this classification, for the most part, include categories which are representative of those which were characteristic of the region in a state of limited human disturbance as it may be reconstructed from historical records or inference from current ecological study. These natural units represent the integration of organisms and environment over the landscape and over time to produce the complex patterns which ecologists attempt to reduce to systematic order. They are relatively stable entities with self-perpetuating species populations within the polyclimax concept which considers that a variety of factors of the local or regional environment (e.g., climate, physiography, edaphic) operate to maintain a number of relatively stable communities in a region. Within a climatic region, a particular ecosystem may be characteristically stable, for example, on deep well-drained soils. Commonly, a region will be delimited and named by this ecosystem, although the landscape consists of a mosaic of ecosystems which are similarly stable on other sites distinguished by marked departure from the "normal" site conditions due to substrate, topographic or other overriding local habitat conditions.

In many areas, natural disturbance may create extensive areas of vegetation different from the relatively stable ecosystems in an area. These are seral stages which, if they remain free of disturbance for a sufficiently long time, will change toward the most stable ecosystem characteristic of the region and site. The most widespread and important of these have been inserted into the classification in association with the region in which they occur. It is well known that some such communities may occur on disturbed sites in vegetational zones of the same or different physiognomy and in widely different regions; e.g., seral pine forests and aspen or white birch forests. It has not been possible to list all of the seral communities which may appear in an area. In some areas there is still doubt about the nature of succession or the seral status of specific communities which are subject to differing interpretations. In many instances, human disturbance produces substantially the same or similar seral communities as natural disturbance. Relatively stable ecosystems perpetuated by human disturbance (disclimax) are included under the Cultural Ecosystems.

The major Formations recognized for the purposes of this classification may be characterized in the following way:

Arctic and Alpine Treeless Ecosystems

Vegetation of severely cold environments N. of or above treeline. Characterized by slow-growing, low (less than 60 cm on uplands) vegetation of dwarf shrubs, low herbs, lichens, and mosses. Arctic treeless vegetation (tundra) is characterized by permafrost; in alpine ecosystems of temperate and subtropical regions permafrost is absent or rare. Cover varies from sparse to complete.

Forest Ecosystems

Ecosystems dominated by trees normally exceeding 5 m in height and covering enough of the ground surface to create forest conditions, i.e., limited light, restricted growth of intolerant herbs, especially grasses, and accumulation of a predominantly forest litter. Most of the biomass above ground. Tree-form forest grown with straight bolls and narrow crowns. On extreme sites the canopy may be thinned, woodland or even stature dwarfed and form distorted. In these instances some forest species may then appear in the woodland or even shrub category.

Woodland Ecosystem

Ecosystems dominated by trees normally 5 m tall with a relatively open canopy allowing considerable light penetration to maintain a conspicuous grass layer or low shrub layer under the tree canopy. Tree crowns are rounded and branched. These woodlands may overlap with savannahs in which the tree cover is very sparse and the ground story is predominantly grass. Savannahs appear in this classification under grassland.

Shrubland Ecosystem

Ecosystems with the tallest layer of shrubs ca. 0.5-5m tall. Shrubs may be widely scattered with crowns not touching, commonly with a ground layer of grasses and herbs (= shrub steppe) or the shrubs may form a dense cover with overlapping crowns and limited understory (= thicket).

Herbaceous Ecosystem

Vegetation dominated by herbs, especially grasses, or grasslike plants with woody plants nearly absent. These merge with shrubsteppe and savannah. Principally included here are grasslands and savannahs which are extensive regional vegetation types. Also included are wetlands dominated by graminoid species which are physiographically controlled ecosystems.

Desert Ecosystems

Vegetation of arid environments characterized by low shrubs, or small trees in some cases with succulents, which may reach tree size. Vegetative cover of all layers is sparse so that the major impress is given by the substrate.

Cultural Ecosystems

Ecosystems which have been influenced or created by consistent human action are appropriately called cultural. As much of the United States and its territories are in cultural ecosystems, it is important that these be recognized.

Human impacts vary greatly in frequency and intensity and range from those which are similar to or mimic the effect of natural disturbance on the natural ecosystems of an area to those which grossly change the ecosystems and the habitat conditions.

In the present classification, four categories are recognized and treated as subclasses of the natural terrestrial classification.

1. Natural communities which are lightly harvested or used without major modification of the habitat or substantial change in the biota or seral patterns. Human impact is limited to hunting, fishing, or nomadic pastoral use of a native animal exploiting the natural primary and secondary production base of the region. Little change if human activity is removed.
2. Seminatural or man-modified ecosystems, in which the natural ecosystems including seral stages are manipulated for continued or enhanced production of the primary production base of the region. Such use of ecosystems does not modify the substrate (e.g., cultivation, drainage) but may introduce substantial changes in fauna (e.g., elimination of predators), introduction of exotics (e.g., cattle). Continued use may maintain a relatively stable ecosystem (disclimax) substantially different from the natural ecosystem of indigenous organisms.
3. Artificial ecosystems which are initiated and maintained through multiple generations of the exploited organisms only by human actions and which involve some manipulation of the substrate for their initiation and maintenance (e.g., drainage, cultivation, fertilization).
4. Urban-industrial areas. Areas in which the natural or biological production base has been substantially eliminated by human action and the area is substantially dominated by human artifact (e.g., roads, buildings or other gross effects substantially modifying the habitat).

The following outlines present:

Appendix i. An Overview of the First Three Levels of the Terrestrial Classification System.

Appendix ii. A Complete Outline for the Northern Boreal Forest Formation.

Appendix iii. An Example of the Narrative that Supplements the Outline.

The complete classification, including aquatic ecosystems, has been similarly constructed (although the level of detail varies somewhat). However, space does not permit a complete presentation here. As previously mentioned, this classification is still in the developmental stages. Problems to be resolved center around the acceptance of a uniform and logical hierarchy, if indeed one exists, the integration of aquatic systems, and the determination of the level of resolution that will be required to insure the utility of the system to the EER project.

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Appendix i

An Overview of the First Three Levels of the Terrestrial Classification

Arctic Tundra and Alpine Treeless Ecosystems

- Arctic
  - High arctic
  - Low arctic
- Alpine
  - Arctic-boreal alpine tundra
  - Temperate alpine (true alpine)
  - Tropical and subtropical alpine
- Arctic and Alpine Timberline
  - Forest-tundra ecotone
  - Forest-alpine ecotone
  - Miscellaneous types

Forest Ecosystems

- Boreal
  - Needle-leaved evergreen conifer
- Temperate
  - Needle-leaved evergreen conifer
  - Broad-leaved deciduous
  - Broad-leaved evergreen
- Tropical and Subtropical
  - Broad-leaved evergreen
  - Broad-leaved semi-deciduous

Woodland Ecosystem

- Boreal
  - Arctic timberlines
- Temperate
  - Needle- or scale-leaved evergreen
  - Broad-leaved deciduous
  - Broad-leaved evergreen
  - Mixed broad-leaved evergreen and conifer
- Tropical and Subtropical
  - Broad-leaved deciduous
  - Broad-leaved semi-deciduous
  - Broad-leaved evergreen
  - Sclerophyll

Appendix i (continued)

Shrubland Ecosystems

- Boreal
  - Broad-leaved deciduous (willow shrub)
  - Open bog
- Temperate
  - Alpine
  - Montane
  - Shrub-steppe
  - Coastal sagebrush
  - Chaparral
  - Wetlands
- Tropical and Subtropical
  - Beach hedge and dune thicket
  - Mixed evergreen sclerophyll
  - Halarch scrub
  - Semi-arid
  - Subalpine
  - Miscellaneous types

Herbaceous Ecosystems

- Grassland
  - Temperate
    - Subalpine-mountain meadow
    - Plains grasslands
    - Short grasslands (steppes) and short grass-low shrub
    - Valley grassland (California)
    - Wet grasslands
  - Tropical and Subtropical
    - Littoral
    - Halophytic grass sward
    - Dry
    - Moist submontane
    - Tussock subalpine
    - Wetland
- Grassland Forest Ecotones
  - Boreal
  - Temperate
- Nongrass
  - Boreal
    - Sedge meadow

Appendix i (continued)

Temperate
Sedge meadow
Tule marsh
Cattail

Tropical and Subtropical
Cattail

Desert Ecosystems

Arctic
Polar desert

Temperate
Great basin
Mojave
Chihuahuan

Tropical and Subtropical
Sonoran

Appendix ii

A Complete Outline for the Northern Boreal Forest Formation

Boreal (Needle-leaved evergreen conifer)

- White spruce (*Picea glauca*-*Betula papyrifera*)
    - Paper birch (*Betula papyrifera*-*Picea glauca*)
    - Aspen (*Populus tremuloides*-*Picea glauca*-*Alnus crispus*-*Salix*)
    - Balsam poplar (*Populus balsamifera*- *P. trichocarpa*-*Picea glauca*)
        - (Note: These three broad-leaved deciduous forests are seral to white spruce forest and are initiated or maintained by disturbance; e.g., fire.)
- Black spruce (*Picea mariana*-*Salix*)
- White spruce-balsam fir (*Picea glauca*-*Abies balsamea*)
- White spruce-pine (*Picea glauca*-*Pinus banksiana*)
- Red spruce-balsam fir (*Picea rubens*-*Abies balsamea*)
    - Aspen (*Populus tremuloides*)
    - Paper birch (*Betula papyrifera*)
        - (Note: These broad-leaved deciduous forests are seral to white spruce and red spruce-balsam forests and are initiated or maintained by disturbance; e.g., fire.)
- Wetland
    - Black spruce-tamarack bog (*Picea mariana*-*Larix laricina*)
    - Black spruce-white cedar bog (*Picea mariana*-*Thuja occidentalis*)
- Transition spruce-fir-northern hardwoods (see northern hardwoods)

Appendix iii

An Example of the Narrative that Supplements the Outline

North American Boreal Forest

The North American boreal forest (taige) extends in a broad transcontinental belt southeast from Alaska to Maine with subalpine extensions south, at increasing elevation, in the Appalachian Mountains from New England to North Carolina and in the Rocky Mountains to Arizona and New Mexico in the United States. It is dominated, when not seriously disturbed, by cold-tolerant, needle-leaved, evergreen (Larix excepted), trees of the genera Picea (spruce), Abies (fir), Pinus (pine), Larix (larch). On many sites, where disturbed, the needle-leaved, deciduous tree species of the genera Populus (aspens) and Betula (birch), or shrubs of the genera Alnus (alder) and Salix (willow). Extensive areas of wetland and poorly drained sites are in various stages of peat-building communities initiated by sedges or Sphagnum, and developing into diverse muskeg types ranging from heath-shrub communities dominated by Ledum, Chamaedaphne, Vaccinium or, in some areas Alnus or Salix, to conifer swamp forest dominated by Larix, Picea mariana (black spruce) or Thuja occidentalis (white cedar). These forests may revert to open muskeg due to changes in water table or other disturbances.

Alaskan Boreal Forest

The Alaskan boreal forest occupies the extreme western end of the boreal forest and is continuous with similar forests in the adjacent provinces of Canada. It merges at its northern extreme with the Tundra (see Appendix I, Billings, D.W., 3. "Artic Timberline Areas: Tundra-Taiga Ecotone") and at its southeastern edge with the Coastal Extension of Alaska (see Appendix VIII, Daubenmire, R.I., "Western Forest and Woodland").

Picea glauca (White spruce) forest.

Closed or open evergreen, needle-leaved forest on upland sites, especially E, W, N lower slopes, and well-drained river terraces.

Tree layer - *Picea glauca*, *Betula papyrifera*, *Populus balsamifera*, *Populus tremuloides*

Shrub layer - *Alnus crispa*, *Rosa acicularis*, *Ribes triste*, *Viburnum edule*

Herb and low shrub layer - *Linnaea borealis*, *Cornus canadensis*, *Pyrola asarifolla*, *Vaccinium vitis-idaea*

Vertebrate animal species

Herbivores -

Caribou	Ground squirrel
Moose	Varying hare

Carnivores -

Grizzly Bear	Wolf
Wolverine	Red Fox
Lynx	

Present state - Extensive areas are in various stages of post-fire succession the earliest in open, herbaceous, grass-dominated rangeland. Later stages are covered with *Alder* and *Salix* shrubs and young aspen. Most forest stands are mixed with intolerant broad-leaved trees, e.g., balsam popular, white birch, aspen.

Principal references.

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________. 1974. A vegetation map of an area near Fairbanks, based on an ERTS image. Mimeo.

Discussion

Mr. Heinselman (University of Minnesota): I noted with interest that in your last chart you had post-fire disturbance lumped with range land and some other strong human disturbances. Was there any connection between the two, or where do you regard fire in terms of the natural ecosystem in the arborial forest?

Mr. Bedford: Obviously, fire is a natural component in many of these areas. The northern Great Lakes forest has been dominated by fire for many years, and many other forests have been dominated by fire also. The conditions produced are similar to those produced when man clears the land; however, they have different facets in terms of nutrient flow, and so on. I have not answered your question in terms of how do I lump them; I guess I am not quite sure of what you are asking.

Mr. Heinselman: I guess my only question was, did you consider this to be a man-created facet of arborial forest, because I noticed in your first breakdown that you had *Pinus banksiana* forest following the white spruce forest. Would there be some implication here that *Pinus banksiana* per se might be unnatural in some respect? I guess my only concern is that we recognize that fire in this kind of an ecosystem is part of the system and that this is also true of wetlands, particularly in arborial regions.

Mr. Bedford: Yes, precisely so. Those seral stages were recognized as natural communities caused by fire, and this is not adequately developed at present in the text. Essentially, you go to the references for that.

Sport Fishing Institute

by

Carl R. Sullivan

The primary goal of the Sport Fishing Institute is the conservation of sport fisheries resources and related aquatic habitats. Naturally, the Institute has strong concerns for a broad range of environmental issues associated with the nation's water areas and wetlands. In the past decade SFI has adopted six wetland-related resolutions, concerning 1) highway construction and aquatic resources, 2) protection and development of estuaries, 3) dredging and filling controls, and 4) management of the coastal zone. In order to limit the scope of my remarks today, however, I will talk only about those wetlands which relate directly to the sport fisheries. The roster of workshop participants assures that other concerns will be more than adequately covered.

SFI is not directly involved in inventorying wetland resources although we recognize the value of having such an inventory and of protecting and expanding such resources. We have considered the desirability of a system of stream classification, but no policies, publications, or procedures have resulted. A national inventory of wetlands would have obvious benefit to fisheries managers, because, in many instances, a fish species or combination of fish species is as characteristic of a wetlands type as are its other parameters. Thus, a wetlands inventory would be invaluable in the quantitative measurement of specific fish habitat.

Based upon the wetlands definition for this workshop, and eliminating the Great Lakes, a very high percentage of all U.S. waters would be classified as wetlands. The importance of stream and deepwater wetlands to our sport fisheries resources is so obvious as to require little attention here. Accordingly, I direct your further attention to a few of the highly specialized kinds of wetlands, which have important, but perhaps less understood, sport fisheries value.

Estuaries

"An estuary is a semi-enclosed coastal body of water having a free connection with the open sea and within which the sea water is measurably diluted with fresh water deriving from land drainage" (Cameron and Pritchard, 1963). When measured in terms of their landed value, 63 percent of the Atlantic Coast commercial catch is made up of species believed to be estuarine dependent at some stage of their life cycle (McHugh, 1966). The Sport Fishing Institute estimates that more than 90 percent of recreationally-harvested fish exhibit a corresponding estuarine dependence. Obviously, estuaries are tremendously valuable areas and absolutely indispensable to the future of our coastal fisheries resources.

Springs

Because of their constant supply of cool, even-temperatured, oxygen-rich water, the availability of natural springs is often crucial to the success of eastern book trout (*Salvelinus fontinalis*) and of rainbow trout (*Salmo gairdneri*). Such areas are also ideal sites for trout and salmon hatcheries and their protection is vital.

High-Water Marsh

In nature, completion of the life cycle of the northern pike (*Esox lucius L.*) is dependent upon the availability of flooded marsh lands adjacent to the lake or stream habitat preferred by these fish. These marsh lands must be flooded when the fish are ripe for spawning in the spring and, of course, they must be accessible to the spawning fish. Young northern pike are dependent upon the larger zooplankters found in such areas until they are large enough to begin preying on other fish forms.

Changing Lake Margins

In 1974, the weight of fish harvested from Bull Shoals Reservoir, Arkansas, was five times the average for the period from 1971-73. The increase was attributed to high reservoir surface levels in 1973 (Keith, 1975). Such temporary lake-level increases cause flooding of dense shoreline vegetation and result in: 1) improved spawning habitat, 2) better protection for eggs and fry and, more importantly, 3) a sharp increase in biological productivity (resulting from increased surface area and related recycling of nutrients bound up in shoreline vegetation). The zones of fluctuating reservoir margins may not normally be classified as wetlands, but they ought to be. As fisheries management becomes more and more sophisticated, there will be much more deliberate manipulation of lake levels. This circumstance will result in this specialized type of wetland becoming even more important than at present.

Potential Wetlands

The discussion of areas not normally classified as wetlands brings me to a very important, perhaps unusual, wetland category. In May, 1974, the Board of Directors of the Sport Fishing Institute unanimously adopted a resolution calling for a "National Inventory of Recreational

Lake Sites." The resolution called attention to the limited number of suitable recreational impoundment sites and the urgency of identifying such sites for protection until such time as their development becomes practical.

It surprises many people to learn that more than 43 percent of all freshwater angling is done in man-made lakes, ponds, and reservoirs (Fish and Wildlife Service, 1970). These artificial waters are more easily managed than natural lakes, and in consequence, generally provide superior recreational fishing opportunities. The National Water Commission asserts that water areas are the focal point of more than half of all outdoor recreation. The nearly 60 million Americans who fish today are increasing at a rate of nearly 3 percent each year. In addition, it seems probable that the time each fisherman spends pursuing his sport will continue the growth it has shown in the past. Based upon all available evidence, the Sport Fishing Institute conservatively predicts at least a 200 percent increase in the sport fishing demand by the turn of the century. To meet that demand we must continue our anti-pollution efforts, protect our wetlands, improve our fisheries management effectiveness, and create new fishing waters (especially near urban concentration).

Good recreational impoundment sites are rare and correspondingly valuable. We believe that the use of such sites for recreational impoundments represents their highest and best possible use. We believe there is a National urgency to locate and identify such sites so that, hopefully, they will be zoned in such a manner as to protect them until such time as construction is possible. A good recreational impoundment site must have the following characteristics:

1. Size.--A minimum surface area of 50 acres, up to a maximum of 1,000 acres.

2. Location.--Relatively close to areas of high population (within two hours driving time).

3. Depth.--Generally not over 40 feet maximum.

4. Drainage Area.--Generally, not less than 10 nor more than 25 acres in the drainage basin for each actual acre to be impounded, actual ratio governed by other factors. (This is a key condition that rules out a high percentage of otherwise acceptable sites).

5. Cost.--There must be a suitable topographical area site for the dam so that its cost in ratio to resulting surface acreage is reasonable (suggested to fall, preferably, in the range of $1,000 to $5,000 per surface acre).

6. Water Quality.--Must be of sufficiently good quality to be capable of supporting warmwater fishes, as a minimum.

7. Soil.--Must be relatively impermeable.

8. Improvements.--Area to be inundated must not contain cemeteries, expensive highways, railroads, factories discharing toxic wastes, or other improvements of developments which preclude feasibility due to excessive costs of purchase or relocation of improvements.

An outstanding example of a potential wetland after development is the 218-acre Burke Lake (Fairfax County, Virginia), located approximately 25 miles southwest of Washington, D.C. Burke Lake accommodated more than 59,000 anglers in 1971--among the most intense fishing pressure in the nation. Uncounted more thousands used adjacent park lands for hiking, picnicking, camping, etc.

The Sport Fishing Institute considers these "potential wetlands" to be indispensible to future fisheries management. Only a finite number of such sites exist, and many have already been lost to other developments. This is particularly true in or near metropolitan areas where the need for recreational waters is the greatest. As the National Wetlands Inventory proceeds, we urge that adequate attention be given to these priceless resources.

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Discussion

Mr. Mason: In the spirit of levity, this is the first time I have ever heard of a cemetery being listed as an improvement.

Mr. Sullivan: I cannot take exception to that.

Unidentified Participant: What is the Institute's philosophy of quality versus quantity in terms of sport fishing recreation? In other words, you speak of impoundments, manmade impoundments or reservoirs, versus stream fishing.

Mr. Sullivan: Every man has his own cup of tea. There are great percentages of people, 43 percent of fresh water fishermen in this country, who prefer impoundment-type and lake and pond fishing. Personally, I am almost exclusively a stream fisherman, but the Institute is in favor of both. We are strongly in favor of management that will enable us to get the maximum use from these resources, streams or impoundments.

Unidentified Participant: I am trying to make the point that as generations go on people become accustomed to some type of thing and eventually maybe you could say that they didn't know what they missed. By the time we are all fishing in swimming pools or hunting on shooting preserves, no one will worry about that because they will not know what they were missing 20 or 40 years ago. There is a quality aspect.

Mr. Sullivan: I think I get your point. Now, generally, the good recreational lake sites are not on permanent streams. We will not take streams out of availability to sport fishermen because, in most instances, the good sites have a far greater drainage ratio to surface area that is compatible with a good recreational site. For example, a lake created on an intermittent stream does not reduce the availability of any streams for fishermen. Is that what you were getting at?

Unidentified Participant: I was not quite clear on the relationship between the impoundment and the drainage area. Did you say not less than 10 nor more than 25 per area or per acre?

Mr. Sullivan: This is per acre. Generally, 25 acres is the upper limit. Of course, the rainfall is a factor also.

The Conservation Foundation

by

John Clark

The U.S. Army Corps of Engineers has somehow got into the business of land use control. The Corps of Engineers is the primary authority on land use control for millions and millions of acres of private wetlands--an idea which seems to have garnered much enthusiasm to date from the national environmental community. This is a stop gap solution, and we do not know how it will work. However, putting the Federal government into control of private lands will not work permanently. It may not even work permanently at the State level. Tradition opposes it.

In the United States, local government has always been the major land use authority, and it is likely to hold that authority for a long time in the future. Therefore, the control and administration of wetland areas will have to involve local government along with higher levels of government. The Federal Coastal Zone Program recognizes this.

As an example, after many years of experience in the Commonwealth of Massachusetts (starting in 1963) the state regulating program for wetlands was turned over to local conservation commissions formed within existing political boundaries of towns and counties. Control was passed from the State to the level of government that had the traditional authority to control land use.

Florida's State-operated Endangered Lands Program gives the administration of critical areas, including a lot of wetland, to local government. This is an important trend that in a Federal or State framework I foresee happening all over the country, probably working in concert with higher units of government. But one way or another a framework will be set up so that important decisions are made at the local level.

We should consider what relationship this has to an inventory of wetlands. The old Circular 39 was set up to determine the national stockpile of wetlands according to a standard classification system. But it then became widely used in other ways--for administration and regulation of wetlands, and for general classification and evaluation of wetlands. What started out to be a resource classification system for inventory turned out to be the most available useful administrative classification of wetlands--a completely different purpose. This did not work out too well, as many of you realize, because it was not designed with administration in mind.

Now, the Fish and Wildlife Service is ready to start again with a modernized inventory to determine what the current stockpile is. It will serve a good purpose for national policy planning and program planning, but may not be of any value to local communities unless it is specifically designed for the purpose.

Tax maps, the kind of mapping that they work on in local areas, are often on a scale of 1:300; very large scale maps. At a 1:24,000 scale map, a lot may completely disappear under a pen line. Down in the local areas the issues are narrowed; a wetlands boundary moved 50 feet one way or the other may have a momentous consequence. The crunch will come when the wetlands involved have a very high market value. For example, The Conservation Foundation is now working on a wetlands problem for the city of Sanibel, Florida in relation to a natural reserve inventory for a comprehensive master plan. Here the interior wetlands in their raw state, totally unimproved, are valued at $7,000 an acre.

The system designed for an inventory of wetlands should have a simplified framework and clear ground rules. Further, the framework should be tested on local governments in real situations. It would be useful to go to local areas where there is effective wetlands control going on and find out what would work for them; then elaborate it back on up from there.

One needs to start at the local level, because that is where the wetlands are that are going to be saved or lost. The exercise of local government land use controls is important in this, principally the new higher wetland areas coming in under the expanded Federal authority in Section 404 of the 1972 Federal Water Pollution Control Act.

You have to ask the question of what this inventory is for. An example, a colleague named Don Strauss, who for years ran the American Arbitration Society, decided there had been enough environmental confrontations--court cases and battles over environmental issues. It occurred to him that he might help out by starting with the coastline of New Jersey where the scientists who recognized fact as fact could sit down and define the game rules ahead of time, before confrontation and polarization over the issue. They could look at the data ahead of time and decide what they mean, what classifications to use, what scales to use, and so on. So he set up a large meeting in New Jersey, brought in the experts, and said: "We are going to agree on what the parameters are, what classification systems to use, and so forth." He requested that the scientists not be concerned about what the data would be used for. So he started out with many unclassified categories to get settled; in each case, when he put the question to the assembled scientists, they would say to him, "What do you want to know for?" In each case, what do you want to know for? He found it impossible to get agreement on any parameter without the specific use defined. The same holds for wetlands inventory. What scale of mapping should be used--what do you want to know for?

If wetlands are to be controlled by local governments ten years from now, the classification system that you devise should be designed to be of the best possible help to local governments.

Discussion

Mr. Mason: May I comment? In asking the question, 'What do you want to know for?' they were inquiring as to what his systematic motive was and that sets the parameters of pertinence of the data of the system.

Mr. Clark: Exactly, and I think that is the underlying question here. There is no such thing as a wetland, pure and simple, in this connotation.

Mr. Garcia: I do believe there is a reasonable bias in your statement in regards to the future of wetlands, particularly with regard to the West Coast as opposed to the East Coast. But on the West Coast I think Federal and State agencies have more land-holding ability and own a lot more land and, therefore, possible have as much, if not more, wetland resources.

Mr. Clark: I should have clarified that. I am sorry if I have caused confusion; I wasn't at any time talking about acquisition. I was not talking about any land that is or might be acquired in the public domain. I was talking about the direct process of regulating the use of wetlands to limit the kind and amount of development that goes on in them.

Mr. Garcia: But even so, under Section 10 of the River and Harbors Act, there is some control; also, many of the coastal states have statewide regulations in terms of development.

Mr. Clark: Right! That is the way it is going now. I am predicting that within five years the Corps of Engineers will have found a way to partially re-delegate the authority for land use controls to local areas, operating, perhaps, through the State under the Federal Coastal Zone Management Act, for lands that should be under local control, and a way will be found to bring that about. Even with continuing Federal control, local government will play a strong role.

Mr. Garcia: Well, one of the issues that you bring up is whether it is appropriate to have such local control. If a whole county was classified as wetland, control at the local level might result in the area being rated as of low value despite the fact that at the national or regional level it may be of high value.

Mr. Clark: That problem has to be so recognized, and efforts have to be made to redirect the local area's decisions to a wider interest field. But the thing that I always hear from these local areas is, "Okay, if you want to make a park out of this town or this county, if we are going to have to forego a lot of taxes, construction, income, and other benefits to our community in order to protect this for the country, then the country is going to have to help us out economically." I see this coming. I don't know if you have been tuned-in recently to the matter of trying to get a national land use policy act through Congress; it is sobering.

The national land use policy act started out with a lot of constraints and ended up without any constraints. It turned out to be mostly a soft pedal grant program to the States, and still it did not make it through Congress. I just don't think the country is ready to turn over major land use to unilateral and/or State government control.

Mr. Larson: (Joseph Larson, University of Massachusetts): John, I am very cognizant of the local situation that you describe, because I am a member of a local conservation commission that is doing this in a small Massachusetts town with a population of 1003. But I hope you are not trying to suggest to us that there has to be a different classification system for every user, or for every value that is to be protected under the law. The State laws that protect wetlands or give the local authorities power to restrict uses, recognize a whole array of values to be protected, all the way from ground water to control of wildlife, et cetera. Now, if we follow your line of logic, we should be developing a classification system of wetlands as they relate to ground water, as they relate to flood amelioration, as they relate to wildlife. That is a separate system for each, and I don't really believe that is necessary at all.

I believe that we can define wetlands on acceptable, scientifically sound parameters, putting them in a system that allows each of these values to be extracted, or at least does not preclude them. Perhaps that is a more important way to look at it. When you devise a classification system for wetlands, you do not preclude identification and association of the system with a whole array of values. Are you telling us that we need to have, for each user, for each identifiable value, a separate classification system?

Mr. Clark: Well, let me relate a little from my own experience in trying to establish such a program in Collier County in Florida. We had strongly advocated the idea of not zoning for protection of wetlands--not just drawing a boundary and zoning it for specified uses--but rather to encourage the use of indicators for recognition and performance standards for control. Then they would not need to identify these areas ahead of time, except for their own convenience. The presence of certain vegetation would trigger off an administrative review procedure, which then would lead to decisions as to whether, in fact, the lands in question were wetlands; whether, in fact, certain controls were necessary; whether, in fact, one had to do something special about drainage channels; and so on. Control would be worked with a series of standards for development of the property, rather than by establishing a zone. However, they could not handle it, and they had to resort to a type of zoning. What they did was compromise. They zoned all the wetland areas in a Special Treatment District, and in that particular district you always have to go through a special administrative review procedure. I think you would find that that would be the most likely thing to happen in most localities. They want to relate it to zoning. They want to relate it to spatial and predetermined areas or parcels of land.

They will want to go along a road because it is a nice boundary, or they will want the boundary to go around a particular parcel. They want to simplify it. If you get into a water management program for a municipality, you get into a wetlands program, you get into a flood control program, you get into a variety of things and come up with many different, overlapping boundaries that have different meanings. If you give them a program they cannot work with, they will abandon it in frustration.

To be more specific about what I mean, there are a lot of people who interpret the mean high water line as being that which separates private and public property along the coast. A _Spartina alterniflora_ marsh may extend from somewhat below to somewhat above the line. The tides fluctuate on a 19-year cycle. The sea level has risen six inches in the last 30 years and has no relationship to the mean sea level of 1929. You get into these many complications. In effect, you must come up with something that relates to the methods presently used in these towns. The classification system for wetlands developed here should give the locals very clear zonal demarcations that they can work with.

Mr. Macomber: (U.S. Corps of Engineers): I think we could all agree on many of your points, but I mapped Sanibel and I think you are confusing a couple of things. The point is that I think you are confusing the National Wetland Inventory with the needs of the local planner. There is no way that Congress is going to provide the money for a National Wetland Inventory that is going to be of much help to you, a local planner, in Sanibel Island, Florida. There is no way that a national inventory is going to pinpoint alligator holes and so on; that is where you as a local planner comes in. I don't see any national wetland inventory ever being directly applicable at the county or local town level such as you are working with.

Mr. Clark: I agree, but I also think there is a possibility of making adjustments in the classification system that will bring it into close agreement with the kind of procedures that are normally used for local land use control purposes. The Federal-State systems have to be imposed on top of the local systems, and be made compatible. I am merely making a plea to keep this type of problem in mind while working on a new classification system.

WORKSHOP SESSIONS: CONCURRENT WORK-STUDY GROUP SESSIONS

Tuesday, July 22, 1975, 8:30 a.m.-5:00 p.m.

The entire day was devoted to workshop sessions. On the basis of expressed interests, participants were assigned to work-study groups representing broad geographic regions of the United States. Each of these groups was referred to as a particular Division, and the participants in each Division were asked to focus their attention upon the following topics: 1) Applicability of proposed wetland classification system to needs of users, 2) Wetland-upland interrelationships of importance in inventorying wetlands, 3) Refinements of inventory required by users, and 4) Other pertinent items. One group that dealt with inter-agency cooperation in conducting the national inventory was an exception to the above description of groups.

Each group was under the direction of a Moderator who was assisted by a Recorder. The Moderators and Recorders were informed that the last General Session on Wednesday morning would be devoted to reports from each work-study group. The work-study groups and the persons serving as Moderators and Recorders for each were as follows:

1. Gulf-Atlantic Division

   Moderator: William Palmisano, U.S. Fish and Wildlife Service.

   Recorder: Virginia Carter, U.S. Geological Survey.

2. Eastern Highland Division

   Moderator: Frank Golet, University of Rhode Island.

   Recorder: Joseph Larson, University of Massachusetts.

3. Interior Division

   Moderator: Harvey Nelson, U.S. Fish and Wildlife Service.

   Recorder: Keith Young, U.S. Soil Conservation Service.

4. Rocky Mountain and Inter-Montane Divisions

   Moderator: Richard Hopper, Colorado Division of Wildlife.

   Recorder: John Kadlec, Utah State University.

5. Pacific Mountain, Alaska, and Hawaii Divisions

   Moderator: James Bartonek, U.S. Fish and Wildlife Service.

   Recorder: Paul Springer, U.S. Fish and Wildlife Service.

6. Means of Assuring Inter-Agency Cooperation in Completing the National Wetland Inventory

   Moderator: John Montanari, U.S. Fish and Wildlife Service.

   Recorder: Col. John Hill, U.S. Army Corps of Engineers.

THIRD GENERAL SESSION: REPORTS BY MODERATORS OF WORK-STUDY GROUPS AND SUMMARY STATEMENT

Wednesday, July 23, 1975, 8:00 a.m.-12:00 noon.

Presiding: John Montanari

REPORTS BY MODERATORS:

(Editor's Note: As one might anticipate, the reports by the Moderators did not follow a standard format. The following outline represents my attempt to organize the contributions of the various groups in an orderly fashion. The report by the Pacific Mountain, Alaska and Hawaii work-study group could not be handled in this manner. Their report consisted wholly of a skeletal outline of a suggested classification system; this system is presented in its entirety at the end of this section).

I. Definition of Terms Used in the Classification System

A. Wetland

1. Gulf-Atlantic Division

a. The definition must be concise, scientifically sound, and easily understandable.

b. It should be based upon hydrology and modified or qualified by plants, soils, etc.

c. The group was about evenly divided as to whether or not a seaward boundary should be established. If there is a need to establish a boundary, perhaps the edge of the continental shelf should be considered.

2. Eastern Highlands Division

a. All water areas--including ponds and lakes--should be included in the definition.

(1) In order to make the inventory as complete as possible, why not include ponds and lakes? Streams are already included.

(2) It is not possible to separate wetlands as defined from the open water areas of ponds and lakes without establishing very arbitrary boundaries.

(3) Ponds and lakes could be included in the inventory without the expenditure of a great deal more effort.

(4) There are many who regard ponds and lakes as being "wetlands."

(5) After the wetlands inventory of 1954 was conducted, the permanent water bodies were then inventoried.

b. The definition should be general, and it should be tied to extensive descriptive material on wetland plants, soils, and water regimes. This material should be grouped by region. Specific mention should then be made in the definition to the descriptive material; however, the descriptive material should not be made a part of the definition itself.

c. All agricultural lands where water regimes and soil types are wetland (by definition) should be included. The existing type of vegetation (agricultural crops, trees, or emergent herbacious plants) should not deter us from classifying such areas as wetlands if the water regime and soils are typically wetland in nature.

d. Suggest that the "one month" figure be eliminated from the definition.

3. Interior Division

   a. The definition needs to be revised with a view to simplifying it.

   b. It should be tied to descriptive material on vegetation, soils, etc. This should not be a part of the definition, but it should be referred to in the definition.

4. Rocky Mountain and Inter-Montane Divisions

   a. The group felt that the definition emanating from the Bay St. Louis meeting may be better than the suggested definition.

   b. Any mention of maximum depths in the definition should be limited to coastal areas.

   c. The definition should include entire lakes and reservoirs.

   d. Riparian vegetation, even though not considered hydrophytic vegetation, should be included (flood plains, etc.).

   e. The 20" limit in the proposed definition should be carefully reviewed.

5. Pacific Mountain, Alaska and Hawaii Divisions

   (This work-study group devoted its attention to the development of an alternative method of classifying wetlands. Inasmuch as their report consisted of a skeletal outline of a classification system, it has not been possible to incorporate their work with that of the other groups. The suggested classification scheme emanating from this group is presented in its entirety at the end of this section).

B. Other Terms

1. Gulf-Atlantic Division

a. Mean High Water (MHW)

(1) Eliminate this as a term; substitute some other description.

b. Salinity

(1) Salinity alone is not sufficient to separate types; We need vegetation indicators.

(2) Perhaps the upper limit of the fresh category is too low.

(3) It was recommended that hypersaline be added--: >40%.

(4) It was suggested that an intermediate category (0.5 - 5.0%) be adopted, because of its importance to the Gulf Coast.

c. Marine algae and "sea grasses."

(1) These intertidal plant communities should not be included in the marsh class.

(2) A new term should be used to designate this intertidal algal zone.

d. Southern "bogs."

(1) More research is needed to clarify the nature of southern "bogs." The present terminology related to bogs, fens, and marshes is confusing.

2. Eastern Highlands Division

a. Floodplain.

(1) Some portions of floodplains may be wetland, but cannot accept the concept that all floodplains are wetlands.

(2) We do not know how wet the soil is once the surface water is gone.

(3) Recommend that the list of soils be handled in such a way that floodplains are excluded from the definition of wetlands.

b. Non-tidal basins.

(1) Temporarily flooded: add a statement that the soil may be saturated when not flooded.

(2) Semipermanently flooded: consider the possibility of substituting the term "ice-free" for "growing season."

(3) Shallow permanent: "average" modifier should be applied to water depth rather than the growing season.

(4) Deep permanent: discussed the 6-inch limit on shallow and deep permanent waters, but decided that there was no better alternative.

c. Non-tidal channels.

(1) In Figure 2, bars and flats should be listed as classes under non-tidal channels.

d. Beach-bar and flats.

(1) Definitions should be changed to include possible channel location.

e. Water quality modifiers.

(1) No serious objections to proposed descriptions, but there was some question concerning the value of pH information.

(2) Dr. Heinselman suggested that if pH classes are to be used the number of classes should be increased from three to four and that the values be changed.

f. Floating mats.

(1) The value of recognizing these as subforms in the Eastern Highlands, or elsewhere, was seriously questioned.

g. Peatlands.

(1) There was a strong feeling that the term "fen" should be used wherever it seems appropriate; in other words, it should not be restricted to the Boreal Forest region.

(2) It was recognized that there are southern wooded wetlands that might be distinctly different from either swamps or boreal bogs; perhaps these should be recognized as southern bogs or pocosins.

(3) Perhaps the difference between fens and bogs is not significant. Inasmuch as they are so different from the other wetland types, they might be combined under the term "peatlands."

3. Interior Division

a. Fen.

(1) It was felt that there was a lack of consistency in the use of this term; it should also be used to label such habitats in the south despite our usual association of the term with northern latitudes.

b. Basin-littoral.

(1) Suggest that a better term be selected; one that would include hillside seeps and other non-basin

wetlands. Perhaps "non-channeled" would be better.

c. Beach-bar.

(1) Beach-bars are not now recognized under non-tidal channels; they need to be added.

4. Rocky Mountain and Inter-Montane Division

a. Basin wetlands.

(1) Are these depression wetlands? The term basin needs clarification.

b. Life forms.

(1) Permanent water is not a life form. A more appropriate term should be substituted for life form if permanent water is to be included in this category.

(2) Another reason for questioning the labeling of this category as "life form" is the fact that some of the subforms are actually good life forms.

c. Soils.

(1) The relationship of soils to the classification scheme is not clear. They are undoubtedly important, but to what extent? Research on this aspect is needed.

(2) The numeral and organic breakdown may be sufficient, but the need for a breakdown of peat--into cold and warm--is not clear.

d. Classes.

(1) Where do floodplains fall?

(2) Littoral water should include non-vegetated, permanent deep water such as reservoirs and lakes.

Along these same lines, where does a drawdown reservoir fit?

(3) Inasmuch as it is difficult on the ground to distinguish between fens and bogs, perhaps they should be lumped.

e. Water regimes.

(1) Suggest that it might be possible to use the gradient rather than velocity; this would enable one to make determination from contour maps rather than a field survey.

II. Miscellaneous Comments and Suggestions.

A. Eastern Highlands Division

1. There is a great need to clearly indicate the relationship between the new classification system and Circular 39 and other regional or national systems. It was felt that people could live with the classification system as long as it could be translated into inventory wetland types already being used.

2. There seemed to be no disagreement with the general concepts upon which the new classification system is based; most of the questions raised tended to be very specific, involving wording and definitions.

B. Interior Division

1. We need a classification system that can be used to classify the whole as well as the parts of a wetland basin, and it must relate to other disciplines.

2. The new classification system must be related to other established wetland classification systems.

3. We need a classification system that can be understood and used by persons with a minimum of specialized training.

4. We need a classification system that is capable of incorporating the wide diversity of wetlands that exist under both natural and artificial conditions.

5. The classification system should enable users to make value judgments for their program needs, but in itself should not establish value judgments. The user must make the interpretation of the facts provided by the classification system.

6. How do artificial areas such as reservoirs, strip mine lakes, stock ponds, borrow pits, etc., fit into the proposed classification system?

7. Will any consideration be given to the potential for restoration of drained wetlands or creation of new wetlands?

8. Beach-Bars are not now recognized under non-tidal channels; they should be added.

9. Are we attempting to classify individual wetland basins or classes and zones within wetland basins? We recognize that the latter may have to be done along coastal areas and rivers; however, the recognition of zones in interior basins poses problems, especially in the inventory stage. The user will have to make the decision as to the final degree of resolution required, but this requirement for some users must be accommodated.

10. We should clarify the objective of the proposed wetland classification system. The general concensus was that a

system is needed to establish a framework within which various disciplines can work and communicate. From a broader viewpoint, however, the system should serve as a tool to achieve wetland management objectives; i.e., preservation, enhancement, management.

11. Continued consideration should be given to making this system compatible with other recognized regional or local classification systems which do not conflict with or jeopardize the major categories. In this regard, there was general concensus that the proposed national system be strictly adhered to through the Class level. Below this level other compatible systems requiring greater detail could be used.

12. A future course of action needs to be established, including:
    a. A time frame for returning comments of the special study groups.
    b. Furnishing the workshop participants with a revised draft of the proposed classification system which presumably will incorporate suggestions emanating from this workshop.
    c. Encouragement of participants to carry out field tests of the proposed system with a return of results by a specified time.

13. In general, the group agreed that the proposed classification system was ecologically sound, could be used by a variety of users, it permits the inclusion of additional classes of wetlands not previously fully considered, and it establishes

a framework which States and other local entities can tie to.

C. Rocky Mountain and Inter-Montane Division

1. The group preferred the use of "Land Forms" to "potential vegetation." Potential vegetation stresses botanical aspects which may be more complicated than land form, and Kochler's potential vegetation map is not complete, even in the West.

Pacific Mountain, Alaska and Hawaii Divisions' Proposed Classification System

I. Life Zone (or Biome). Physiographic regions are an acceptable alternate to biomes or life zones in lieu of accurate delineations of the latter.

A. Ecosystem. Wetland would fall into one of five ecosystems:

Marine

Estuarine

Riverine

Lacustrine

Terrestrine

1. Class. Any of the above ecosystems may contain one or more of the following classes:

Wet meadow

Marsh

Swamp

Bog

Fen

Flooded agriculture

Submerged land (unveg.)

Shore (unveg.)

Tidal creek

Coral

Bed

Mat

2. Types. Each of the above classes may be described by one or more, but usually two or three, of the following modifiers:

Water Movement

- Torrential
- Swift
- Slow
- Sluggish
- Energy: high, medium, low

Duration of Flooding

- Occasionally flooded
- Regularly flooded
- Seasonally flooded
- Shallow permanently flooded
- Deep permanently flooded
- Saturated

Swamp

- Tree
- Shrub
- Dead tree/shrub
- Deciduous
- Evergreen

<u>Riverine Types</u>

Braided

Sinuous

Straight

Channelized

<u>Water Quality</u>

Fresh

Acid

Circumneutral

Alkaline

Brackish

Saline

Turbidity

<u>Substrate</u>

Rock

Boulder

Cobble

Shingle

Gravel

Sand

Silt

Clay

Salt

Muck

Peat

Shell

Detritus

3. <u>Association</u>. Key organisms or biotic relationship

Summary Statement

by

Laurence R. Jahn

Background

The group of papers on the first day laid some essential background and developed an overall perspective for this workshop. Various speakers emphasized the drastically changing public attitudes toward wetlands. Historically wetlands of all types were regarded as wastelands to be converted to other uses through drainage and filling. The error of this traditional view now is recognized widely, and gradually institutional arrangements are being realigned to protect public values represented in aquatic areas.

An array of legal authorities, policies, and programs call for maintaining wetlands. These include treaties and agreements on migratory birds and fishes, the Fish and Wildlife Coordination Act, National Environmental Policy Act and its associated environmental assessments, state and federal acquisition and management programs for refuges and management areas, the Accelerated Wetland Loan Fund Act, Water Bank Act, Coastal Zone Management Act, and Endangered Species Act. Policies of a variety of state and federal agencies call for consideration and maintenance of wetlands. Among these are those of the U.S. Soil Conservation Service, Department of Transportation, Environmental Protection Agency, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and Tennessee Valley Authority.

Wetlands now are regarded as important units of the landscape deserving of careful classification, inventory, maintenance and restoration. This workshop was designed to yield information from individuals knowledgeable on these subjects. The three primary objectives were to:

1. Obtain suggestions from major "users" in developing a standard wetland classification system.
2. To bring the expertise and experience of participants to bear in making decisions on methods to be employed in conducting the proposed national wetland inventory.
3. To assess the status of wetland inventories carried out by various governmental agencies and private organizations.

Standard Classification System

Cowardin and Carter provided a valuable service in preparing the "draft" paper outlining a framework for a standard wetland classification system. Specific comments were invited on it from all participants. But limited time between receipt of the document and arrival at the workshop prevented preparation of thorough written comments by many attendees.

That fundamental paper stimulated thinking and discussion in all of the work groups. It sought to:

1. Provide a basis for communications on aquatic areas among resource managers, researchers, users, and citizens.
2. Improve on Circular 39, the legally recognized reference that describes 20 types of wetlands. Goals are to add wetland classes and types as needed, make other modifications as identified and agreed upon, and provide consistency in terms among classification systems.

3. Stimulate design of a standard classification system that is ecologically sound, but not necessarily developed specifically for the proposed national wetland inventory. The standard system should be cross referenced to other major existing wetland classifications.
4. Avoid constraints of inventory, such as minimum sized wetland capable of being identified through a specific inventory procedure. Such limitations should not constrain the wetland classification system.
5. Promote a logical, sequential wetland classification system. Although various views have been expressed, I sense a consensus that this system should emphasize three dimensions: (a) geographic location (physiographic region or biome), (b) hydrologic characteristics, and (c) appearance or absence of vegetation.

Many spokesmen focused on Circular 39, which resulted from a classification developed by Martin, et al. that was used to complete the first national wetland inventory in the early 1950's. That inventory, finished over two decades ago, focused on 20 types of wetlands, not all aquatic areas. Permanent waters, such as lakes, reservoirs, streams and rivers, were inventoried and reported separately on a state basis.

Several speakers emphasized that although Circular 39 has some weaknesses it is of immediate practical value to the man in the field faced with making decisions on specific wetlands. It is recognized legally in several authorities and is still in great demand largely because it gives illustrations, descriptive names, and simple explanations for each wetland type.

Nevertheless, the inventory that produced the data for Circular 39 had some serious shortcomings. It was based on a sampling system, not complete coverage of wetlands, and only included wetlands of 40 acres or more in size. Acreage estimates and geographic distribution of some wetland types are incomplete. Therefore, information on location, number, and acreage of wetlands by types did not meet all needs of users. Many states recognized these limitations and subsequently proceeded to complete a more refined inventory. Kusler and Bedford provided us with the overall current status of state inventory accomplishments and activities.

Problems With Sequential Classification System

Both workshop and general discussions identified a variety of problems with the draft classification system. This is understandable, considering the total geographic area of the U.S. to be covered by the proposed standard classification system. From these exchanges, three significant problems evolved.

1. Recognizing the dynamic nature of wetland types over time at the field level. This results from water level fluctuations due to flooding and drought. A given basin having the capacity for different water depths may be dry, a shallow marsh (Type 3) at low level, or an open water area (Type 5) at greater water depth. Therefore, classification of the basin at a given moment in time may be difficult.
2. Assigning a wetland type for a basin where there is a variety of habitat classes, as judged by vegetation and open water, within that entire basin. Mixed zones of vegetation may occur in close prodimity to each other. This problem occurs in the prairie pothole region, salt marshes, bogs, and on flood plains.

3. Defining and using descriptive terms in the classification system that describe wetland types as functional ecological units of the landscape and also aid people in visualizing and understanding those types. Considerable discussion focused on this need. Views lead to the following summary points:

   a. The overall framework for describing wetlands should involve at least three major items: biome, ecosystem, and community. Dominant or indicator species of plants and important influencing factors should be identified for each wetland community.

   b. Overall appearance of wetlands at ground level must be stated to aid a variety of users at the field level. Photographs or diagrammatic illustrations are needed to show the major wetland classes, types, and dominant influences yielding the different types of wetlands.

   c. Descriptions of the wetland types should include some of their local names to help people understand and use the new classification system. Communicating the new system would be made more difficult by changing only to new terms.

Overall it seems best to develop terminology for the wetland classification system in two stages.

1. Immediately prepare an interim improved classification system featuring wetland classes and types. This may be accomplished by using Circular 39 as a base and refining and expanding it as required. This would meet the need for having, in the immediate future, a consistent legal reference for maintaining wetlands. Eventually the improved Circular 39 should be replaced with the new standard classification system.

2. Continue testing the proposed standard classification, complete it, and issue it as the final classification system. This task will require more time and involve resolution of some critical questions.

   a. Shall agricultural lands be included on the basis of soil and water characteristics?

   b. Shall flood plains, to the 100-year flood frequency countour, be included? Those delineations now are required by law for flood plain management programs. Such information is needed to assist in recognizing stream systems (channel plus flood plains and associated wetland basins) and implementing needed non-structural measures on a broader basis. Delineations of flood plains would be helpful in maintaining wetland basins as part of national, state, and local flood prevention and control programs. A decision is required on flood plain delineation. Shall it be part of the national wetland classification and inventory or will it be left for others to accomplish?

   c. Shall permanent waters, such as oceans, bays, lakes, reservoirs, streams, and rivers be covered by the standard wetland classification and inventory systems? How should existing information on permanent surface waters be used?

Wetland Inventory

The interim wetland classification system called for will provide an improved system for conducting wetland inventories on a continuing basis, as called for in a variety of legal authorities and policies, until the final classification system is made available.

An inventory must, as a minimum, provide the location, type, and acreage of wetlands or aquatic areas. This information is required at different scales dictated by the level of planning and operation of users at national, regional, and local levels. Responsibilities of both federal and state governments span all of these. Needs for information on wetlands include the following:

1. National
    a. For framework planning (LevelA), as carried out through the U.S. Water Resources Council.
    b. To locate all wetlands by type and acreage, and concentrations of small wetlands 10 acres or less in size.
    c. To show trends in gains and losses of wetlands over time.
2. Regional
    a. For state and river basin planning (Level B).
    b. In coastal zone planning and management programs.
    c. In federal and state regulatory programs.
3. Local
    a. For project planning and development (Level C).
    b. For federal and state regulatory programs, as Section 10 permits.
    c. In land acquisition.
    d. In farm, ranch, forest, etc., planning.
    e. In research, as on plant communities and individual species and to correlate with distribution of animal populations.

Agreement was reached that most user needs could be met with three products:

1. Maps at 1:750,000 and 1:250,000 giving the distribution of aquatic areas 10 acres or larger in size and having the digitized data on tape or in a tub to be made available in printed form as requested. An estimated total of 650 maps of 1:250,000 is required to cover

the 48 states and Alaska. The new ongoing Land Use Data and Analysis Program (LUDA) of the U.S. Geological Survey will yield this information. Remote sensor data will provide information on land use and landcover types. At discrimination levels I and II water (streams and canals, lakes, reservoirs, bays and estuaries), wetlands (forested and nonforested), barren land (dry salt flats, beaches, bare exposed rock, etc.), and surrounding land use will be identified. Data can be made available by county, state, river basin, and other similar types of units. Under cooperative agreement with the U.S. Geological Survey, States and others can obtain additional data at finer levels of discrimination (levels III and IV). Florida is now doing this. A three-year update of data on file is anticipated where changes in land cover and land use are considerable.

2. Maps at 1:24,000 giving the distribution of aquatic areas as scribed and labeled units down to 5 to 2.5 acres and as dots to a fraction of an acre. Information will be digitized and can be made available as requested. Approximately 56,000 maps of this scale would cover the 48 states and Alaska. Various users expressed great need for base maps of this scale to help complete environmental assessments, reviews of permit applications, etc. The U.S. Geological Survey anticipates having maps of this scale available for the U.S. coastal zone in 2-3 years.

3. Aerial photographs at 1" to 330' or 1" to 660' for ground truth evaluations. These photos continue to be essential in land acquisition, establishing precise boundaries of landownerships and aquatic areas, farm and ranch planning, etc. They are available in agricultural areas through the U.S. Agricultural Stabilization and

Conservation Service, in forested areas through the U.S. Forest Service, the Department of Transportation, and other sources remaining to be identified in each state.

Further exploration is needed to define how information at these three scales can be integrated and made available to users in a form best suited to meet their needs. Maps of each scale are not, at this time, available for the entire United States.

Immediate Follow Through Actions

1. That a small nucleus group be designated to revise the "draft" classification statement, check it in the field, and distribute it for review and possible further checking by participants represented at this workshop. Also at the appropriate stage of development consider putting it in the *Federal Register* to insure wide distribution and public comments. Following all reviews the nucleus group should complete a manuscript for a manual on the classification system which contains suitable ground illustrations (including photographs) of as many wetland types as possible to accompany the caption description of each. Target dates remain to be established to complete these steps. Upon completion, distribute the manual to all potential national, state and local users.
2. That an individual or group of individuals be invited to prepare a well-illustrated "Peterson field guide" on aquatic communities and dominant or indicator species of each for the public. Produce the manuscript and the Wildlife Management Institute will help see it is published.

3. Identify location and types of state and regional wetland inventories that have been conducted. Accomplish by February 1976. Also identify which states plan to conduct wetland inventories before 1979 and the type of products to be produced.

4. Identify location, type and availability of imagery, aerial photographs, and maps that identify wetlands in U.S. In particular, identify the availability and sources of 1:24,000 scale maps. A list by state showing what photographs and maps are available, where, and at what cost would be welcomed by user groups. This information is considered critical by many.

5. Explore fully the viability of the LUDA Program to complete the national wetlands inventory. Report on this evaluation by November 1975. Be sure to test accuracy of information generated and displayed on water and wetland areas. Also test fit the proposed classification system within Levels I, II, III, and IV of the land use and land cover classification systems. Identify costs, if any, to individuals and agencies, other than U.S. Geological Survey, that obtain LUDA printouts on aquatic areas.

6. Identify specific ways to enhance interagency cooperation in completing the national wetland inventory. This will require improved understanding of the LUDA Program. Define opportunities for states and others to (a) obtain computer data at Levels I and II from the U.S. Geological Survey and (b) enter into cooperative agreements with U.S. Geological Survey to obtain selected data from Levels III and IV at a price remaining to be identified.

7. Explore the need for and possibilities of developing a grant program to assist the states in acquiring suitable maps needed at state and

local levels to carry out essential wetland management activities.

246

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ADDENDUM

INTERIM CLASSIFICATION OF WETLANDS AND AQUATIC HABITATS OF THE UNITED STATES

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March 1, 1976

U.S. Fish and Wildlife Service, Office of Biological Services,

Washington, D. C.

CONTENTS

	page
Introduction	1
The Martin et al. (1953) system	1
A new classification system	3
The concept of wetland	5
Definition of wetland and aquatic habitats	6
Limits of wetland and aquatic habitats	7
Objectives and structure of the system	9
The Classification System	17
Provinces	17
Ecological systems and subsystems	21
Marine system	22
Estuarine system	24
Riverine system	25
Lacustrine system	27
Palustrine system	29
Habitat classes, subclasses and orders	30
Vegetated habitats	32
Nonvegetated habitats	49
High gradient riverine habitats	59
Habitat types	61
Water regime modifiers	61
Water chemistry modifiers	65
Special modifiers	72

page

Correlation Between Classification Systems 74

Correlation with Circular 39 76

Correlation with Golet and Larson (1974) 80

Correlation with Stewart and Kantrud (1971) 83

Correlation with Odum et al. (1974) 84

Correlation with Zoltai et al. (1975) 93

Literature Cited 97

Appendix A. Selected references [1/]

Appendix B. Soils of wetlands and aquatic habitats

Appendix C. Plant indicators of wetlands and aquatic habitats

Appendix D. Invertebrate indicators of wetlands and aquatic habitats

Appendix E. Illustrations of habitat classes, subclasses, orders and types

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1/ Appendices to be added for final draft.

INTRODUCTION

In 1954 the U.S. Fish and Wildlife Service conducted an inventory of the wetlands of the United States (Shaw and Fredine 1956). Since then, wetlands in this country have undergone considerable change, both natural and man-related, and their characteristics and natural values have become better defined and more widely known. In this interval, many states have passed legislation to protect wetlands, and a few have also produced statewide wetland surveys.

In 1974 the U.S. Fish and Wildlife Service directed its Office of Biological Services to design and conduct a new national inventory of wetlands. Whereas the single purpose of the 1954 inventory was to assess the amount and types of valuable waterfowl habitat, the scope of the present project is vastly broader. Hopefully, it will provide data that will be useful to wildlife managers, hydrologists, landscape planners, economists, engineers and many other workers in public and private agencies and organizations.

THE MARTIN ET AL. (1953) SYSTEM

Before the 1954 inventory was begun, Martin et al. (1953) devised a classification system for wetlands of the United States to serve as a framework for the inventory. The combined classification and inventory (Shaw and Fredine 1956) - Circular 39 as it is popularly known - has been one of the most common and most influential tools in the battle to preserve a rapidly vanishing and critically valuable national resource (Stegman in prep.). However, the shortcomings of this work are well known and have been documented frequently (e.g., Leitch 1966, Stewart and Kantrud 1971).

In its attempt at simplicity, the Martin et al. system ignored ecologically critical differences such as the distinction between fresh and subsaline inland wetlands, and often placed dissimilar habitats (e.g., boreal black spruce forests and southern cypress-gum forests) in the same class. The central emphasis on waterfowl habitat also led to far greater detail for vegetated areas than for nonvegetated areas.

Probably the greatest single disadvantage of the Martin et al. system was the poor definition of classes, which led to extreme inconsistency in application at the time of inventory. For example, inland saline flats (Type 9), inland saline marshes (Type 10), and inland saline water (Type 11), all common types in North Dakota, were not recorded in that state. Stewart and Kantrud (1973) estimated there to be 192,000 acres of alkali ponds and lakes in that state alone. The moderately brackish to subsaline subclasses of Stewart and Kantrud (1971) were probably included in the fresh classes (Types 3 - 5) of Circular 39. As a result, highly productive wetlands in the prairies were placed in the same class as impounded bogs (Shaw and Fredine 1956:34). The inconsistent application of the classification led to very misleading interpretations of the value of wetlands to waterfowl.

A NEW WETLAND CLASSIFICATION SYSTEM

Numerous other classifications of wetlands and aquatic areas have been developed (Appendix A), but most of these are regional systems and none would fully satisfy national needs. Because of the problems inherent in Circular 39, and because our knowledge of wetland ecology has grown significantly since 1954, the U.S. Fish and Wildlife Service elected to construct a new national classification system for wetlands as the first step toward a new national inventory. This interim classification of wetlands and aquatic habitats of the United States is the first working draft for the new system.

Like most ecological problems, the question of how best to classify wetland and aquatic habitats requires input from many diverse disciplines. A useful classification must also address the needs of a varied array of potential users. Therefore, prior to preparation of this report, we sought advice from a number of experts in water-related fields and from various state and Federal agencies that represent potential users. Two meetings were particularly important in formulating the system presented here. At the first meeting, held at Bay St. Louis, Mississippi in January 1975, experts in wetland ecology and classification from across the country were invited to suggest an outline for a new national system. Many of the ideas developed at the meeting were incorporated in a draft classification (Cowardin and Carter 1975) which was presented at the National Wetland Classification and Inventory

Workshop held at the University of Maryland in July 1975 (Sather, in prep.). We have attempted to incorporate recommendations received during the Maryland meeting in this report.

The breadth and complexity of this assignment and the narrow time frame for its accomplishment have forced us to base the classification on the massive literature of wetland and aquatic ecology, and on advice obtained from numerous individuals who have agreed to help us. We acknowledge their help, but accept responsibility for all portions of this report, including those with which any individual mentioned here does not agree. The following, who attended the meeting at Bay St. Louis, contributed substantially to initiation of this classification: R. R. Anderson, J. C. Bartonek, D. Bowen, R. M. Hopper, L. Jahn, J. S. Larson, A. W. Palmisano, H. Sather, J. R. Singleton, P. F. Springer and K. K. Young. The individuals who participated in the Maryland workshop, and in many cases furnished us with detailed written comments, also contributed to the development of this system. The library work performed by E. P. Multer, S. Larson, S. Sather, and G. Balvic was essential. D. A. Davenport furnished needed computer programming. Numerous other individuals kindly gave their time to offer counsel on specific aspects of the classification. J. Everett advised us on geomorphology, K. K. Young and O. Carter aided with soil taxonomy, R. Novitzki advised us on hydrologic problems and R. H. Chabreck provided advice on coastal wetland ecology. M. Heinselman and R. Hofstetter helped with the difficult problems of peatland ecology and terminology. Particular credit is due J. H. Montanari, Project Leader, National Wetlands Inventory, for his supervision of the classification project.

THE CONCEPT OF WETLAND

For centuries we have spoken of marshes, swamps and bogs, but only relatively recently have we attempted to group these landscape units under a single term, wetland. The need to do this has grown out of our desire: (1) to understand and describe the characteristics and values of all types of land, and (2) to wisely and effectively manage wetland ecosystems. Effective management requires legislation; out of such legislation, legal definitions are born. Unfortunately, legal definitions are usually based as much upon facility and pragmatism as they are upon accuracy of meaning. Hence, legal definitions of wetland may bear little resemblance to the ecological concepts embodied in the term.

There is no single, correct, indisputable, ecologically sound definition for wetland because the gradation between totally dry and totally wet environments is continuous. Moreover, no two people view the identity of any object in the same fashion. For these reasons, and because the reasons for defining wetland vary, a great proliferation of definitions has arisen.

Our primary task here is to impose arbitrary boundaries on natural ecosystems for the purposes of inventory, evaluation and management. We are obliged to use sound reasoning as we attempt to describe the concepts of wetland and aquatic habitats in terms that past, present and projected future users will accept.

The concept of wetland embraces a number of characteristics, including the elevation of the water table with respect to the ground surface, the duration of surface water, soil types that form under permanently or temporarily saturated conditions, and various types of plants and animals that have become adapted to life in a "wet" environment. The single feature that all wetlands share is the presence of more soil moisture than is necessary to support the growth of most plants. This excess of water creates severe physiological problems for all plants except hydrophytes, which are adapted for life in water or in saturated soil. Rather than attempt to place arbitrary limits on the fluctuation of the water table for the purpose of defining wetland, a task of great complexity at best, it seems more reasonable to define wetland broadly and simply, and then to place limits on the concept.

DEFINITION OF WETLAND AND AQUATIC HABITATS

Wetland is land where an excess of water is the dominant factor determining the nature of soil development and the types of plant and animal communities living at the soil surface. It spans a continuum of environments where terrestrial and aquatic systems intergrade.

For the purpose of this classification system, wetland is defined more specifically as land where the water table is at, near or above the land surface long enough each year to promote the formation of hydric soils[1] and to support the growth of hydrophytes,[2] as long as other environmental conditions are favorable. Permanently flooded lands lying beyond the deep-water boundary of wetland are referred to as aquatic habitats.

In certain wetland types, vegetation is absent and soils are poorly developed or absent as a result of frequent and drastic fluctuations of surface-water levels, wave action, water flow, turbidity or extremely high concentrations of salts or other substances in the water or substrate. Wetlands lacking vegetation and hydric soils can be recognized by the presence of surface water at some time during the year and their location within, or adjacent to, vegetated wetlands or aquatic habitats.

LIMITS OF WETLAND AND AQUATIC HABITATS

The upland limit of wetland is determined by: (1) the change from predominantly hydrophytes to predominantly mesophytes or xerophytes;[3] (2) the change from predominantly hydric to predominantly non-hydric soils; or, in the case of wetlands without vegetation or hydric soils, (3) the change from land that is flooded at some time to land that is never flooded during years of normal precipitation.

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1 Appendix B provides a list of hydric soils as identified and classified by the U.S. Soil Conservation Service.

2 Appendix C lists the dominant hydrophytes of the U.S., arranged in taxonomic order and indexed by physiographic region.

3 See page 27 for definitions.

The lower limit of wetland in marine and estuarine systems coincides with the elevation of extreme low spring tide; thus, permanently flooded areas in these systems are considered aquatic habitats, not wetland. In riverine, lacustrine and palustrine systems, the lower limit of wetland has been set at a depth of 2 m below low water; however, if emergents, shrubs or trees grow beyond this depth at any time, their deep-water boundary is taken as the wetland boundary.

The 2 m limit for the wetland definition was selected because it represents the maximum depth to which emergent plants normally grow. Daubenmire (1968) and Ruttner (1963) described the deep-water limit of emergents at about 1 m. Sculthorpe (1967) placed this limit at 150 cm (5 ft) or more, and Welch (1952) gave 2 m as the average figure. In the Soviet Union, Zhadin and Gerd (1963) placed the limit at 2-3 m. In their wetland classification for Canada, Zoltai et al. (1975) include only areas with water less than 2 m deep, a depth which they feel represents the deep edge of the zone where maximum growth of rooted aquatic macrophytes occurs.

The deep-water extent of the emergent zone marks an ecologically sound break between wetland and aquatic habitats, for as Daubenmire (1968:138) says, emergent, anchored hydrophytes are not true aquatics, but are "amphibious". They grow in both permanently flooded and wet, non-flooded soils. Thus, emergents represent fairly well the zone of transition between aquatic and terrestrial systems, and this is the essence of wetland. This classification system covers both wetlands and aquatic habitats.

OBJECTIVES AND STRUCTURE OF THE SYSTEM

The classification has three primary objectives: (1) to group ecologically similar habitats, so that value judgments can be made; (2) to furnish habitat units for inventory and mapping; and (3) to provide uniformity in concepts and terminology throughout the entire United States, as an aid to people charged with management of wetlands and aquatic habitats.

The structure presented below is hierarchical, and progresses from provinces (Fig. 1) at the most general level, to major ecological systems and subsystems, to habitat classes, subclasses and orders, and finally to the habitat type which is formed by adding modifiers for water regime and water chemistry to the order. Where no orders have been defined these same modifiers may be applied to classes or subclasses. Figures 2-6 illustrate the classification structure within each of the five ecological systems. The same parameters are not always used at the same level in all systems. Although consistency is conceptually appealing, it is not always ecologically meaningful or, in some cases, even possible. For example, we subdivide marine and estuarine systems on the basis of tidal inundation, whereas the riverine system is subdivided first on the basis of stream gradient, water velocity, stream bed composition and presence or absence of a floodplain.

Finally, we must stress that this is an interim classification. It must be tested in the field in order to determine its

Figure 1. **Wetland** provinces of the United States. Numbered provinces are directly equivalent to the sections in Bailey's (1975) map of ecoregions of the United States. Named provinces apply to estuarine and marine systems and were developed for this wetland classification.

ECOREGION LEGEND

1000 POPLAR DOMAIN

1200 TUNDRA DIVISION
- 1210L Arctic Tundra Province
- 1210M Brooks Range Province
- 1220L Bering Tundra Province

1300 SUBARCTIC DIVISION
- 1310L Yukon Parkland Province
- 1310M Alaska Range Province
- 1320L Yukon Forest Province

2000 HUMID TEMPERATE DOMAIN

2100 HUMID COOL-SUMMER CONTINENTAL DIVISION
- 2110L Laurentian Mixed Forest Province
  - 2111L Spruce-Fir Section
  - 2112L Northern Hardwoods-Fir Section
  - 2113L Northern Hardwoods Section
  - 2114L Northern Hardwoods-Spruce
- 2110M Columbia Forest (Dry-Summer) Province
  - 2111M Douglas Fir Section
  - 2112M Cedar-Hemlock-Doulas Fir Section

2200 HUMID WARM-SUMMER CONTINENTAL DIVISION
- 2210L Eastern Deciduous Forest Province
  - 2211L Mixed Mesophytic Section
  - 2212L Beech-Maple Section
  - 2213L Maple-Basswood/Oak Savanna Section
  - 2214L Appalachian Oak Forest Section
  - 2215L Oak-Hickory Section

2300 HUMID SUBTROPICAL DIVISION
- 2310L Outer Coastal Plain Forest Province
  - 2311L Beech-Sweetgum-Magnolia-Pine-Oak Forest Section
  - 2312L Southern Floodplain Forest Section
- 2320L Southern Mixed Forest Province

2400 HUMID MARITIME DIVISION
- 2410M Willamette-Puget Forest Province
  - 2411M Sitka Spruce-Cedar-Hemlock Section
  - 2412M Redwood Forest Section
  - 2413M Cedar-Hemlock-Douglas Fir Forest Section
  - 2414M California Mixed Evergreen Forest Section
  - 2415M Silver Fir-Douglas Fir Forest Section

2500 SUBHUMID PRAIRIE DIVISION
- 2510L Prairie-Parkland Province
  - 2511L Oak-Hickory-Bluestem Parkland Section
  - 2512L Oak-Bluestem Parkland Section
- 2520L Prairie Brushland Province
  - 2521L Mesquite-Buffalo Grass Section
  - 2522L Juniper-Oak-Mesquite Section
  - 2523L Mesquite-Acacia Section
- 2530L Tall Grass Prairie Province
  - 2531L Bluestem Prairie Section
  - 2532L Wheatgrass-Bluestem-Needlegrass Section
  - 2533L Bluestem-Grama Prairie Section

2600 MEDITERRANEAN (DRY-SUMMER SUBTROPICAL) DIVISION
- 2610L California Grassland Province
- 2610M Sierran Forest Province
- 2620M California Chaparral Province

3000 DRY DOMAIN

3100 SEMIARID STEPPE DIVISION
- 3110L Great Plains-Short Grass Steppe Province
  - 3111L Grama-Needlegrass-Wheatgrass Section
  - 3112L Wheatgrass-Needlegrass Section
  - 3113L Grama-Buffalo Grass Section
- 3110M Rocky Mountain Forest Province
  - 3111M Grand Fir-Douglas Fir Forest Section
  - 3112M Douglas Fir Forest Section
  - 3113M Ponderosa Pine-Douglas Fir Forest Section
- 3120L Palouse Grassland Province
- 3120M Southern Rocky Mt. Pine-Douglas Fir Forest Province
- 3130L Intermountain Sagebrush Province
  - 3131L Sagebrush-Wheatgrass Section
  - 3132L Lahontan Saltbush-Greasewood Section
  - 3133L Great Basin Sagebrush Section
  - 3134L Bonneville Saltbush-Greasewood Section
  - 3135L Ponderosa Shrub Forest Section
- 3130M Upper Gila Mts. Pine-Douglas Fir Forest Province
- 3140L Mexican Highland Shrub Steppe Province
- 3140P Colorado Plateau Province
  - 3141P Juniper-Pine/Sagebrush-Saltbush Mosaic Section
  - 3142P Grama-Galleta Steppe/Juniper-Pinyon Woodland Section
- 3150A Wyoming Basin Province
  - 3151A Wheatgrass-Needlegrass-Sagebrush Section
  - 3152A Sagebrush-Wheatgrass Section

3200 ARID DESERT DIVISION
- 3210L Chihuahuan Desert Province
  - 3211L Grama-Tobosa Section
  - 3212L Tarbush-Creosote Bush Section
- 3220L American Desert (Mojave-Colorado-Sonoran) Province
  - 3221L Creosote Bush Section
  - 3222L Creosote Bush-Bur Sage Section

4000 HUMID TROPICAL DOMAIN

4100 TROPICAL SAVANNA DIVISION
- 4110L Tropical Mangrove Province

4200 TROPICAL RAINFOREST DIVISION
- 4210M Hawaiian Islands

MARINE/ESTUARINE

1 ARCTIC
2 ACADIAN
3 VIRGINIAN
4 CAROLINIAN
5 WEST INDIAN AND PUERTO RICO AND VIRGIN ISLANDS
6 LOUISIANIAN
7 CALIFORNIAN
8 COLUMBIAN
9 FIORD
10 PACIFIC INSULAR

L - Lowland Ecoregions
M - Mountains
P - Plateaus
A - Altiplano

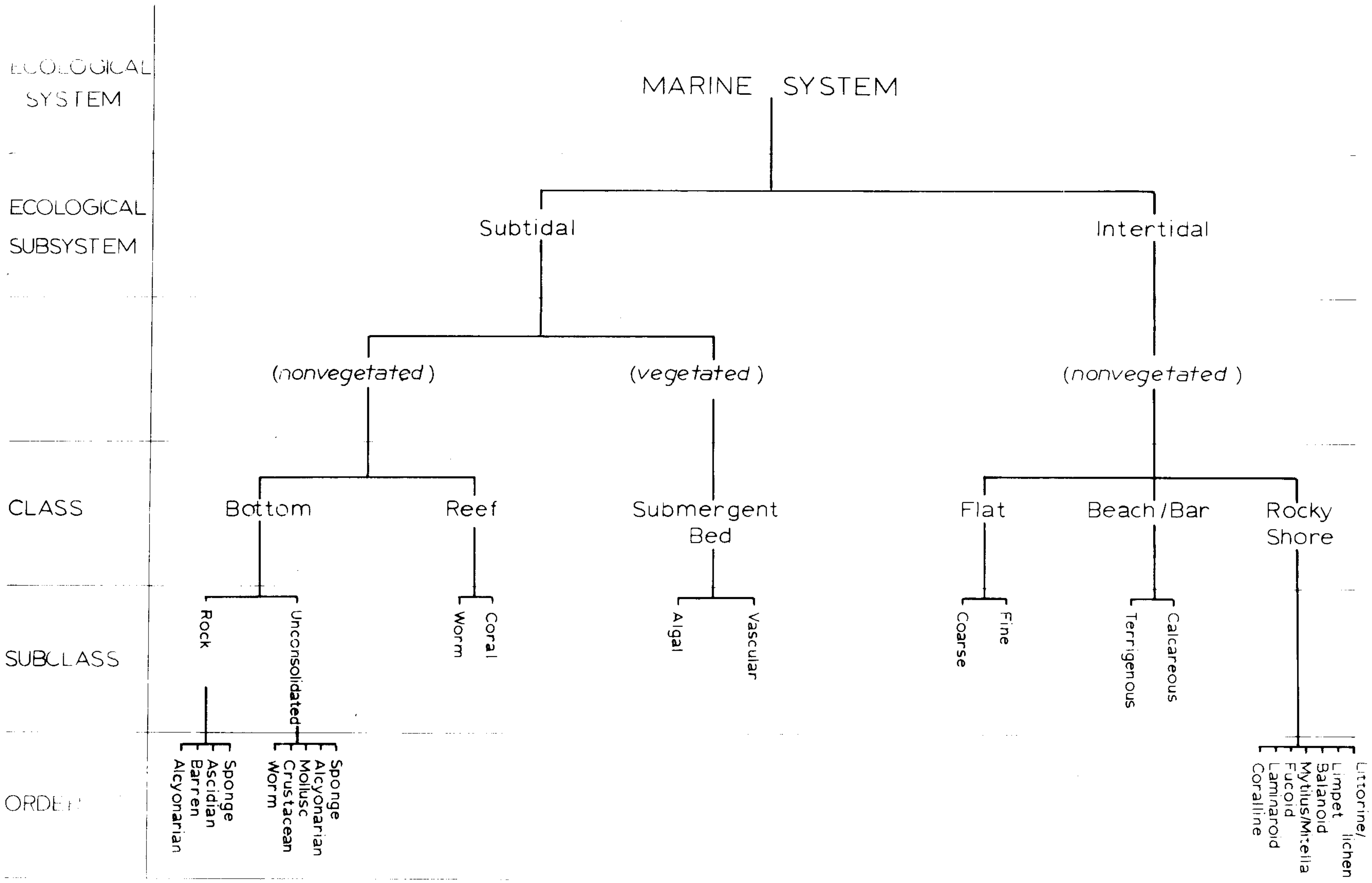

Figure 2. Diagram of the wetland classification hierarchy for the marine ecological system to the order level.

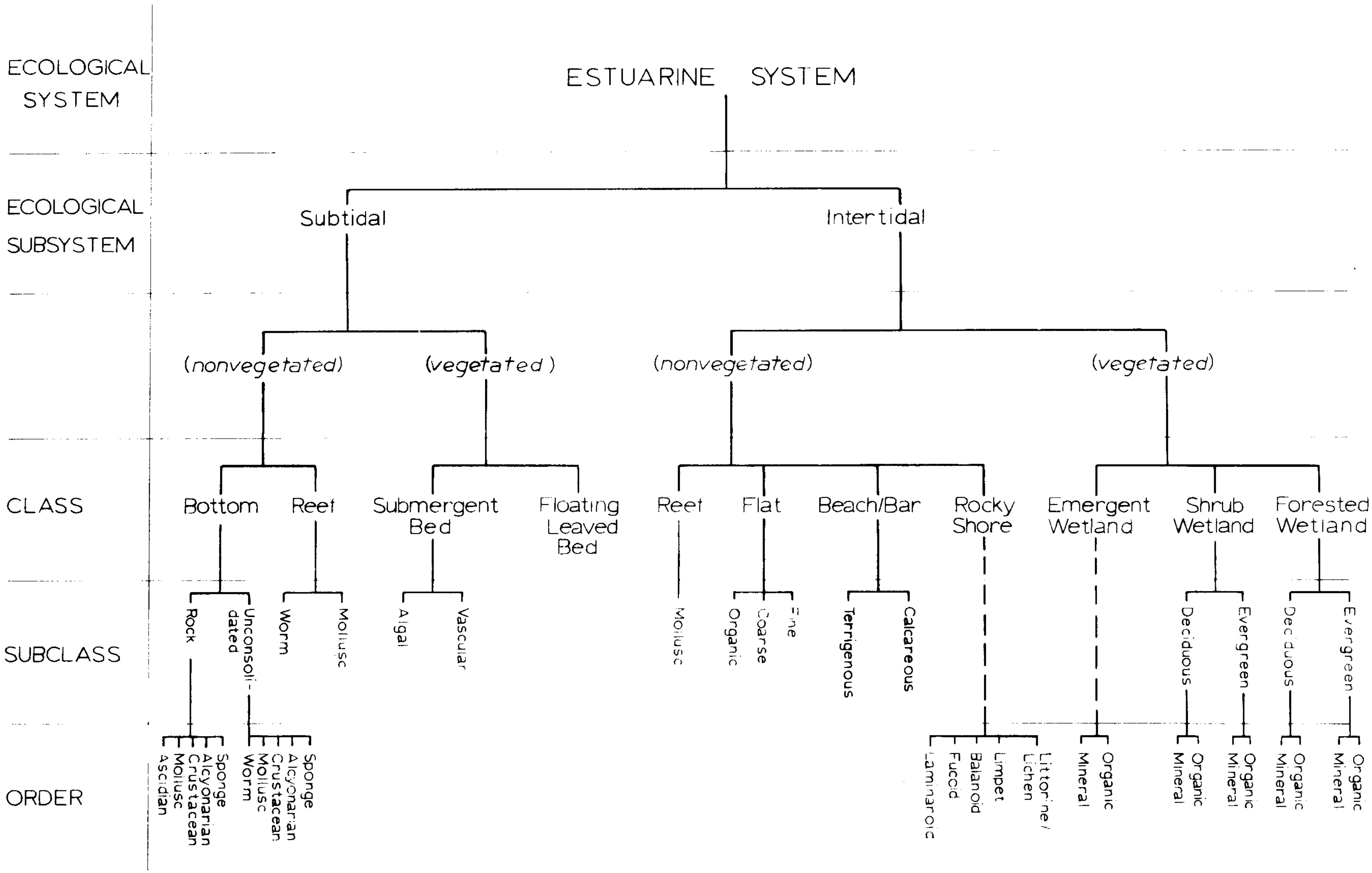

Figure 3. Diagram of the wetland classification hierarchy for the estuarine ecological system to the order level.

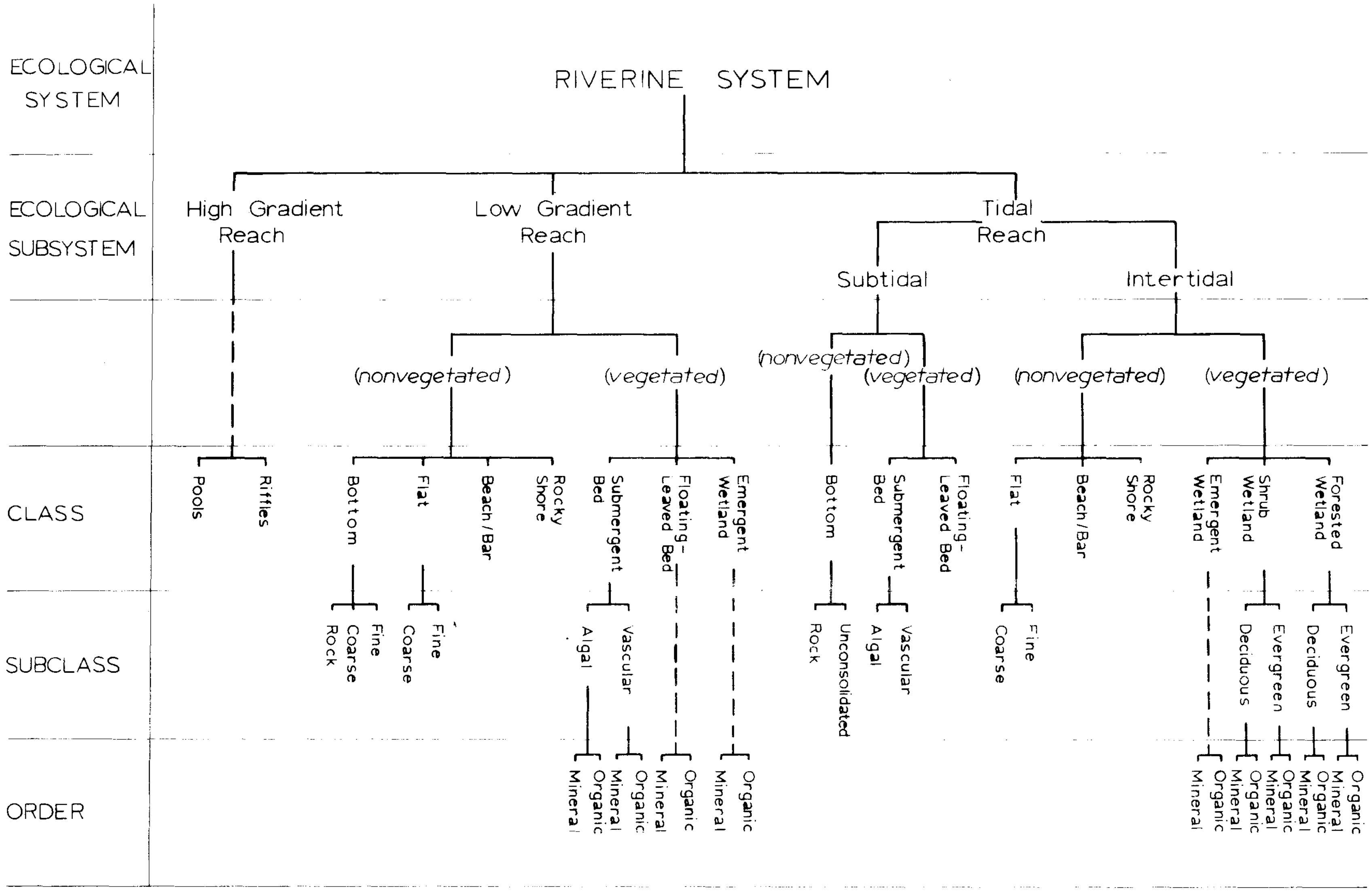

Figure 4. Diagram of the wetland classification hierarchy for the riverine ecological system to the order level.

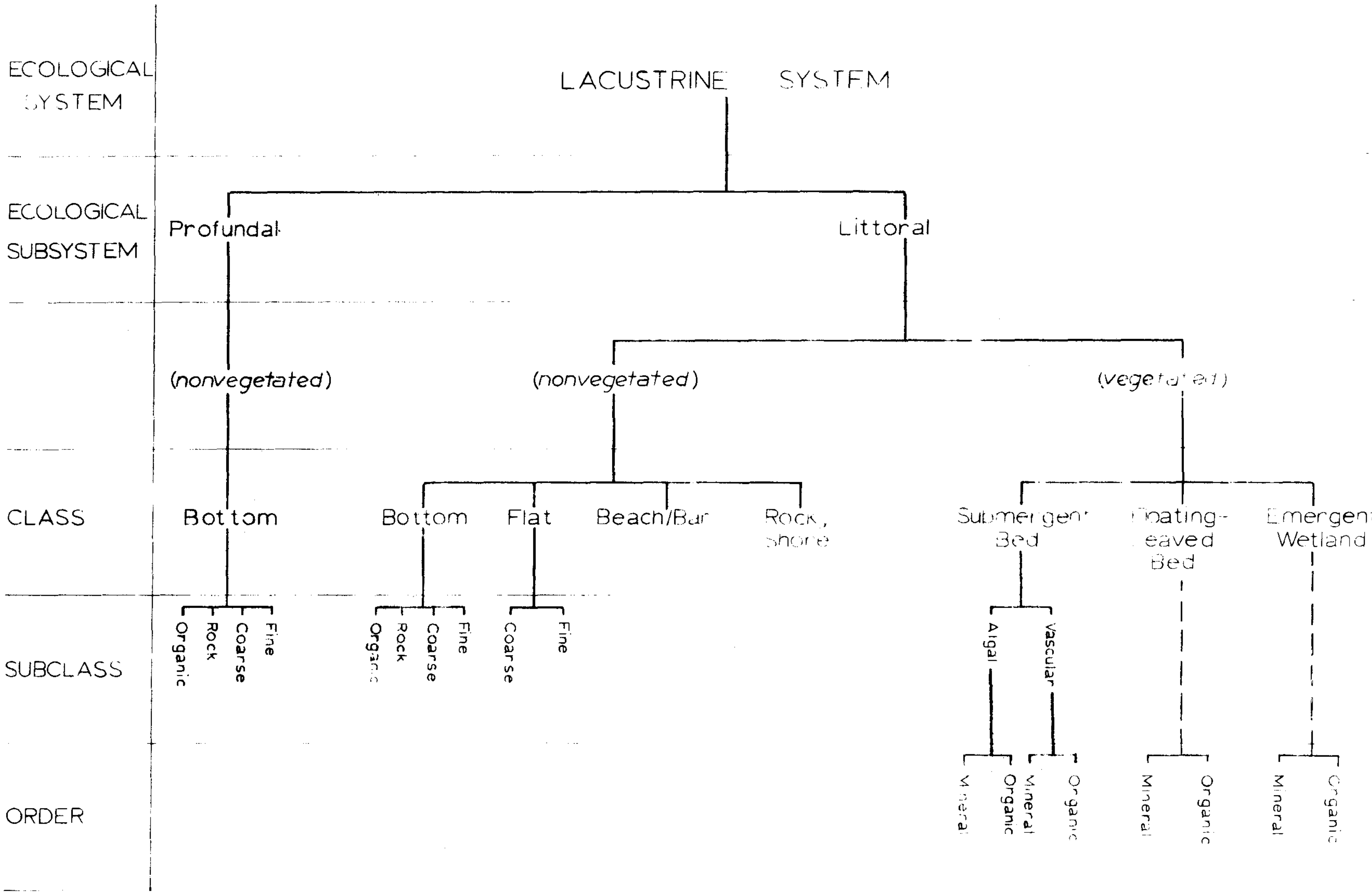

Figure 5. Diagram of the wetland classification hierarchy for the lacustrine ecological system to the order level.

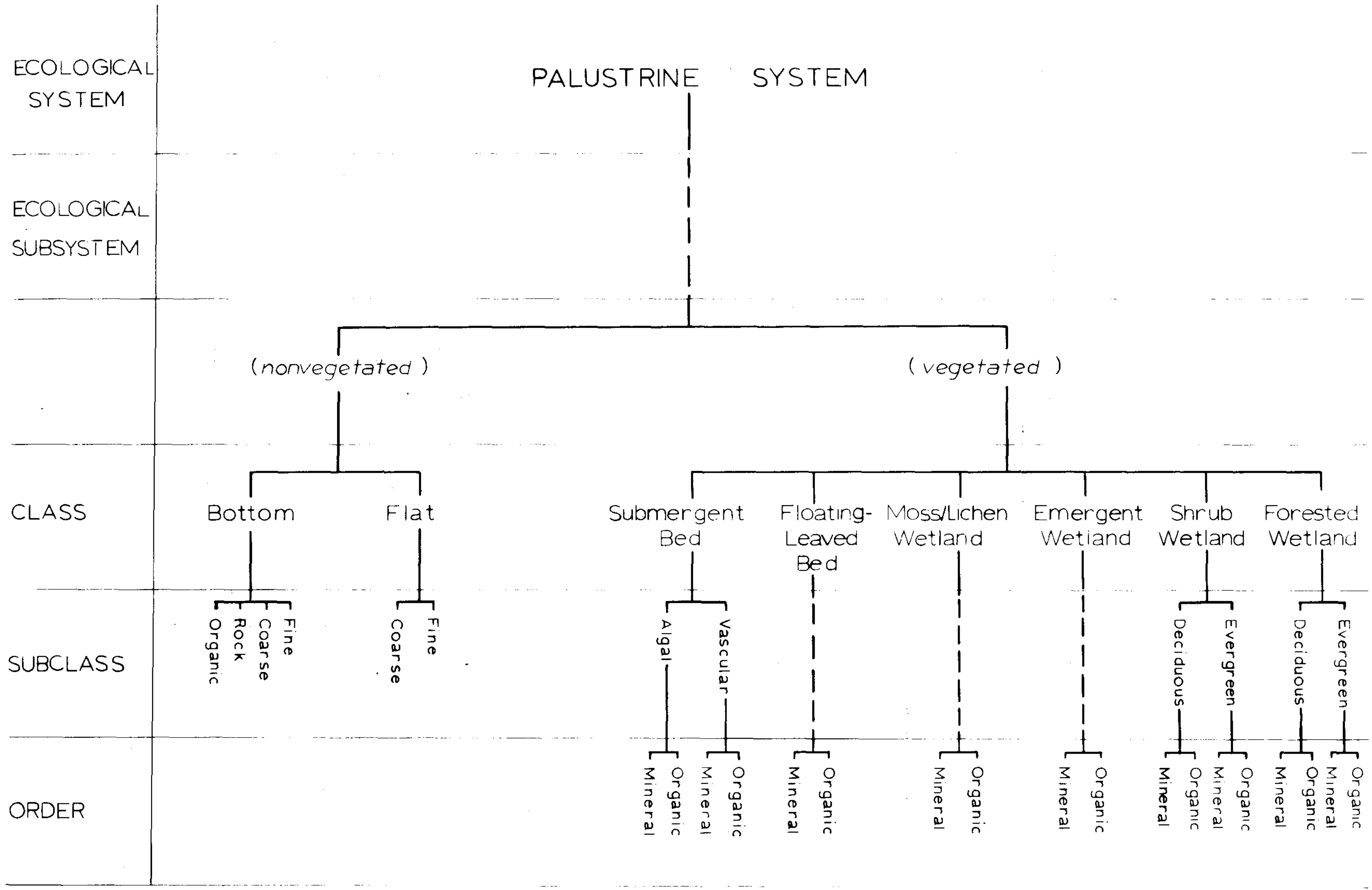

Figure 6. Diagram of the wetland classification hierarchy for the palustrine ecological system to the order level.

applicability and utility. We suspect that a number of omissions and inconsistencies will be found during the period of testing, and that these will prompt further alteration and redefinition.

THE CLASSIFICATION SYSTEM

PROVINCES

In this classification system, a given taxon below the level of province has no particular regional alliance; it may be found in one or many parts of the United States. However, regional variations in climate, geologic history, soils and vegetation are important in the development of different wetland habitats; and, often, different regions have very different management problems. For these reasons, we felt the need to recognize regional differences at the highest level in the classification. This regionalization is designed to facilitate: (1) planning at the national level, where it is necessary to study management problems and potential solutions on a regional basis; (2) organization and retrieval of data gathered in a resource inventory; and (3) interpretation of inventory data, including differences in indicator plants and animals among the provinces.

We have adopted the Bailey (in press) classification and map (Bailey 1975) of ecoregions to fill the need for regionalization inland. Bailey's classification of ecoregions is hierarchical. The first four levels are: domain, defined by subcontinental areas of related climates; division, defined by regional climate at the level of Köppen's (1931) types; province, defined by broad vegetational types; and section, defined by climax vegetation at the level of Küchler's (1964) types. On the map, the boundaries between the different levels were designated by various line widths and the sections are numbered with a four digit code where digits 1 through 4 represent the first four levels in the hierarchy (Fig. 1). The interested reader is referred to Bailey's map for a discussion and description of the units appearing on the map. Our provinces are directly equivalent to Bailey's sections. The map of ecoregions, like this wetland classification, is new and yet untested. Adjustments in regional boundaries may become necessary during testing of this classification, but Bailey's system appears to be conceptually sound, and it could form the basis for relating aquatic habitats, wetlands and uplands within a single, meaningful structure.

The Bailey system terminates at the ocean, whereas this wetland classification includes marine and estuarine habitats. Many workers have divided marine and estuarine realms into series of biogeographic provinces (e.g., U. S. Senate 1970, Ketchum 1972). These provinces differ somewhat in detail, but the broader concepts are similar. We have developed the following provinces for North America.

(1) The Arctic Province extends from the southern tip of Newfoundland (Avalon Peninsula), northward around Canada to the west coasts of the Arctic Ocean, Bering Sea, and Baffin and Labrador Basins. It is characterized by the southern extension of floating ice, the 4°C summer isotherm and arctic biota.

(2) The Acadian Province extends along the northeast Atlantic coast from the Avalon Peninsula to Cape Cod and

is characterized by a well developed algal flora and boreal biota. It has a large tidal range and is strongly influenced by the Labrador Current.

(3) The Virginian Province extends along the middle Atlantic coast from Cape Cod to Cape Hatteras. The province is transitional between Acadian and Carolinian. The biota is primarily temperate with some boreal representatives. The Labrador Current occasionally extends down to Cape Hatteras and winter temperatures may approach 4°C.

(4) The Carolinian Province is situated along the south Atlantic coast from Cape Hatteras to Cape Kennedy. It contains extensive marshes and well developed barrier islands. Waters are turbid and productive. The biota is temperate with seasonal tropical elements. The Gulf Stream is the primary influence and winter temperatures reach a minimum of 10°C; summer temperatures are tropical (in excess of 20°C). The tidal range is small to moderate.

(5) The West Indian Province extends from Cape Kennedy to Cedar Key, Florida and also includes the southern Gulf of Mexico, the Yucatan Peninsula, Central America and the Caribbean Islands. Shoreland is usually low lying limestone with calcareous sands and marls except for volcanic islands. The biota is tropical and includes reef corals and mangroves. Minimum winter temperatures are about 20°C and the tidal range is small.

(6) The Louisianian Province extends along the northern coast of the Gulf of Mexico from Cedar Key to Port Aransas, Texas. The characteristics of the province are similar to those of the Carolinian, reflecting the past submergence of the Florida Penninsula. The biota is primarily temperate and the tidal range is small.

(7) The Californian Province extends along the Pacific coast from Mexico northward to Cape Mendocino. The shoreland is strongly influenced by coastal mountains and the coasts are rocky with limited fresh-water runoff. In the southern part volcanic sands are present; marshes and swamps are scarce throughout the province. The climate is Mediterranean and influenced by the California Current. The biota is temperate, and well developed offshore kelp beds are present. The tidal range is moderate.

(8) The Columbian Province extends along the northern Pacific coast from Cape Mendocino to Vancouver Island. Mountainous shoreland with rocky foreshores are prevalent. Estuaries are strongly influenced by fresh-water runoff. The biota is primarily temperate with some boreal components and there are extensive algal communities. The province is influenced by both the Aleutian and California Currents. The tidal range is moderate to large.

(9) The Fjord Province extends along the Pacific coast from Vancouver Island to the southern tip of the Aleutian Islands.

Precipitous mountains, deep estuaries (some with glaciers), and a heavily indented shoreline subject to winter icing are typical of the coast. The biota is boreal to subarctic. The province is influenced by the Aleutian and Japanese Currents and the tidal range is large.

(10) The Pacific Insular Province surrounds all of the Hawaiian islands. The coasts have precipitous mountains and wave action is stronger than in most of the other. The biota is largely endemic and composed of tropical and subtropical forms. The tidal range is small.

Combining the Bailey system with the estuarine and marine provinces provides a province level for every ecological system, but it also results in discontinuities between boundaries along the coasts. These discontinuities arise because some parameters used to delineate provinces are different in the two systems. Bailey mapped according to climate, vegetation, soils and landform. In the ocean environment, however, some of these features are not applicable, and marine currents, sea temperature, turbidity and ionic concentration are critically important. The lack of agreement between boundaries should cause no concern, because it does not preclude the use of both systems in this classification.

ECOLOGICAL SYSTEMS AND SUBSYSTEMS

The term ecological system refers here to a complex of wetland and aquatic habitats that share the influence of one or more dominant hydrological, geomorphological or chemical factors.

The characteristics of the five major ecological systems described below have been discussed at length in the scientific literature, and the concepts are well recognized even by the general public, but there is frequent disagreement as to which attributes should be used to bound the systems in space. For example, both the limit of tidal influence and the limit of salt influence have been proposed for bounding the upstream end of the estuarine system. As Borman and Likens (1969) pointed out, boundaries of ecosystems are defined to meet pragmatic needs. The boundaries of our systems are certainly artificial in many cases, but we feel that they will serve the practical needs of inventory and mapping.

Within a given ecological system, the habitats often can be grouped or differentiated according to dominant ecological factors, and it seems reasonable to recognize such groupings as subsystems.

Marine System

The marine ecological system is a coastal land and water system with unobstructed access to the open ocean; the water regimes and water chemistry are determined primarily by the ebb and flow of oceanic tides. There is little or no dilution of ocean water except opposite the mouths of estuaries, and salinities generally exceed 30 ‰. Marine systems are frequently considered high energy systems in terms of wave and current action.

The marine system extends inland to: 1) the upper limit of spray and storm surge where trees, shrubs or emergents are absent;

2) the seaward limit of emergents, trees or shrubs where they extend into open ocean waters; or 3) the seaward limit of estuarine waters, where this limit is determined by factors other than vegetation. The seaward limit of the marine system is located at the edge of the continental shelf. Aquatic habitats lying beyond the seaward limit of the marine system are outside of the scope of this classification system.

The distribution of plant and animal species in the marine system primarily reflects differences in: 1) degree of exposure of the site to waves; 2) the texture and physico-chemical nature of the substrate; 3) the amplitude of tides; and 4) latitude, which governs water temperature, the intensity and duration of solar radiation, and the presence or absence of ice. For the purpose of classifying marine wetlands and aquatic habitats, this system can be divided into the following subsystems:

Intertidal Subsystem. This extends from the shoreward limit of the marine system to extreme low spring water. It is that portion of the system where the substrate is ever exposed to the air as a result of tides.

Subtidal Subsystem. This includes habitats within the marine system from the level of extreme low spring water to the seaward limit of the system. Subtidal habitats are continuously submerged in waters of oceanic salinity (30-40 $^{\circ}/_{\circ\circ}$), but are subject to tide-induced pressure changes.

Estuarine System

The estuarine ecological system is a coastal land and water system, semi-enclosed by land, with open, partially obstructed, or sporadic access to the ocean and with a measurable quantity of ocean-derived salt in the water. The water regime and water chemistry of an estuary are affected by one or more of the following forces: (1) oceanic tides, (2) fresh-water runoff from land areas, (3) the balance between precipitation, runoff and evaporation, and (4) wind. Estuarine salinities range from hyperhaline to oligohaline (see water chemistry modifiers). The salinity may be variable (poikilohaline), as in the case of hyperhaline lagoons (e.g., Laguna Madre, Texas) and most brackish estuaries (e.g., Chesapeake Bay, Virginia-Maryland); or relatively stable (homoiohaline), as in the case of sheltered euhaline embayments (e.g., Chincoteague Bay, Maryland) or brackish embayments with partially obstructed access or small tidal range (e.g., Pamlico Sound, North Carolina). Estuaries are generally considered low energy ecosystems in terms of wave and current action and the estuarine system is more strongly influenced by its association with land than the marine ecosystem.

Estuaries extend upstream and landward to the extent of measurable ocean-derived salt water; we suggest 0.5 $^{\circ}/_{\circ\circ}$ as a practical limit. The seaward limit of the estuarine system is determined by a straight line which closes the mouth of a river or bay, or by the seaward limit of intertidal vascular vegetation if this extends seaward beyond the above line. By definition, then, all intertidal wetlands with vascular hydrophytes and salinities greater than 0.5 $^{\circ}/_{\circ\circ}$ are estuarine.

The estuarine system, like the marine, consists of two subsystems:

Intertidal Subsystem. This includes all habitats from the shoreward limit of the estuarine system to the level of extreme low spring water. It is that portion of the system where the substrate is ever exposed to the air as a result of tides.

Subtidal Subsystem. This includes all habitats within the estuarine system that are permanently flooded with tidal water. It extends from the level of extreme low spring water to the upstream and seaward limits of the estuarine system.

Riverine System

The system is bounded on the landward side by the channel bank (including natural or man-made levees), and vegetation channelward of the bank is included in the riverine system regardless of density. If the channel bank cannot be identified, the system is bounded on the landward side by upland or by hydrophytic trees, shrubs, persistent emergents, mosses or lichens with an areal coverage of more than 30 percent. In tidal portions of rivers, the system is bounded on the landward side by the extent of tidal inundation at extreme high spring tide.

The riverine system terminates at the estuarine (downstream) end where the ionic concentration of the water becomes dominated by sea salt (NaCl $\geq$ 0.5°/₀₀ suggested) or where the water becomes part of a lacustrine system. It terminates at the upstream end where tributary streams originate, whether their flow is perennial or intermittent. A lake is included in the riverine system if it is a continuation of the river channel and lies entirely within the river floodplain; if a lake is wider than the river floodplain or is isolated from the channel, it is considered to constitute a lacustrine system. Riverine habitats generally furnish suitable habitat for fish if the water is permanent.

The riverine system is divided into three subsystems: the high gradient reach, the low gradient reach and the tidal reach. The boundaries of these subsystems cannot be precisely defined, and all three are not necessarily present in all riverine systems. The reaches are defined in terms of gradient, water velocity, streambed composition and presence or absence of a floodplain. They appear to have characteristic fauna and water temperatures where the water is permanent. (See Hynes 1970, Reid 1961, Illies and Botosaneau 1963).

High Gradient Reach. In the high gradient reach, the flow is fast and the streambed consists of rock, cobbles, or gravel with occasional patches of sand. The natural O_2 concentration is normally near saturation, the fauna is characteristic of running water, and there is little or no true plankton. There is very little floodplain development, and generally the monthly mean temperature is less than or equal to 20°C.

Low Gradient Reach. In the low gradient reach, the flow is slower and the streambed is mainly sand, silt and clay. Oxygen deficits may occur at times, the fauna is composed mostly of species that reach their maximum abundance in still water, and there is often a rich assemblage of plankton. The floodplain is well developed and generally the highest monthly mean temperature is more than 20°C.

Tidal Reach. In the tidal reach, the gradient is low and water velocity fluctuates under tidal influence. The streambed is mainly silt and clay with occasional patches of sand. Oxygen deficits may occur at times, and the fauna is similar to that in the low gradient reach. The floodplain is typically well developed and the monthly mean temperature generally rises to more than 20°C.

Lacustrine System

This system includes all non-tidal habitats situated in topographic depressions, (1) where a wave-formed or bedrock shoreline feature forms all or part of the boundary; or, if such a feature is not present, (2) where the deepest part of the catchment is at least 20 acres in size and permanently devoid of trees, shrubs or persistent emergents.

Where a wave-formed or bedrock feature is present, the habitats lakeward of this feature are included in the lacustrine system regardless of the density of the vegetation. Where such a shoreline feature forms only part of the boundary, the remainder of the system is bounded by upland or by a permanent cover of hydrophytic trees, shrubs, emergents, mosses or lichens, with an areal coverage of more than 30 percent. If a shoreline feature is entirely lacking, the boundary is placed at the upland edge or where hydrophytic trees, shrubs, emergents, mosses or lichens surrounding the lake reach an areal coverage of more than 30 percent. Lacustrine habitats may be permanently or intermittently flooded, but typically, they contain extensive areas of deep water, exhibit considerable wave action and furnish suitable habitat for fish if the water is permanent.

Most limnologists subdivide lacustrine systems into zones which indicate the ability of the substrate to support various life forms of macroscopic plants (Welch 1952, Ruttner 1963, Hutchinson 1967). The different life forms are distributed according to surface-water depth and permanence, and the lakeward boundary of rooted or adnate, macroscopic plants occurs where insufficient light penetrates to the bottom to support photosynthesis. The position of this boundary is a function of both water depth and turbidity.

Some authors (e.g., Hutchinson 1967) have labeled as many as eight zones in lakes, but most agree that the first, most general subdivision is into littoral and profundal zones. We have employed these two basic zones as subsystems within the lacustrine system. Although the boundary between the zones is often difficult to locate precisely, we feel that the practical task of assigning habitats to one subsystem or the other will be relatively simple.

The subsystem definitions are as follows:

Littoral Subsystem. This extends from the shoreward boundary of the lacustrine system to the maximum depth of effective light penetration (photic zone). All portions of the lake that support rooted or adnate, macroscopic plants lie within the littoral zone, but some areas within this zone may be nonvegetated.

Profundal Subsystem. This includes the deep zone of a lake where rooted or adnate, macroscopic plants are absent because of insufficient light for photosynthesis. Some lacustrine environments may be so shallow that they lack a profundal zone.

Palustrine System

This system includes all non-tidal wetland and aquatic habitats where all of the following conditions hold: (1) surface water is not restricted to a definable channel; (2) wave-formed or bedrock shoreline features are absent; (3) areas permanently lacking trees, shrubs, persistent emergents, mosses and lichens, and representing the deepest part of a catchment, are less than 20 acres in extent. As this definition implies, the palustrine system includes all wetlands and aquatic habitats which do not fall within marine, estuarine, riverine or lacustrine systems. A palustrine habitat may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. The erosive forces of waves and flowing water are of minor importance. Because the palustrine system does not lend itself readily to subdivision, in the same way that the other systems do, no subsystems have been recognized.

HABITAT CLASSES, SUBCLASSES AND ORDERS

The habitat class is the highest taxonomic unit below the subsystem level. It describes the general appearance of the habitat, in terms of dominant plant life forms for vegetated areas and the form of the substrate for nonvegetated areas. Any obvious variation in appearance from one area to another must be the result of some environmental change, either natural or man-related. In many cases, however, the relationships between habitat appearance and the many, interrelated ecological factors are complex and poorly understood. We have sought to define habitat classes that can be recognized without the aid of detailed environmental measurements, but where the relationships are better known, we have attempted to demonstrate them in our diagrams of classification structure (Figs. 2-6).

In many cases, it has seemed reasonable to recognize finer categories, termed subclasses, within a class. Forested and shrub wetlands, for example, have been divided into evergreen and deciduous subclasses on the basis of leaf persistence. Flats, beach/bars and bottoms are similarly divided into subclasses according to substrate texture and origin (e.g., fine, coarse, organic).

The habitat order forms the taxon subordinate to habitat subclass. Orders are distinguished on the basis of soil type, vegetation or dominant sedentary animal communities. Boundaries between orders are less obvious than those between classes, and during inventory, the determination of most orders will undoubtedly have to be made through ground sampling. For example, deciduous forested wetlands occur on both organic and mineral soils, but this difference in soil types may be reflected only in slightly different plant species composition. Many dominant species such as red maple (*Acer rubrum*) grow on both soil types, and though the distinction may be subtle and sometimes difficult to determine, we feel that it is a very basic one which influences wetland hydrology, water chemistry, engineering properties and wildlife values. In a similar manner, unconsolidated bottoms in the marine system support several different kinds of invertebrate communities which can only be identified in the field.

The wetland and aquatic habitats in Figures 2-6 have been grouped under vegetated and nonvegetated headings. For the purpose of this classification, a vegetated habitat is defined as any habitat where more than 30 percent of the substrate is covered by vegetation at the peak of the growing season. In a few cases, habitats which may be vegetated according to the above rule have been placed under the nonvegetated heading, because the substrate is considered to be the dominant feature. For example, rocky shores and flats in estuaries are considered nonvegetated habitats even though they may support algal communities.

Vegetated Wetlands and Aquatic Habitats

Such terms as marsh, bog, swamp, fen and meadow have not been used in this classification system because there is considerable disagreement among wetland scientists and managers as to the meaning of these words. When we attempted to define these vernacular terms, we realized that our definitions were reasonable for one part of the United States, but meaningless in another. It is virtually impossible to define these words in a manner that will be accepted throughout the country. Therefore, we have abandoned their use (except colloquially), and instead offer a classification of the components (life form, soil type, water regime and water chemistry) which give rise to such concepts as swamp or marsh. We believe that this approach will greatly reduce the misunderstandings that result from use of the common terms. In the discussions which follow, we have described the approximate relationship between our taxa and the common terms as used in various regions of the country.

One of the most important parameters used in this and most other wetland classifications is the life form, growth habit or physiognomy of the dominant plants present. The relevance of life form as a criterion of classification has been stressed by several authors (e.g., Radforth 1962, Golet and Larson 1974). Use of life forms at the class level has two major advantages: (1) People without a high degree of botanical or ecological expertise can identify them relatively easily, and (2) they have been used extensively in inventories conducted by remote sensing (e.g., Anderson et al. 1972).

A "dominant" plant has traditionally meant a plant that exerts control over the environment (Weaver and Clements 1938:91). For practical reasons, we define dominants as plants with the same life form which constitute the uppermost layer of vegetation at a site and possess areal coverage greater than 30 percent. For example, an area with 50 percent areal cover of trees over a layer of shrubs with 60 percent areal cover would be classified a forested wetland; an area with 20 percent areal cover of trees over the same shrub layer would be classified a shrub wetland. As stated above, if a stand of plants covers less than 30 percent of the substrate, the area is considered to be nonvegetated. Thus, a sparse stand of salt marsh cordgrass (Spartina alterniflora) over bare mud would be classified a flat. In those cases where vegetation dies back at one season of the year, dominance is determined during the peak of the growing season.

Before describing the various vegetated habitats, a number of terms must be defined. Terms relating to the plant life forms and appearances used to distinguish classes and subclasses are defined first. Unless otherwise indicated, life form definitions are based on the following references: Sculthorpe (1967), Daubenmire (1968), Golet and Larson (1974). Descriptions of organic and mineral soils, which separate orders of vegetated habitats, follow:

Vascular plant. A plant having a conducting system (xylem and phloem) (Cronquist 1961:883); e.g., trees, ferns, grasses.

Non-vascular plant. A plant lacking a conducting system; e.g., algae, fungi, mosses.

Woody plant. A seed plant (gymnosperm or angiosperm) which develops persistent, hard, fibrous tissues, basically xylem; e.g., trees and shrubs.

Tree. A woody plant which at maturity is 6 m (20 ft) or more in height, usually with a single trunk, unbranched for at least several feet above the ground, and having a more or less definite crown (Harlow and Harrar 1969:1-2); e.g., red maple (*Acer rubrum*), northern white cedar (*Thuja occidentalis*).

Shrub. A woody plant which at maturity is less than 6 m (20 ft) tall, usually exhibiting several erect, spreading or prostrate stems and a generally bushy appearance (Harlow and Harrar 1969:2); e.g., red osier dogwood (*Cornus stolonifera*), buttonbush (*Cephalanthus occidentalis*).

Deciduous. A descriptive term for woody plants that shed their green leaves or needles during the cold or dry season; e.g., bald cypress (*Taxodium distichum*), black ash (*Fraxinus nigra*). We define deciduous stands as those where less than 70 percent of the dominant trees or shrubs are evergreen.

Evergreen. A descriptive term for woody plants that retain their green leaves or needles throughout the year; e.g., black spruce (*Picea mariana*), inkberry (*Ilex glabra*), red mangrove (*Rhizophora mangle*). We define evergreen stands as those where greater than 70 percent of the dominant trees or shrubs are evergreen.

Herb. A flowering seed plant (angiosperm) that does not develop persistent, woody tissues; e.g., cattails (*Typha* spp., pondweeds (*Potamogeton* spp.).

Emergent. An erect, rooted, herbaceous hydrophyte which may be temporarily or permanently flooded at the base, but is nearly always exposed at the upper portion; e.g., arrow arum (*Peltandra virginica*), salt marsh cordgrass (*Spartina alterniflora*). Certain non-flowering plants such as horsetails (*Equisetum* spp.) which meet the structural requirements for emergents are also included in this life form.

Floating-leaved plant. A rooted, herbaceous hydrophyte with leaves floating on the water surface; e.g., white water lily (*Nymphaea odorata*), floating-leaved pondweed (*Potamogeton* natans). Plants such as yellow water lily (Nuphar advena) which sometimes have leaves raised above the surface are also considered floating-leaved plants (Hutchinson 1975).

Submergent. An herbaceous or non-vascular hydrophyte, either rooted or nonrooted, which lies entirely beneath the water surface, except for flowering parts in some species; e.g., wild celery (Vallisneria americana, eelgrass (Zostera marina), muskgrasses (Chara spp.).

Hydrophyte. Any plant growing in a soil that is at least periodically deficient in oxygen as a result of excessive water content.

Xerophyte. Any plant growing in a habitat in which an appreciable portion of the rooting medium dries to the wilting coefficient at frequent intervals.

Mesophyte. Any plant growing where moisture and aeration conditions lie well between both extremes.

Organic Soil.[1] In this classification system, the term organic soil is used to mean a Histosol, as defined by the U.S. Soil Conservation Service, Soil Survey Staff (1973). It is a general rule that a soil is classed as a Histosol either if more than 50 percent of the upper 80 cm of soil is organic material, or if organic material of any thickness rests on rock

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[1] The description of organic soils (Histosols) is taken directly from McKinzie (1974:2-3).

or on fragmental material having interstices filled with organic materials. The organic materials must contain at least 12 to 18 percent organic carbon, by weight, depending on the clay content of the mineral fraction. Histosols are readily distinguished from mineral soils by bulk density.

In addition to the required organic carbon content, Histosols are organic soils that, except for thin mineral layers, extend from the surface to one of the following:

(1) A depth of 60 cm or more if 75 percent or more of the volume is fibric sphagnum or moss or if the bulk density is less than 0.1 g/cm^3;

(2) A depth of 40 cm if the organic soil material is saturated with water for long periods (6 months) or is artificially drained, and the organic material has a bulk density of 0.1 g/cm^3 or more;

(3) A depth of 10 cm or less above a lithic (rock) or paralithic contact, provided the thickness of the organic soil material is more than twice that of the mineral material above the contact;

(4) Any depth, if the organic material rests on fragmental material (gravel, stones, or cobbles) in which the interstices are filled or partly filled with organic materials or rests on a lithic or paralithic contact.

In the United States, the terms peat and muck have often been used to describe organic soils. <u>Peat</u> refers to organic soil which has undergone very little decomposition so that the plant remains can be identified. Peat deposits tend to be brown, orange or reddish in color and relatively coarse in texture. Muck is organic soil which is so well decomposed that the identification of plant constituents is impossible. Muck deposits are generally dark brown to black in color and very fine in texture. In most other parts of the world, wetlands with organic soils have been termed peatlands and the word peat has been applied to all organic soils regardless of the degree of decomposition.

The degree of decomposition of an organic soil reflects plant composition, water regime and water chemistry (Heinselman 1970), and, in some parts of North America, it has been utilized in wetland classification (Golet and Larson 1974, Zoltai et al. 1975). However, because latitude and climate also affect rates of decomposition, and because there is little information on this aspect of wetland soils, we decided that wetland types in this system could not be distinquished by degree of decomposition of organic soils.

Mineral Soils. Any soil with less organic matter content or a thinner organic surface horizon than an organic soil is classified a mineral soil. Mineral soils are usually vegetated, unless the substrate is subject to continuous erosion or sedimentation, or unless it has excessively high salt content in the surface layer. Organic soils are generally vegetated, except immediately following fire or a sudden drawdown of surface water. Substrates which are permanently covered with water so deep that only floating-leaved plants or submergents can exist are considered to be non-soils (U.S. Soil Conservation Service, Soil Survey Staff 1973). Appendix B lists the major organic and mineral soils of wetland and aquatic habitats in the United States.

Forested Wetlands

Forested wetlands are wetlands dominated by trees. They are particularly extensive in the palustrine system, but are also represented by mangroves (*Rhizophora mangle*, *Languncularia racemosa*, *Avicennia nitida*) in estuarine areas. Martin et al. (1953) considered mangroves sufficiently different from other forest communities to warrant placing them in separate class (Type 20, mangrove swamps).

Evergreen forested wetlands are widespread in the north where vast acreages of mineral-poor peatland (See section on Water Chemistry Modifiers below) are dominated by black spruce (*Picea mariana*), often in association with the deciduous, needle-leaved species, larch (*Larix laricina*). Such wetlands were classed as swamp in Circular 39 (Shaw and Fredine 1956), and are frequently called swamps locally. The term bog or forested bog has also been applied to mineral-poor organic soils with tree cover and dense ground cover of mosses of the genus *Sphagnum* (e.g., Heinselman 1970, Golet and Larson 1974).

Evergreen species such as northern white cedar (_Thuja occidentalis_) that occur on mineral-rich sites in the north have been called either swamps or forested fens.

Along the Atlantic Coast, evergreen forested wetlands dominated by Atlantic white cedar (_Chamaecyparis thyoides_) are common on organic soils, and the shrub and ground cover layers often include species found in more northern evergreen forested wetlands. These areas have been classified as swamps (e.g., Akerman 1923, Korstian 1924, Wells 1928), evergreen wooded swamps or wooded bogs (e.g., Buell and Cain 1943, Oosting 1942, Golet and Larson 1974) and peaty swamps by Penfound (1952). In the southeast, evergreen forested wetlands dominated by the broad-leaved bays, _Persea borbonia_, _Gordonia lasianthus_, and _Magnolia virginiana_, are called simply bays or bay heads. Mangroves are found in the tropical and subtropical United States (Kuenzler 1974, Walsh 1974).

Deciduous forested wetlands are also widespread throughout the United States, but whereas evergreen forested wetlands tend to be dominant in the far north, the deciduous forested wetlands reach their greatest importance in the south and east. In the northeast, species such as red maple (_Acer rubrum_), black ash (_Fraxinus nigra_) and American elm (_Ulmus americana_) are found on both organic and mineral soils. Red maple is able to dominate a wide range of sites, from organic to mineral soils, and mineral-poor to mineral-rich water supplies but, in general, the deciduous species are more typical of mineral soils and well decomposed (sapric) organic soils than the evergreen species. In the Lake States, the terms swamp and forested fen are both applied to deciduous forested wetlands.

Deciduous forested wetlands in the south are represented by a large number of tree species. Some of the most important are the cypresses (Taxodium distichum, T. ascendens), the gums (Nyssa sylvatica, N. aquatica), the elm-ash-maple association found also in the north, and several species of oaks (Quercus spp.). Deciduous forested wetlands are usually referred to as swamps or bottomland hardwoods in the south, but isolated islands of forested wetland within emergent wetlands are also called hammocks, heads, and houses.

In the central and western parts of the country, where the climate is drier, forested wetlands are much less common and are restricted to river courses. Willows (Salix spp.) sufficiently tall to be classed as trees are the prevalent species. Forested wetlands of the mountainous west show a close affinity to northern forested wetlands.

Shrub Wetlands

Shrub wetlands are wetlands dominated by shrubs. Like forested wetlands, they are widespread through the United States, and much of the preceding discussion applies equally to them. Some authors (Penfound 1952, Zoltai et al. 1975) did not make a split between forested and shrub communities.

Martin et al. (1953) did make the distinction, and the same was done for systems based on their classification (e.g., Golet and Larson 1974). We recognize the two types, both because the distinction is important for many users, and because it will facilitate the task of relating this system to those based on Martin et al. (1953).

Shrub wetlands are most prevalent in the palustrine system, but they also occur in the estuarine system where they are dominated by such plants as buttonwood (Conocarpus erecta), sea-myrtle (Baccharis halimifolia) and marsh elder (Iva frutescens). Because of our restrictive definitions of riverine and lacustrine, shrub wetlands are relatively unimportant in these systems, but palustrine shrub wetlands do commonly occur on floodplains and along the shores of lakes.

Most evergreen shrub wetlands in the north have been called bogs, and in the south they have been labelled bogs, pocosins, or evergreen shrub bogs. Though common on organic soils, they were described in the south on sands with a high water table (Wells 1932). Wells also pointed out that many evergreen shrubs have evolved leaves capable of retarding water loss, a critical problem for bog plants which, although they grow in saturated soil, must withstand high temperatures resulting from intense solar radiation. Many northern and southern species such as leatherleaf (Chamaedaphne calyculata), bog laurel (Andromeda glaucophylla), tetter-bush (Lyonia lucida) show this adaptation.

Deciduous shrub wetlands occur on both organic and mineral soils, but like deciduous forested wetlands, they are more common on mineral soils and well decomposed organic soils with a mineral-rich water supply. A large number of deciduous shrubs occur in wetlands, but various species of alder (Alnus spp.) and willow (Salix spp.) are among the most common in many regions. In the north, shrub wetlands are called both shrub swamps (Martin et al. 1953) and fens (Heinselman 1963, 1970; Zoltai et al. 1975). Curtis (1959) introduced the European term shrub carr for deciduous shrub wetlands in Wisconsin.

Emergent Wetlands

Wetlands dominated by emergent vegetation are called emergent wetlands. They are found throughout the United States and are most widespread in the palustrine and estuarine systems, but also occur in lacustrine and riverine systems. Wetlands dominated by emergent vegetation such as cattails (Typha spp.), bulrushes (Scirpus spp.), arrowheads (Sagittaria spp.), reedgrass (Phragmites communis), cordgrasses (Spartina spp.), and sawgrass (Cladium jamaicensis) have generally been called marshes or prairies in the United States.

In the north, extensive areas of emergent wetland dominated by sedges (Carex spp.) and grasses (Gramineae) growing on peat soils, where there is a supply of mineral-rich water, are frequently called fens (Curtis 1959, Heinselman 1963, 1970; Damman 1964; Zoltai et al. 1975). Other authors (e.g., Sjörs

1950, Dirschl et al. 1974, Erman and Erman 1975) use the term fen for minerotrophic peatlands regardless of the dominant life form. Emergent palustrine wetlands with saturated, temporarily-flooded or, in some cases, seasonally-flooded water regimes have been called meadows (Martin et al. 1953, Stewart and Kantrud 1971, Golet and Larson 1974). Similar communities in the colder parts of Alaska have been labelled wet tundra (Fay and Cade 1959). Martin et al. also used the term meadow for certain coastal wetlands (Type 16, coastal salt meadows).

Emergent wetlands dominated by cordgrasses (*Spartina alterniflora*, *S. patens*) and needlerush (*Juncus roemerianus*) are major components of the estuarine systems of the Atlantic and Gulf Coasts of the United States. On the Pacific Coast, glassworts (*Salicornia* spp.), seablites (*Suaeda* spp.) and *Spartina foliosa* are the usual dominants. Many of the genera that occur in the estuarine system are also found in high salinity habitats of the palustrine system (e.g., *Suaeda*, *Salicornia*, *Distichlis*, *Spartina*, *Puccinellia*) (Ungar 1974).

Emergent wetlands are generally considered to represent a seral stage in succession from water to dry land. In areas with relatively stable climatic conditions, succession is extremely slow and emergent wetlands maintain the same appearance year after year. In other areas, such as the prairies of the central United States, violent climatic fluctuations cause emergent wetlands to revert to an open water phase in some years (Stewart and Kantrud 1972), and the concept of succession, in the normal sense of the word, has little meaning. Fire also plays an important role in maintaining emergent wetlands (Davis 1946, Curtis 1959), especially in the south (Penfound 1952), and it may retard paludification (Heinselman 1975, Cohen 1974).

Moss/lichen Wetlands

Mosses and lichens are important components of the flora in many wetlands, especially in the north, but these plants usually form a ground cover under a dominant layer of trees, shrubs or herbs. In those relatively uncommon cases where mosses or lichens are not overtopped by other plants, but are instead dominant, the area is classified a moss/lichen wetland. Mosses such as *Drepanocladus* and the liverwort *Cheloscyphyus fragilis* may dominate shallow water areas in Alaska, and *Sphagnum* spp., *Camphylium stellatum*, *Pothia heimii*, *Autacomnium palustre* and *Oncophorus wahlenbergii* are typical of wet soil (Britton 1957, Drury 1962). Mosses are of special ecological importance because of their role in peat formation. Areas dominated by *Sphagnum* spp. are usually called bogs; in fact, the presence of this genus is often used as a defining characteristic for the term bog. Pollett and Bridgewater (1973) described areas with mosses and lichens (*Cladonia* spp.) as bogs and as fens, the split being based on nutrient status and the particular plant species present.

Floating-leaved Beds

Floating-leaved beds are wetlands and aquatic habitats dominated by floating-leaved plants. They are found primarily in the lacustrine, riverine, and palustrine systems throughout the United States, although small beds may occur in the fresh-water end of the estuarine system. They generally occur in sheltered habitats in which there is little water movement (Wetzel 1975) and where the water depth averages 1-3.5 m (Ruttner 1963, Sculthorpe 1967, Daubenmire 1968). They may occur in shallower waters, but are often outcompeted there by emergent plants. Floating-leaved beds are sometimes stranded during periods of drawdown or low water, and some species like yellow water lily (*Nuphar advena*) or water smartweed (*Polygonum amphibium*) may take on the appearance of emergents. Within the range of chemical tolerance, the local distribution of these plants is greatly influenced by the type of substrate and the physical nature of the body of water (Moyle 1945). Typical dominants include water lilies (*Nuphar*, *Nymphaea*), floating-leaved pondweed (*Potamogeton natans*) and water shield (*Brasenia schreberi*).

Free-floating aquatic genera such as *Lemna*, *Pistia*, *Salvinia*, *Eichornia*, *Trapa*, and *Azolla* are found primarily in sheltered habitats in slow flowing rivers or in lacustrine and palustrine systems. These species are easily moved about by the wind or water currents, and therefore cannot be considered as a life form that dominates, or is characteristic of, a separate habitat class.

Submergent Beds

Submergent beds are aquatic habitats dominated by submergents. They occur in all systems and in all parts of the United States. Generally they support a great diversity of invertebrate species, both benthic and epiphytic, and they provide a primary source of cover for many kinds of fish. In the marine and estuarine systems, vascular submergent beds are common and have been described as temperate grass flats (Phillips 1974); tropical marine meadows (Odum 1974); eelgrass beds, turtlegrass beds and seagrass beds (Eleuterius 1973, Akins and Jefferson 1973, Phillips 1974). Vascular submergent beds in the marine and estuarine systems range from the upper subtidal (occasionally being exposed at low tides) to over 10 m deep in clear marine waters. The greatest numbers of plant species occur in shallow, clear, tropical or subtropical waters of moderate current strength in the Caribbean and along the Florida and Gulf Coasts. Principal dominants in these beds include turtlegrass (*Thalassia testudinum*), *Diplanthera wrightii*, *Syringodium filiforme*, widgeon grass (*Ruppia maritima*), *Halophila* spp. and wild celery (*Vallisneria americana*).

Only five or six major species populate vascular submergent beds on the temperate coasts of North America: *Diplanthera wrightii*, *Phyllospadix scoulier*, *P. Torreyi*, *Ruppia maritima* and eelgrass (*Zostera marina*). *Zostera* beds have the most extensive distribution in United States waters, but they appear to be limited to the more sheltered estuarine environment. In the lower salinity zones of estuaries, dense stands of Ruppia, Potamogeton and Vallisneria often occur, along with Najas and Myriophyllum.

Vascular submergent beds in the riverine, lacustrine and palustrine systems generally are most abundant in waters greater than 2.5 - 3.0 m deep (Welch 1952, Ruttner 1963, Sculthorpe 1967) or in shallower waters in sheltered locations (Wetzel 1975). They occur at all depths within the photic zone. Typical inland genera include Potamogeton, Ceratophyllum, Myriophyllum, Najas, Utricularia, and Vallisneria. The texture and fertility of the substrate and the chemical composition of the water are important factors determining the local distribution of submergents (Moyle 1945).

Algal submergent beds occur both in tidal and in nontidal locations, but they are far more diverse and widespread in the marine and estuarine systems. Inland, algal beds are represented chiefly by plants such as the muskgrasses (Chara spp.) and stoneworts (Nitella spp.) which look much like vascular submergents and grow in similar locations. Chara is often abundant in the deeper waters of lacustrine systems where hydrostatic pressure is a limiting factor for vascular submergents (Welch 1952). Zhadin and Gerd (1963) described Chara meadows growing as deep as 40 m in Lake Issyk Kul in the Soviet Union.

Like submerged seagrass beds, algal submergent beds occur in all marine and estuarine areas of the United States. They provide important habitat for many types of marine fauna, and some species are commercially harvested. They generally occupy rocky bottoms or bottoms with only thin sediment, in contrast to the seagrasses which require sufficient sediment deposits for root development. They may extend to depths of 30 m.

The coastal algal beds are generally more luxuriant in northern waters along the rocky coasts of the northeast and northwest. The most conspicuous beds on the Pacific Coast are dominated by kelp (*Macrocystis* spp.). These support a diverse group of invertebrate and vertebrate fauna, including many epiphytic forms and marine mammals. Along both coasts, some fucoids and laminaroids occur subtidally and can also form dense algal beds. In tropical areas, this subclass is dominated by green algae, especially forms containing calcareous particles; beds of *Halimeda* and *Penicillus* are common examples. *Caulerpa*, *Laurencia* and *Iridicea* may also form large algal beds. Other types, such as *Enteromorpha*, are very tolerant of fresh water and may flourish in estuarine situations.

Nonvegetated Wetlands and Aquatic Habitats

Nonvegetated areas seldom have been included in wetland classification systems, partly because wetlands have traditionally been equated with land supporting hydrophytes, and partly because our interest in, and knowledge of, nonvegetated habitats has been relatively limited. In addition, interest in wetlands has centered around shallow-water areas and moist soils where vegetation is usually present; the deeper, aquatic habitats, which are commonly nonvegetated, have usually been ignored. The primary feature separating wetlands and aquatic habitats from uplands is not just particular kinds of vegetation, but wetness, and we feel that nonvegetated wet areas should receive as much recognition as vegetated ones in this classification system.

Rocky Shores

Rocky shores are high energy environments where stable bedrock surfaces or relatively stable, large rock fragments lie exposed as a result of continuous erosion by wind-driven waves or strong currents. Although large boulders may be moved by exceptional storm waves, the substrate is characteristically stable enough to permit the attachment and growth of sedentary invertebrates and attached algae or lichens.

Rocky shores occur in all systems except the palustrine, but they have been studied in greatest detail in the marine and estuarine systems (Ricketts and Calvin 1968, Stephenson and Stephenson 1972, Lewis 1964). Because of such research, we have been able to divide marine and estuarine rocky shores into several orders characterized by dominant animal (Thorson 1957) or plant communities. The orders usually display a vertical zonation which is a function of tidal range, wave action and degree of exposure to the sun.

The uppermost zone characterized by periwinkles (Littorina spp. and Nerita spp.) and lichens was placed in the Littorine/lichen order. This zone frequently takes on a dark, or even black, appearance, although abundant lichens may lend a colorful tone. These organisms are rarely submerged, but are kept moist by sea spray. Frequently, this habitat is invaded from the landward side by semi-marine genera such as Ligia, an isopod.

The next lower zone is commonly occupied by molluscs, green algae and barnacles of the Balanoid group; hence, this zone was placed in the Balanoid order. From a distance, the zone appears white. The Balanoid zone may be an almost pure sheet of barnacles such as Balanus, Chthamalus and Tetraclita, or these animals may be interspersed with molluscs, tube worms and algae such as Pelvetia.

The transition between the Littorine/lichen and Balanoid zones is frequently marked by the replacement of the periwinkles with both true and false limpets such as Acmea and Siphonaria. The limpet band approximates the upper limit of the regularly flooded intertidal zone and was placed in the limpet order.

In the middle and lower intertidal areas, which are flooded and exposed by tides at least once daily, lie a number of other communities which can be characterized by dominant genera. The Mytilus/Mitella order is a mollusc community (mussels and gooseneck barnacles) exposed to strong wave action. The Fucoid (rockweed) and Laminaroid (kelp) communities lie slightly lower, just above the Coralline algae (Lithothamnion) zone. These communities were placed in the Fucoid order, the Laminaroid order, and the Coralline order respectively. The Laminaroid zone approximates the lower end of the intertidal; it is generally exposed at least once daily. The Coralline zone forms the transition to the subtidal subsystem and is exposed only irregularly.

Although the various orders within the rocky shore often can be characterized by one or two dominant genera, each zone supports a rich assemblage of invertebrates and algae.

Beaches and Bars

Beaches and bars are sloping landforms composed of unconsolidated sand, gravel or cobbles. They occur in all systems except the palustrine, and they are characterized by a shifting, unstable substrate with high permeability, variable surface moisture, high oxygen content in the surface layers and relatively low organic matter content (Ranwell 1972). Beaches extend landward from the water's edge to a distinct break in landform or substrate type (e.g., a foredune or cliff), or to the point where vegetation covers 30 percent or more of the substrate. Bars are elongate, offshore ridges, banks or mounds exposed at low water, built up by the action of waves and currents, and usually running parallel to the shore.

Beaches and bars may be sparsely vegetated and are populated by a diversity of specialized, burrowing invertebrates (molluscs, crustaceans and echinoderms) and interstitial fauna (including algae, diatoms and polychaetes) which are usually filter feeders. Those areas with a high silt content tend to be anaerobic near the surface; they have less pore space, more organic matter and support a relatively small population of burrowing invertebrates. Areas composed of gravel and cobbles are usually completely nonvegetated and have extremely sparse animal populations.

On marine and estuarine beaches, annual plants may colonize the zone just below highest spring high tide, where organic tidal litter accumulates, but growth is short-lived and plants are widely scattered (Ranwell 1972). Faunal distribution is controlled by wave and tidal action, desiccation, salinity and sediment grain size, but it is generally better developed than in lacustrine or riverine beaches (Riedl and McMahan 1974).

Marine and estuarine beaches and bars are represented by two subclasses based on the type of sands from which they are formed: (1) Calcareous beaches and bars are composed of skeletal material from molluscs, corals, foraminfera, algae and other biota. They occur only in warm or tropical waters. (2) Terrigenous beaches and bars are composed of materials derived from erosion of rock or unconsolidated deposits of non-biological origin. They are generally siliceous, but beaches and bars of volcanic origin are included in the terrigenous subclass.

Flats

A flat is a nearly level, unconsolidated substrate that is alternately flooded and exposed; it can be found in all five ecological systems. Normally, flats occur only in low energy situations which are sheltered from strong currents and wave action. Flats are divided into 3 subclasses, fine flats composed of fine mineral sediments (clay and silt: less than .074 mm diam[1].), coarse flats composed of coarse mineral sediments (sand, gravel or cobbles: greater than .074 mm diam.), or organic flats composed of peat. Those flats with a high silt content tend to be anaerobic below the surface.

Estuarine and marine flats occur in both the regularly flooded and the irregularly flooded intertidal zones. Regularly flooded fine and coarse flats support diverse populations of tube dwelling and burrowing invertebrates including worms and clams (Gray 1974). These invertebrates are mostly detritus feeders. The distribution of fauna is dependent on substrate texture, current and wave action, and salinity. Irregularly flooded flats have been called salt flats, pans or pannes, are typically high in salinity and are usually surrounded by, or lie on the landward side of, emergent wetland (Martin et al. 1953, Type 15). Where they occur within well established

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[1] Values for fine and coarse sediments were established after comparing several particle size classification systems (See Black 1968, Liu 1970).

stands of emergents, the substrate is often peat (Teal and Teal 1969). These flats support burrowing crustaceans and often have an algal crust or mat.

Riverine flats are found in the low gradient and tidal reaches. They are generally exposed at low water and covered at high water or flood stage. Both fine and coarse flats occur; the distribution of organisms is dependent upon the substrate material, current and wave action, and the frequency of inundation. Lacustrine fine and coarse flats are uncovered at low water and may include the entire basin of an intermittent lake. Palustrine flats are generally the result of high salinity or the discharge of thermal waters, but they also include the basins of small, intermittent water bodies. In many arid areas, palustrine and lacustrine flats are crusted or saturated with salt. Martin et al. (1953) called these inland salt flats (Type 9); they are also called alkali flats, salt flats, salt pans, and saline seeps. Faunal diversity and abundance varies with salinity, duration of inundation and temperature.

Reefs

A reef is a ridge- or mound-like structure formed by the colonization and growth of sedentary invertebrates, particularly corals, oysters and tubeworms (serpulids). Reefs are characterized by their elevation above surrounding sediments and their interference with normal wave flow; they are primarily subtidal, but portions of some reefs may be intertidal as well. Although the above organisms are mainly responsible for reef formation, other molluscs, foraminifera, coralline algae and other forms of life also contribute substantially to reef growth. Frequently, reefs contain a great deal of dead skeletal material in comparison to the amount of living matter.

Coral reefs are widely distributed in shallow waters of warm seas. In the United States they are found in Hawaii, Puerto Rico, the Virgin Islands and southern Florida. They are characterized by Odum (1971) as stable, well adapted, highly diverse and highly productive ecosystems with a great degree of internal symbiosis. Coral reefs lie almost entirely in the marine subtidal zone.

Oyster reefs occur in both the estuarine intertidal and subtidal zones. They are found on the Pacific, Atlantic, and Gulf Coasts and in Hawaii and the Caribbean. Oyster reefs may become extensive, affording a substrate for sedentary and boring organisms and a shelter for many others. They are adapted to great variations in water level, salinity and temperature, and these same factors control their distribution.

Worm reefs are constructed by large colonies of serpulid worms living in individual tubes constructed from cemented sand grains. Although they do not support as diverse a biota as do coral and oyster reefs, they provide a distinct habitat which may cover large areas. Worm reefs are confined to tropical waters, and are most common along the coasts of Florida, Puerto Rico, and the Virgin Islands. They occur in both the marine and estuarine systems where the salinity approximates sea water. Although occasionally awash at extreme low tide, they are considered to be within the subtidal subsystem.

Bottoms

The class bottom includes all permanantly flooded, nonvegetated substrates that occur in all systems. Bottoms have been divided into subclasses on the basis of type of substrate, the principal feature determining what kinds of organisms will inhabit these areas.

Marine, estuarine and tidal-riverine bottoms have been divided into two subclasses, unconsolidated bottoms and rock bottoms. In marine and estuarine ecosystems, temperature, waves, currents, salinity and light penetration are also often important in determining the distribution of organisms. Thorson (1957) has described the characteristics and types of bottom communities in detail. Less distinct communities are found on bottoms than on rocky intertidal shores. Five orders: sponge, alcyonarian, mollusc, crustacean and worm bottoms, were established for unconsolidated bottoms and 4 orders: sponge, ascidian, alcyonarian and barren bottoms were established for rock bottoms. Crustacean bottoms include shrimp beds, crab beds and lobster habitats. Mollusc bottoms include clam and scallop beds. Sponges and alcyonarians, including sea whips and sea pansies, form distinct communities on areas of firm substrate. Worms are generally found on finer, less firm substrate. Ascidians, encrusting sponges, and attached algae grow on submerged rocks and pilings. Echinoderms, both starfish and sea urchins are the dominant biota in only a few areas. Finally, where the bottom is unstable or subject to strong scouring, it may lack characteristic biota and be classed simply as barren.

In the low gradient riverine ecosystem, 3 subclasses were recognized; rock, fine and coarse bottoms. In these riverine bottoms, the type of substrate is, to a great extent, controlled by current or stream velocity. Some invertebrates are confined to well defined types of substrate and others appear to be more abundant on one type than they are on others. In general, the larger the area, and the more complex the substrate, the more diverse is the invertebrate fauna (Hynes 1970).

Lacustrine and palustrine bottoms are subdivided into 4 subclasses; rock, fine, coarse and organic bottoms. These bottoms represent a variety of substrates, including the completely organic substrate which occurs in bog lakes (Welch 1952). Within a given water body, there is usually a high correlation between the nature of the substrate and the species richness and population density of invertebrates. Furthermore, each substrate type typically supports a relatively distinct community of organisms (Reid 1961). The profundal bottoms of lakes are characterized by the absence of light, generally low oxygen content and generally high carbon dioxide concentration (except in oligotrophic lakes). The sediments are ooze-like, organic materials and species diversity is low.

High Gradient Riverine Habitats

The flow of water is the major force determining the nature of stream environments and the distribution of plants and animals in the high gradient reach of rivers. For this reason, we have decided to differentiate the habitats in this section according to the nature of flow instead of plant life form or substrate as was done in the other systems and in the low gradient and tidal reaches of the riverine.

Riffles

A riffle is an area within the channel of a high gradient stream where rapidly flowing water meets obstructions such as bedrock, boulders, and sand and gravel bars, creating turbulent water with a rough and broken surface. Waterfalls are included in this class. Riffles are present in nearly all high gradient channels and are best developed over gravel bottoms. They are spaced at intervals approximately 5 to 7 times the width of the channel (Leopold et al. 1964). The bottom material is coarser than in the intervening pools and there is little deposition of fine material. In this classification, the term riffles is synonymous with the term rapids, and applies to all high gradient reaches, regardless of stream size or volume. The riffle is readily visible at times of normal flow, but when the river is bankfull or in flood, the riffle may be "drowned out" (Leopold 1964:206) and difficult to detect. During periods of low flow, most of the riffle area may be without water while the intervening pools remain flooded. The flora and fauna of riffles are distinctly different from that of the pools; not only must organisms inhabiting riffles maintain themselves against a strong current, but they are also subjected to different conditions of water chemistry, temperature, light and organic matter availability (Neel 1951).

Pools

A pool is an area within the channel of a high gradient stream where the channel is deep, relative to the riffles, and the surface of the water is smooth and unbroken, except by wind-generated waves. In pools, the velocity of the water slows sufficiently to allow deposition of some silt, organic material can be retained for decomposition and free CO_2 is produced (Neel 1951). They also provide a calmer habitat for fish. In intermittent streams, the pools may remain as isolated water bodies that are more lacustrine than riverine in nature, but these areas furnish refuge for many riverine organisms. Once again, pools have a different flora and fauna than riffles because of reduced water velocity, finer-textured substrates, reduced O_2 levels and differences in light and temperature.

HABITAT TYPES

The habitat type is the most detailed taxon of this classification. It is formed by adding modifiers for water regime and water chemistry to the habitat order (e.g., seasonally flooded, subsaline, emergent wetland on mineral soil). The habitat type has a characteristic plant and animal community in a given province. Such communities are often easily recognized in the field, and sometimes even on aerial photographs; but, in some cases, detailed botanical data and ecological studies relating communities to edaphic and hydrologic features of the site will be required to determine habitat type.

The habitat type also may be difficult to determine at a given point in time. For example, an area that undergoes fluctuating water levels may appear as deep, open water during one season and be covered with moist-soil vegetation during another. Classification of habitat types, therefore, requires a knowledge of wetland dynamics. Stewart and Kantrud (1971) demonstrated the use of plant indicators for classification of the same wetland class during its open water, emergent and drawdown phases. Without the benefit of such basic studies, classification to the level of habitat type may not be possible. This is particularly true for such vast and ecologically complex areas as Alaska.

Water Regime Modifiers

The hydrology of wetland and aquatic habitats is often exceedingly complex. A precise description of the water regime for an individual wetland would require detailed hydrologic data over a period of years, because water tables fluctuate as a result of short-term and long-term weather cycles. Despite this complexity, it is useful to categorize general groupings of water regimes. Those listed below cannot be precisely defined, but the majority of areas should be readily assignable to one of these broad categories. Dominant plant and animal communities usually reflect the average soil moisture condition over a period of years; therefore, the water regime can often be inferred from indicator species, rather than determined directly from long-term hydrologic measurements. All of the definitions below refer to average conditions. For example, in areas with a highly variable climate, a seasonally flooded wetland might be dry during a drought year or wet all year during a year of extremely high rainfall. Our definitions refer to that period of the year when the surface of the land is free of ice, even though surface water may be underlain by ice or permanently frozen ground.

Nontidal Water Regimes. The water regime is not influenced by oceanic tides, although it may be affected by lunar tides or seiches in large lakes. Nontidal habitats occur in riverine, lacustrine and palustrine systems. The term inland often is used as a synonyn for nontidal.

Saturated: The substrate is saturated with water for extended periods of time, but surface water is seldom, if ever, present. Fluctuations of the water table are slight, averaging 15-20 cm over most of the year (Malmer 1975).

Temporarily flooded: Water is seldom present above the land surface for more than 10 consecutive days. Fluctuation of the water table is much greater than in the saturated regime and ranges from a few meters above to a few meters below the surface. Flooding may occur few to many times during the year.

Seasonally flooded: Water covers the land surface for more than 10 consecutive days, but generally less than half the year. Surface water is present during the local wet season, but may occur at other times also, because of heavy surface runoff or riverine flooding.

Semipermanently flooded: Water covers the land surface for more than half the year, but not permanently. Generally, the surface is exposed during the same season each year, but during wet years it may be continuously flooded.

Permanently flooded: Water covers the land surface at all times of the year, every year.

Intermittently flooded: Water covers the land surface at irregular intervals without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation.

Tidal Water Regimes. The water regime is largely determined by oceanic tides. Tidal habitats occur in the marine, estuarine and riverine systems.

Irregularly flooded: Tidal water covers the land surface less frequently than once a day. Water may be derived from normal tides or abnormally high tides resulting from storms and high winds.

Regularly flooded: Normal tides alternately flood and expose the land surface at least once every day. There is considerable variation in the duration of flooding within this zone.

Subtidal: The land surface is permanently flooded, but water depth fluctuates with the tides.

The periodicity and amplitude of tides varies in different parts of the United States, mainly because of differences in latitude and geomorphology. On the Atlantic Coast, two approximately equal high tides are the rule (semidiurnal). On the Gulf Coast, there is frequently only one high tide and one low tide in a day (diurnal). The usual pattern on the Pacific Coast is two unequal high tides and two unequal low tides (mixed semidiurnal).

Individual tides range in height from approximately 9.5 m (28 ft) at St. John, New Brunswick (U.S. National Oceanic and Atmospheric Administration 1974) to less than 1 m along the Louisiana coast (Chabreck 1972). Tides of only 10 cm are not uncommon in Louisiana. Therefore, while there can be no hard and fast rules, the division between regularly flooded and irregularly flooded water regimes would probably occur approximately at: mean high water on the Atlantic Coast, lowest higher high tide on the Pacific Coast, and just above mean tide level on the Gulf Coast. The size of the intertidal zone is determined by the tidal range, the slope of the shoreline, and the degree of exposure of the site to wind, wave and storm surge.

Water Chemistry Modifiers

The accurate characterization of water chemistry in wetlands and aquatic habitats is a very difficult task, both because of problems in measurement and because values tend to vary with changes in the season, weather, time of day and other factors. Yet, very subtle changes in water chemistry, which occur over short distances, may have a dramatic influence on the types of plants that inhabit an area. Despite the problems involved, we feel that a description of water chemistry must be an essential part of this classification system. In many cases, it may not be necessary to make direct measurements, for just as plants and animals indicate prevailing water regimes, they also provide excellent clues to water chemistry values (Stewart and Kantrud 1971, Jeglum 1971).

The two key parameters employed in this system are salinity and hydrogen ion concentration (pH). All habitats are classified according to salinity, and fresh-water habitats are further subdivided by pH levels.

Salinity Classes. Differences in salinity are reflected in the species composition of plants and animals. Many authors have suggested using biological changes as the basis for subdividing the salinity range between sea water and fresh water. For a summary, see Remane and Schleiper (1971). Others have suggested a similar subdivision for the inland salinity spectrum (Moyle 1946, Bayly 1967, Stewart and Kantrud 1971). Since the gradation between fresh and hypersaline waters is continuous, any boundary will be artificial, and few systems agree completely. To complicate matters, salinity has been expressed in various units. In marine and estuarine environments, measurements are generally given in percent NaCl, parts per thousand (°/₀₀) or specific conductance (μMhos). In inland environments, salinity is usually expressed in specific conductance, milligrams or milliequivalents per liter (mg/l or meq/l), percent salt or total dissolved solids.

The salinity of estuarine and marine waters is dominated by sea salt, sodium chloride (NaCl). The relative proportions of the various major ions are very similar to those found in sea water, even if the water is diluted below sea strength. Dilution of sea water with fresh water and concentration of sea water by evaporation result in a wide range of recorded salinities. In intertidal wetlands, the salinity of interstitial (soil) water is probably as important as the salinity of surface water in its effect on plant growth. Very little information is available on soil salinity for most coastal areas of the country, so it seems preferable at this time to use surface-water salinity.

We have modified the Venice System, suggested at a "Symposium on the Classification of Brackish Waters" in 1958, for use in marine and estuarine habitats (Table 1). The system has been

Table 1. Coastal salinity modifiers used in this classification system.

Modifier		Halinity (°/oo)	Approximate specific conductance (μMhos at 25°C)	Degree of halinity variation
hyperhaline		>40	>60,000	poikilohaline
euhaline		40-30	60,000-45,000	homoiohaline
polyhaline	brackish or mixohaline	30-18	45,000-30,000	poikilohaline
mesohaline	brackish or mixohaline	18-5	30,000-8,000	poikilohaline
oligohaline	brackish or mixohaline	5-0.5	8,000-800	poikilohaline
fresh		<0.5	<800	homoiohaline

widely used during recent years (Reid 1961; Macan 1961, 1963; Burbank 1967; Carriker 1967), although there has been some criticism of its applicability (den Hartog 1960, Price and Gunter 1964).

The term haline is used to indicate the dominance of NaCl. The range of values between sea water (euhaline) and fresh water, 30-0.5 °/oo, is generally referred to as brackish, or sometimes, mixohaline. Dahl (1956) used the word poikilohaline to describe water of variable salinity, and Bayly (1967) stressed that the term is associated with the ecological importance of salinity fluctuation; it does not simply refer to a range of absolute salinity values. Brackish waters and marine hyperhaline waters are typically poikilohaline, while euhaline and fresh waters, which fluctuate little in salinity, are considered homoiohaline environments.

The total salinity of inland waters is dominated by four major cations: calcium (Ca), magnesium (Mg), sodium (Na), and potassium (K), and the major anions: carbonate (CO_3), sulfate (SO_4) and chloride (Cl) (Wetzel 1975). Salinity is governed by the interactions between precipitation, surface runoff, ground-water flow, evaporation, and, in some cases, evapotranspiration by plants. The ionic ratios of inland waters usually differ appreciably from those found in the sea, although there are some exceptions (Bayly 1967). The great chemical diversity of these waters, the wide variation in physical conditions such as temperature, and the relative impermanence of surface water in many cases, make it extremely difficult to subdivide the inland salinity range in a meaningful way. Bayly (1967) has attempted a subdivision on the basis of animal life; Stewart and Kantrud (1971) and Moyle (1945) have suggested two very different divisions on the basis of plant life. After reviewing many possibilities, we have decided to employ a subdivision which is identical to that used in the estuarine and marine systems. The modifiers shown in Table 2 apply to the riverine, lacustrine and palustrine systems.

Table 2. Inland salinity modifiers used in this classification system.

Modifier		Salinity (°/oo)	Approximate specific conductance (μMhos at 25°C)	Degree of salinity variation
hypersaline		>40	>60,000	mostly poikilosaline
saline		40-30	60,000-45,000	mostly poikilosaline
near-saline	subsaline	30-18	45,000-30,000	mostly poikilosaline
moderately saline	subsaline	18-5	30,000-8,000	mostly poikilosaline
slightly saline	subsaline	5-0.5	8,000-800	mostly poikilosaline
fresh		<0.5	<800	homoiosaline

The term saline is used to indicate that any of a number of ions may be dominant or co-dominant. The term brackish has been applied to inland waters of intermediate salinity (Remane and Schleiper 1971, Stewart and Kantrud 1971), but is not universally accepted (see Bayly 1967:84); therefore, the word subsaline will be utilized here. In inland wetlands with intermittent water regimes, soil salinities control the invasion or establishment of plants. These soil salinities are expressed in units of specific conductance as well as percent salt (Ungar 1974), and they are also covered by the salinity classes in Table 2.

We do not intend that salinity measurements be made for all wetlands except where these data are required; in many cases, plants species or associations can be used to indicate broad salinity classes. Lists of halophytes have been prepared for both coastal and inland areas (Duncan 1974, MacDonald and Barbour 1974, Ungar 1974), and a number of floristic and ecological studies have described species-soil relationships or species-salinity indicators (e.g., Penfound and Hathaway 1938, Moyle 1945, Kurz and Wagner 1957, Dillon 1966, Stewart and Kantrud 1971, Chabreck 1972, Ungar 1974).

pH Classes. Acid waters are, almost by definition, poor in calcium and often generally low in other ions, but some very soft waters may have a neutral pH (Hynes 1970). It is difficult to separate the effects of high concentrations of hydrogen ions from low base content, and many studies suggest that acidity may never be the major factor controlling the presence or absence of particular plants and animals. Nevertheless, some researchers have demonstrated a good correlation between pH levels and plant distribution (Sjörs 1950, Jeglum 1971). Jeglum showed that plants can actually be used to predict the hydrogen ion concentration of moist peat.

There seems to be little doubt that, where a peat layer isolates plant roots from the underlying mineral substrate, the availability of minerals in the root zone strongly influences the types of plants that occupy the site. For this reason, many authors subdivide fresh-water, organic wetlands into mineral-rich and mineral-poor categories (Sjörs 1950, Heinselman, 1970, Jeglum 1971, Moore and Bellamy 1974). In practice, however, it is difficult to set precise numerical limits on water chemistry parameters and show that these limits are meaningful throughout an area as large and diverse as the United States. Until more research is done on this topic, we suggest the following definitions for mineral-poor and mineral-rich:

> mineral-poor: fresh water extremely low in specific conductance, less than 80 μMhos (Verry in press), calcium, less than 0.6 meq/l or 12 mg/l, and magnesium, less than 0.2 meq/l or 2.4 mg/l (Moore and Bellamy 1974: 61). The pH of this water is always less than 5.5.

> mineral-rich: fresh water medium to high in specific conductance (more than 80 μMhos), and relatively high in calcium (more than 0.6 meq/l or 12 mg/l) and magnesium (more than 0.2 meq/l or 2.4 mg/l). The pH of this water can be greater or less than 5.5.

We have instituted pH modifiers for fresh-water wetlands (Table 3) because pH has been widely used to indicate the difference between mineral-rich and mineral-poor sites, and because it is relatively easy to determine. The ranges presented here are similar to those of Jeglum (1971), except that the upper limit of the circumneutral level (Jeglum's mesotrophic) was raised to bring it into line with usage of the term in the United States. The ranges given apply to the pH of water. They were converted from Jeglum's moist-peat equivalents by adding 0.5 pH units.

Table 3 pH modifiers used in this classification system.

Modifier	pH of Water
acid	<5.5
circumneutral	5.5-7.4
alkaline	>7.4

Special Modifiers

Many wetlands and aquatic habitats are man-made, and most natural ones have been modified to some degree by man's activities. Since the nature of these modifications often greatly influences the character of such habitats, we felt that special modifying terms should be included here to demonstrate man's role. The following modifiers should be used to indicate man-made and man-modified wetlands and aquatic habitats. We suggest that these modifiers be given in parentheses following the habitat type designation. For example, a diked coastal marsh might be classified: irregularly flooded, brackish, estuarine emergent wetland on organic soil (impoundment).

Impoundment: wetland or aquatic habitat created or modified by construction of a man-made barrier (dike, dam) to the gravitational movement of water.

Dugout: wetland or aquatic habitat that lies within a basin excavated by man.

Canal: wetland or aquatic habitat that lies within a channel excavated by man where no previous channel existed.

Channelized: refers to any natural channel that has been deepened and straightened by man.

Irrigated: refers to any area definable as wetland where the water table has been raised above its natural level by mechanical means and where the dominant plants are used as agricultural crops or forage. It is important to note that many areas of irrigated land do not fall within our definition of wetland.

Farmed: refers to any wetland where the soil surface has been mechanically altered for the production of crops. Many wetlands within the west and midwest are farmed in dry years. They should be classified as emergent (farmed) when their natural emergent vegetation has been destroyed by agricultural activity.

CORRELATION BETWEEN CLASSIFICATION SYSTEMS

In proposing this classification system we realize that a simple and orderly transition to it from Circular 39 is essential. In addition to Circular 39, there are several other wetland classification systems that are being widely used in various parts of the United States and Canada. In most cases, the regional systems are sensitive to differences that a national system cannot reflect; therefore, many of these systems will probably continue to be used for intensive research and management. We have attempted to structure our system to be compatible with Circular 39, with the regional systems and with a new Canadian system (Zoltai et al. 1975) insofar as possible.

In this section, we would like to demonstrate the correlation between this system and the other major ones currently in use. There are a few cases of direct equivalence between types, and many more where boundaries fail to match up precisely. The great difference in levels of detail represented by each type will be apparent as well. It would be difficult to clearly portray the correlation between systems in text alone, so we have attempted to do this in Tables 4 - 8. In an attempt to make these tables readily comprehensible, we offer the following guidance and examples.

The far left column in each table gives the wetland type recognized by the system being compared with ours. Under each of the remaining columns is a list of the possible characteristics for that type in our system. For example, in Table 4, a Type 4 wetland of Circular 39 (inland deep fresh marsh) would be classified an emergent wetland in our system. It could occur in the palustrine, lacustrine and riverine systems; on both mineral and organic soils; under permanently flooded, semipermanently flooded, and seasonally flooded water regimes; and the water chemistry could be fresh or subsaline.

When two or more classes or subclasses are given, all of the information in all of the other columns can be applied to any of the classes or subclasses, unless there are obvious spaces within any of the columns. For example, Type 8 (bog) of Circular 39 (Table 4) includes wetlands that would be classified shrub wetlands, evergreen forested wetlands, or emergent wetlands in our system. The soil in any of these wetlands might be organic or mineral, and the water regime might be saturated or seasonally flooded. All of these wetlands would have fresh, acid water and all would occur only in the palustrine system. A Type 1 (seasonally flooded basin or flat) wetland (Table 4) could be classified: (1) a temporarily flooded or seasonally flooded, emergent wetland in the palustrine, lacustrine and riverine systems; (2) an intermittently flooded, emergent wetland in the riverine and lacustrine systems; (3) a seasonally flooded, deciduous forested wetland in the palustrine system; or (4) a temporarily flooded, seasonally flooded or intermittently flooded fine flat or coarse flat in the lacustrine and riverine systems. All of these various wetlands may be fresh or subsaline except for the forested wetland which can be only fresh.

In many cases, habitat classes, but no subclasses, have been listed under the CLASS/SUBCLASS column. This means that all possible subclasses within the class or classes listed are believed to be equivalent to the type appearing in the far left column. For example, in Table 4, a Type 6 wetland (shrub swamp) could be classified either a deciduous shrub wetland or an evergreen shrub wetland in our system. If one or more specific subclasses are listed in the CLASS/SUBCLASS column, this means that only these subclasses are comparable to the type appearing in the far left column. For example, the Type 9 wetlands of Circular 39 (inland saline flats) could be classified: 1) emergent wetland, or 2) either fine flat or coarse flat, but not organic flat, because the latter possibility is not listed.

CORRELATION WITH CIRCULAR 39 (Shaw and Fredine 1956)

Circular 39 presents 20 wetland types for the lower 48 states. These types are defined according to water depth during the growing season, degree of seasonal flooding and the dominant life form of vegetation. In addition, wetland

Circular 39	Cowardin et al. (1976)				
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
1. Seasonally Flooded Basins or Flats	Palustrine	Emergent Wetland	Mineral	Temporarily flooded Seasonally flooded	Fresh Subsaline
		Deciduous Forested Wetland		Seasonally flooded	Fresh
	Lacustrine	Emergent Wetland		Temporarily flooded Seasonally flooded Intermittently flooded	Fresh Subsaline
	Riverine	Emergent Wetland		Seasonally flooded	
2. Inland Fresh Meadows	Palustrine	Emergent Wetland	Mineral Organic	Saturated Temporarily flooded Seasonally flooded	Fresh Subsaline
3. Inland Shallow Fresh Marshes	Palustrine Lacustrine Riverine	Emergent Wetland	Mineral Organic	Seasonally flooded Semipermanently flooded Permanently flooded?	Fresh Subsaline
4. Inland Deep Fresh Marshes	Palustrine Lacustrine Riverine	Emergent Wetland	Mineral Organic	Permanently flooded Semipermanently flooded Seasonally flooded	Fresh Subsaline
5. Inland Open Fresh Water	Palustrine Lacustrine Riverine	Submergent Bed Floating-leaved Bed Bottom	Mineral Organic	Permanently flooded Semipermanently flooded	Fresh Subsaline (except for floating-leaved bed?)
6. Shrub Swamps	Palustrine Riverine-Tidal	Shrub Wetland	Mineral Organic	Seasonally flooded Semipermanently flooded Irregularly flooded Regularly flooded	Fresh

Table 4. (continued)

Circular 39	Cowardin et al. (1976)				
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
7. Wooded Swamps	Palustrine	Forested Wetland	Mineral Organic	Seasonally flooded Semipermanently flooded	Fresh
	Riverine-Tidal			Irregularly flooded Regularly flooded	Fresh
8. Bogs	Palustrine	Shrub Wetland Evergreen Forested Wetland Emergent Wetland	Organic Mineral	Saturated Seasonally flooded	Fresh/acid
9. Inland Saline Flats	Palustrine Lacustrine	Emergent Wetland Fine Flat Coarse Flat	Mineral	Temporarily flooded Seasonally flooded Intermittently flooded	Hypersaline Saline Subsaline?
10. Inland Saline Marshes	Palustrine Lacustrine	Emergent Wetland	Mineral Organic?	Permanently flooded Semipermanently flooded Seasonally flooded	Saline Subsaline?
11. Inland Open Saline Water	Palustrine Lacustrine	Submergent Bed	Mineral Organic?	Permanently flooded Semipermanently flooded	Hypersaline Saline Subsaline?
		Fine Bottom Coarse Bottom			
12. Coastal Shallow Fresh Marshes	Riverine-Tidal Estuarine	Emergent Wetland	Mineral Organic	Regularly flooded Irregularly flooded	Fresh Brackish
13. Coastal Deep Fresh Marshes	Riverine-Tidal Estuarine	Emergent Wetland	Mineral Organic	Regularly flooded Irregularly flooded	Fresh Brackish

Table 4. (continued)

Circular 39	Cowardin et al. (1976) SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
14. Coastal Open Fresh Water	Riverine-Tidal Estuarine	Submergent Bed Floating-leaved Bed Unconsolidated Bottom Fine Bottom Coarse Bottom		Subtidal	Fresh Brackish
15. Coastal Salt Flats	Estuarine	Emergent Wetland Fine Flat Coarse Flat Organic Flat	Mineral Organic	Regularly flooded Irregularly flooded	Brackish Euhaline Hyperhaline
16. Coastal Salt Meadows	Estuarine	Emergent Wetland	Organic Mineral	Irregularly flooded	Euhaline Brackish
17. Irregularly Flooded Salt Marshes	Estuarine	Emergent Wetland	Mineral Organic	Irregularly flooded	Euhaline Brackish
18. Regularly Flooded Salt Marshes	Estuarine	Emergent Wetland	Mineral Organic	Regularly flooded	Euhaline Brackish
19. Sounds and Bays	Estuarine Marine?	All Marine and Estuarine Classes except Rocky Shores?		Subtidal Regularly flooded	Hyperhaline Euhaline Brackish
20. Mangrove Swamps	Estuarine	Evergreen Forested Wetland	Mineral Organic	Regularly flooded Irregularly flooded	Hyperhaline Euhaline Brackish
				Subtidal	

types are grouped into broad water chemistry categories (saline or fresh), and they are designated either coastal (tidal) or inland. Our system goes into considerably more detail, so that a wetland type in Circular 39 often includes several of our types. Table 4 gives a comparison of the two systems.

CORRELATION WITH GOLET AND LARSON (1974)

In response to the need for more detailed wetland classification in the glaciated northeast, Golet and Larson (1974) refined the fresh-water wetland types of Circular 39 by writing more detailed descriptions and subdividing classes on the basis of finer differences in plant life forms. Golet and Larson's classes are roughly equivalent to Types 1-8 of Circular 39, except that they restricted Type 1 to river floodplains. The Golet and Larson system does not recognize the coastal (tidal) fresh wetlands (Types 12-14) as a separate category, but classifies these areas in the same manner as nontidal wetlands. In addition to devising 24 subclasses, they also created five size categories; six site types, giving a wetland's hydrologic and topographic location; eight cover types (modified from Stewart and Kantrud 1971), expressing the distribution and relative proportions of cover and water; three vegetative interspersion types; and six surrounding habitat types. The classification system was devised primarily as a tool for the evaluation of fresh-water wetlands as wildlife

Golet and Larson (1974)	Cowardin et al. (1976)				
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
1. Open Water (OW)					
a. vegetated (OW-1)	Palustrine Lacustrine Riverine	Floating-leaved Bed	Mineral Organic	Permanently flooded	Fresh
b. nonvegetated (OW-2)	Palustrine Lacustrine Riverine	Submergent Bed Bottom	Mineral Organic	Permanently flooded	Fresh
2. Deep Marsh (DM)					
a. dead woody (DM-1)	Palustrine Lacustrine	Forested Wetland Shrub Wetland	Mineral Organic	Permanently flooded Semipermanently flooded	Fresh
b. shrub (DM-2)	Palustrine Riverine-Tidal	Deciduous Shrub Wetland	Mineral Organic	Permanently flooded Semipermanently flooded	Fresh
c. sub-shrub (DM-3) d. robust (DM-4) e. narrow-leaved (DM-5) f. broad-leaved (DM-6)	Palustrine Riverine Lacustrine	Emergent Wetland	Mineral Organic	Permanently flooded Semipermenantly flooded	Fresh
3. Shallow Marsh (SM)					
a. robust (SM-1) b. narrow-leaved (SM-2) c. broad-leaved (SM-3)	Palustrine Riverine Lacustrine	Emergent Wetland	Mineral Organic	Seasonally flooded Semipermanently flooded	Fresh
d. floating-leaved (SM-4)	Palustrine Lacustrine	Floating-leaved Bed	Mineral Organic	Semipermanently flooded	Fresh

Table 5. (continued)

Golet and Larson (1974)	Cowardin et al. (1976)				
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
4. Seasonally Flooded Flats (SF)					
a. emergent (SF-1)	Palustrine	Emergent Wetland	Mineral Organic	Seasonally flooded	Fresh
b. shrub (SF-2)	Palustrine	Deciduous Shrub Wetland	Mineral Organic	Seasonally flooded	Fresh
5. Meadow (M)					
a. ungrazed (M-1) b. grazed (M-2)	Palustrine	Emergent Wetland	Mineral Organic	Seasonally flooded	Fresh
6. Shrub Swamp (SS)					
a. sapling (SS-1)	Palustrine	Deciduous Forested Wetland	Mineral Organic	Seasonally flooded Semipermanently flooded	Fresh
b. bushy (SS-2) c. compact (SS-3)	Palustrine	Deciduous Shrub Wetland	Mineral Organic	Seasonally flooded Semipermanently flooded	Fresh
d. aquatic (SS-4)	Palustrine	Deciduous Shrub Wetland	Mineral Organic	Permanently flooded Semipermanently flooded	Fresh
7. Wooded Swamp (WS)					
a. deciduous (WS-1)	Palustrine	Deciduous Forested Wetland	Mineral Organic	Seasonally flooded Semipermanently flooded	Fresh
b. evergreen (WS-2)	Palustrine	Evergreen Forested Wetland	Mineral Organic	Seasonally flooded Semipermanently flooded	Fresh
8. Bog (BG)					
a. shrub (BG-1)	Palustrine	Deciduous Shrub Wetland Evergreen Shrub Wetland	Organic	Saturated	Fresh/acid
b. wooded (BG-2)	Palustrine	Evergreen Forested Wetland	Organic	Saturated	Fresh/acid

habitat (Golet 1973). Table 5 gives the correlation between Golet and Larson's (1974) classes and subclasses and the taxa of our proposed system. Their classes are numbered 1-8 and subclasses are designed by small letters (e.g., a,b,c).

CORRELATION WITH STEWART AND KANTRUD (1971)

The prairie pothole region of North America presents a unique situation for wetland classification because most wetlands occur in basins without surface discharge, and climate is notoriously unstable from year to year. The amount of annual precipitation is the key factor determining the water depth and acreage of wetlands in a given year. As a result of variable precipitation and complex patterns of groundwater flow, salinity varies widely over time, even within a given wetland. The type and distribution of wetland vegetation is chiefly a function of water permanence and water chemistry.

Although the Martin et al. (1953) system has been widely used in the prairies, it is obviously too generalized to account for the dynamic nature of these wetlands. As a result, Stewart and Kantrud (1971) devised a new classification system to better serve the needs of researchers and wetland managers in this region. Their system recognizes seven classes of wetlands which are distinguished by the vegetational zone occupying the central or deepest part and covering 5 percent or more of the wetland basin. The classes thus reflect the wetland's water regime; for example, temporary ponds (Class II) are those where the wet-meadow zone occupies the deepest part of the wetland. Six possible subclasses were created, based on differences in plant species composition that are correlated with variations in average salinity of surface water. The third component of classification in their system is the cover type which represents differences in the spatial relation of emergent cover to open water or exposed bottom soil.

Except for the use of such terms as wet meadow, shallow marsh and deep marsh to describe plant zones in a basin, Stewart and Kantrud departed entirely from the concepts outlined in Circular 39. Table 6 presents a correlation between their system and ours.

CORRELATION WITH ODUM ET AL. (1974)

In 1968 the U.S. Congress called for a summary of the status of knowledge of the estuaries of the United States, in order to determine how these valuable resources could be better managed for the benefit of man. As part of the National Estuarine Pollution Survey conducted in 1968 and 1969, a four-volume work entitled "Coastal Ecological Systems of the United States" was prepared for the Federal Water Pollution Control Administration. An amended version of this was published (Odum et al. 1974). Volume I, Part I of the report presents "A Functional Classification of the Coastal Ecological Systems," which is designed to give some order to the 893 groups of estuaries surveyed. This system

Stewart and Kantrud (1971)	Cowardin et al. (1976)				
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
I. Ephemeral Ponds			Non-wetland by definition		
II. Temporary Ponds	Palustrine	Emergent Wetland	Mineral	Temporarily flooded Seasonally flooded?	
Subclass A					Fresh
Subclass B					Fresh, Slightly Saline
III. Seasonal Ponds and Lakes	Palustrine Lacustrine	Emergent Wetland	Mineral	Seasonally flooded	
Subclass A					Fresh
Subclass B					Fresh, Slightly Saline
Subclass C					Slightly Saline
IV. Semipermanent Ponds and Lakes	Palustrine Lacustrine	Emergent Wetland	Mineral	Semipermanently flooded	
Subclass A					Fresh
Subclass B					Fresh, Slightly Saline
Subclass C					Slightly Saline
Subclass D					Slightly Saline, Moderately Saline
Subclass E					Moderately Saline, Near Saline

Table 6. (continued)

Stewart and Kantrud (1971)	Cowardin et al. (1976)				
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
V. Permanent Ponds and Lakes	Palustrine Lacustrine	Submergent Bed Fine Bottom Coarse Bottom	Mineral	Permanently flooded	
Subclass B					Fresh, Slightly Saline
Subclass C					Slightly Saline
Subclass D					Slightly Saline, Moderately Saline
Subclass E					Moderately Saline, Near-Saline
VI. Alkali Ponds and Lakes	Palustrine Lacustrine	Fine Flat Coarse Flat		Seasonally flooded	Saline Hypersaline
VII. Fen Ponds	Palustrine	Emergent Wetland	Organic Mineral	Saturated Seasonally flooded Semipermanently flooded Permanently flooded	Fresh Slightly Saline

Table 7. Correlation between Odum et al. (1974) and Cowardin et al. (1976)

Odum et al. (1974)	Cowardin et al. (1976)				
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
A. Naturally Stressed Systems					
1. Rocky Sea Front	Marine Estuarine	Rocky Shore		Irregularly flooded Regularly flooded	Euhaline Brackish
2. High Energy Beaches	Marine	Beach/Bar		Irregularly flooded Regularly flooded	Euhaline
3. High Velocity Channels	Estuarine	Unconsolidated Bottom Rock Bottom Mollusc Reef Worm Reef Submergent Bed		Subtidal	Euhaline Brackish
4. Oscillating Temperature Channels	Estuarine	Unconsolidated Bottom Rock Bottom Mollusc Reef Submergent Bed		Subtidal	Euhaline Brackish
		All Intertidal Estuarine Classes		Regularly flooded Irregularly flooded	
5. Sedimentary Deltas	Estuarine	All Estuarine Classes and Subclasses except Rock Bottom and Rocky Shore		Subtidal Regularly flooded Irregularly flooded	Brackish Euhaline

Table 7. (continued)

Odum et al. (1974)	Cowardin et al. (1976)				
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
6. Hypersaline Lagoons	Estuarine	All Estuarine Classes and Subclasses except Rock Bottom and Rocky Shore		Subtidal Regularly flooded? Irregularly flooded	Hyperhaline
7. Blue-green Algae Mats	Estuarine	Fine Flat Coarse Flat Organic Flat?		Irregularly flooded	Euhaline Hyperhaline Brackish
B. Natural Tropical Ecosystems					
1. Mangroves	Estuarine Riverine-Tidal	Evergreen Forested Wetland	Mineral Organic	Regularly flooded Irregularly flooded	Brackish Euhaline Hyperhaline Fresh
2. Coral Reefs	Marine	Coral Reef		Subtidal	Euhaline
3. Tropical Meadows	Marine Estuarine	Vascular Submergent Bed Algal Submergent Bed		Subtidal	Hyperhaline Euhaline Brackish
4. Tropical Inshore Plankton	Estuarine	Unconsolidated Bottom Rock Bottom Mollusc Reef Worm Reef		Subtidal	Euhaline Brackish

Table 7. (continued)

Odum et al. (1974)	Cowardin et al. (1976)				
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
5. Blue Water Coasts	Marine	Rock Bottom Unconsolidated Bottom		Subtidal	Euhaline
C. Natural Temperate Ecosystems					
1. Tidepools	Estuarine Marine	Rocky Shore	All except Littorine/lichen Mytilus/mitella	Regularly flooded Irregularly flooded	Euhaline Brackish
2. Bird and Mammal Islands			No comparable types		
3. Landlocked Sea Waters	Lacustrine	Fine Bottom Coarse Bottom Rock Bottom		Permanently flooded	Subsaline Saline Hypersaline
4. Marshes	Estuarine	Emergent Wetland	Mineral Organic	Regularly flooded Irregularly flooded	Euhaline Brackish Hyperhaline
5. Oyster Reefs	Estuarine	Mollusc Reef		Subtidal Regularly flooded	Brackish
6. Worm and Clam Flats	Estuarine Marine	Fine Flat Coarse Flat Unconsolidated Bottom		Subtidal Regularly flooded	Euhaline Brackish

Table 7. (continued)

Odum et al. (1974)	Cowardin et al. (1976) SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
7. Eelgrass and Benthic Algae Bottoms; Shallow Salt Ponds	Estuarine Marine	Vascular Submergent Bed Algal Submergent Bed		Subtidal	Euhaline Brackish Hyperhaline
8. Oligohaline Systems	Estuarine Riverine-Tidal	All Estuarine and Riverine-Tidal Classes and Subclasses	Mineral Organic	Subtidal Regularly flooded Irregularly flooded	Brackish Fresh Euhaline
9. Medium Salinity Plankton Estuary	Estuarine	All Estuarine Classes and Subclasses	Mineral Organic	Subtidal Regularly flooded Irregularly flooded	Mesohaline
10. Sheltered and Stratified Estuary	Estuarine	All Estuarine Classes and Subclasses	Mineral Organic	Subtidal Regularly flooded Irregularly flooded	Brackish Euhaline
11. Kelp Beds	Marine	Algal Submergent Bed		Subtidal	Euhaline
12. Neutral Embayment and Shorewaters	Estuarine	All Estuarine Classes and Subclasses	Mineral Organic	Subtidal Regularly flooded Irregularly flooded	Euhaline Polyhaline
	Marine	Rock Bottom Unconsolidated Bottom		Subtidal	Euhaline

Table 7. (continued)

Odum et al. (1974)	Cowardin et al. (1976)				
	SYSTEMS	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
D. Natural Arctic Ecosystems					
1. Glacial Fjords	Estuarine	All Estuarine Classes and Subclasses except Forested Wetlands		Subtidal Regularly flooded Irregularly flooded	Brackish Euhaline
2. Turbid Outwash Fjords	Estuarine	All Estuarine Classes and Subclasses except Forested Wetlands		Subtidal Regularly flooded Irregularly flooded	Brackish
3. Ice Stressed Coasts	Estuarine Marine	All Estuarine and Marine Classes except Emergent Wetlands, Shrub Wetlands, and Forested Wetlands		Subtidal Regularly flooded Irregularly flooded	Euhaline Brackish
4. Sea Ice	No comparable types				
5. Under Ice Plankton System	No comparable types				
E. Emerging New Systems Associated With Man	No comparable types				
F. Migrating Subsystems	No comparable types				

represents the most comprehensive classification of U.S. coastal habitats, so we have attempted to correlate it with our system (Table 7).

The Odum et al. classification includes not only areas considered traditionally as estuaries (i.e., partially enclosed bodies of marine water), but "all the coastal systems where man's culture is or soon will be interacting with the sea" (Vol. I:2). The system is structured around the sources of energy inflow (e.g., sunlight, organic pollution), types of stress (e.g., breaking waves, cold winters), and the resulting diversity of organisms and niches that characterizes each system or subsystem. The 46 systems are placed in five general categories based on latitude, man's influence and the degree of natural stress.

Unlike our system, where one parameter (e.g., life form of vegetation or substrate form) is used to characterize all wetlands at a given level in each ecological system, the Odum et al. system classifies coastal systems according to the <u>prominent process</u> which dominates the functional activity of each habitat. For example, sedimentary deltas (A-5) are habitats where sedimentation is the dominant ecological factor; in hypersaline lagoons (A-6), excessively high salinity is the key. In addition, it should be obvious that the Odum et al. system describes units that vary widely in specificity from kelp beds (C-11) to blue water coasts (B-5) and oligohaline systems (C-8).

It is risky to attempt comparisons when the two classification systems are structured under such different rules, but we feel obliged to do so in this case.

CORRELATION WITH ZOLTAI ET AL. (1975)

In 1969, Adams and Zoltai (1969) published a "Proposed Open Water and Wetland Classification" as part of Canada's Bio-physical Land Classification. The following year, a subcommittee of the National Committee on Forest Land was established specifically to prepare a classification of wetlands for Canada. The new classification was to be compatible with the Adams and Zoltai system, and based on criteria important to many disciplines. Although the final classification has not yet been published, Zoltai et al. (1975) have outlined a tentative system. Hierarchical in structure and designed for air photo interpretation, the system has many similarities in purpose and general approach to ours.

Five basic wetland classes (marsh, swamp, fen, bog and shallow open water) are identified in Level 1, and differentiated on the basis of soil type, water regime, dominant life forms of vegetation, water chemistry, internal drainage characteristics and surface morphology. Each class is subdivided in Level 2, according to surface morphology of the wetland (for bogs and fens), hydrotopographic features (for marshes and swamps) and adjoining land or wetland types (for shallow open waters). Levels 3 and 4 stress vegetation types and the specialized

Table 8. Correlation between Zoltai et al. (1975) and Cowardin et al. (1976)

Zoltai et al. (1975)			Cowardin et al. (1976)		
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
Shallow Open Water	Lacustrine Palustrine	Submergent Bed Floating-leaved Bed Fine Bottom Coarse Bottom Rock Bottom Organic Bottom	Mineral Organic	Permanently flooded	Fresh
Marsh					
Estuarine	Estuarine Riverine-Tidal	Emergent Wetland	Mineral Organic	Regularly flooded Irregularly flooded	All possibilities
Coastal	Estuarine	Emergent Wetland	Mineral Organic	Irregularly flooded	Brackish Euhaline
Fluvial	Riverine Palustrine			Seasonally flooded Semipermanently flooded	Fresh
Lentic	Lacustrine Palustrine	Emergent Wetland	Mineral Organic		
Catchment	Palustrine				
Seepage	Palustrine				
Swamp					
Alluvial					
Lakeside					
Peat Margin	Palustrine	Forested Wetland Shrub Wetland	Mineral Organic	Seasonally flooded Semipermanently flooded	Fresh/circumneutral
Catchment					
Seepage					

Table 8. (continued)

Zoltai et al. (1975)	Cowardin et al. (1976)				
	SYSTEM	CLASS/SUBCLASS	ORDER	WATER REGIME	WATER CHEMISTRY
Fen	Palustrine	Emergent Wetland	Organic	Saturated	Fresh/acid
String		Shrub Wetland		Seasonally flooded	Fresh/circumneutral
		Moss/Lichen Wetland			
Seepage					
Net					
Floating					
Shore					
Draw					
Horizontal					
Pond					
Collapse					
Palsa					
Spring					
Slope					
Bog	Palustrine	Moss/Lichen Wetland	Organic	Saturated	Fresh/acid
		Emergent Wetland			
		Shrub Wetland			
		Evergreen Forested Wetland			

needs of various disciplines respectively. A review of Table 8 will demonstrate that, although we have decided to abandon such traditional terms as bog, swamp and marsh, wetlands would be characterized similarly in Zoltai et al. (1975) and in our system.

In studying Tables 4-8 one must realize that, because the comparisons were made from other systems to our own, in that order, there are several real combinations of ecological systems, habitat classes and subclasses, orders, water regimes and water chemistry modifiers which may not appear, simply because there are no comparable types in the other classification systems. It would be impossible to list all of the habitat types that exist in every ecological system in the United States, because we seldom have complete field data on these characteristics for even one wetland. However, we believe that the hierarchical approach which this classification system provides will permit the classification of the great majority of wetlands and aquatic habitats in this country to levels of detail commensurate with the status of our knowledge and our needs.

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