STRATEGIC INTERAGENCY APPROACH TO DEVELOPING A NATIONAL DIGITAL WETLANDS DATA BASE
(Second Approximation)

Federal Geographic Data Committee
Wetlands Subcommittee

Summer 1994

Federal Geographic Data Committee
Department of Agriculture · Department of Commerce · Department of Defense · Department of Energy
Department of Housing and Urban Development · Department of the Interior · Department of State
Department of Transportation · Environmental Protection Agency
Federal Emergency Management Agency · Library of Congress
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Federal Geographic Data Committee

Established by Office of Management and Budget Circular A-16, the Federal Geographic Data Committee (FGDC) promotes the coordinated development, use, sharing, and dissemination of geographic data.

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Contents

I. Executive Summary

This report, which integrates suggestions from the Domestic Policy Council's Interagency Wetlands Task Force's 1990 "Report of the Wetland Inventory Subgroup," describes a methodology to establish a national digital wetlands data base through a standard national wetland mapping and digitizing program with an emphasis on data integration. The Federal Geographic Data Committee's (FGDC) Wetlands Subcommittee is assigned responsibility to achieve this goal.

Several tasks must be addressed if the goal is to be achieved:

- Agency activities must be coordinated and existing information compiled.
- Ensure that data exchange is unrestricted.
- International data definitions and standards must be developed.
- A mechanism and reporting procedures to correlate data bases of mapping agencies must be established.

A national digital wetlands data base can be in either map or statistical form. It may also be merged with other data bases within geographic information systems (GIS). This flexibility allows for a wide range of such uses as determining status of wetland habitats and gathering baseline information; monitoring changes; and determining biotic potential and sensitivity.

While maps show the locations and characteristics of wetlands, the actual abundance of wetlands throughout a project area, watershed, county, or State can be assessed only by generating acreage statistics. Maps are the graphic display, but the acreage summaries represent the actual accounting of wetlands. Acreage statistics on wetland types are invaluable to resource managers.

A crucial element of this strategic interagency approach is coordination and integration to produce consistently reliable statistics on the Nation's wetlands and the development of a crosswalk between resource agency results. Work is underway to test the feasibility of integrating results of two major wetlands programs: the U.S. Fish and Wildlife Service's (FWS) National Wetlands Inventory (NWI) status and trends program with the Soil Conservation Service's (SCS) National Resource Inventory (NRI) program. The strategy for this effort is described in the Subcommittee report "Coordination/Integration of Wetlands Data for Status and Trends and Inventory Estimates."

Another crucial element of this approach is the integration of information on the health and value of wetlands. Documentation of loss or gain of wetlands is critical to their conservation and to effective wetland habitat management. The National Oceanic and Atmospheric Administration's (NOAA) CoastWatch Change Analysis Program (C-CAP) personnel plan to develop a comprehensive, standard information system for land cover and habitat change in coastal regions. This type and frequency of information (1- to 5-year cycle) will improve understanding of the relationships between coastal wetlands and adjacent uplands by providing data on the distribution, abundance and health of

coastal resources. The NOAA has begun research with the Environmental Protection Agency (EPA) to develop methods for analyzing remotely sensed data to assess wetland health. This aspect of wetland systems also is included in the effort to integrate data from the FWS's Status and Trends and the SCS's NRI.

The Federal Government is involved in several major activities that support the development of a national digital wetlands data base. The FGDC is working to improve the ability to find and access geographically-related data. The U.S. Geological Survey (USGS) and other agencies are developing a program to provide digital orthophoto data. The Corps of Engineers' (COE) Regulatory Analysis and Management System (RAMS) was developed to help evaluate permit applications and assess program performance.

A data exchange standard, the "Spatial Data Transfer Standard" (Federal Information Processing Standard 173), approved in 1992, provides specifications for the organization and structure of digital spatial data transfer, definition of spatial features and attributes, and data transfer encoding. The standard will promote the transfer of digital spatial data between dissimilar computer systems.

II. Introduction

A national digital wetlands data base may have information in either map or statistical form, or may be merged with other data bases within a geographic information system. This flexibility allows for a wide range of uses for impact analysis and resource planning. The following are examples of uses of such a data base:

Determining Status and Baseline Information

- Determine extent of vegetated wetlands by type, size, and location
- Determine length of coastal wetlands in miles and by type and political subunits
- Determine relative abundance and scarcity of wetlands by type, size, and location
- Quantify wetlands types
- Determine proximity to other wetland types or deepwater habitats
- Describe shoreline characteristics (e.g. rock versus marsh)
- Establish a baseline from which to measure changes

Monitoring Change

- Quantify wetland losses and gains by type, size, and location
- Quantify wetland modification
- Quantify cumulative extent of wetland loss, gain, and modification

Managing Wetlands

- Advanced identification or unsuitability determinations
- Determination of the extent of wetlands in a floodplain
- Swampbuster determinations

- Special area designations e.g., State Heritage Program
- Risk analysis (oil spill sensitivity)
- Impacts of sea level and climate change
- Mitigation
- Storm assessment
- Landscape factors
- Evaluation of permitted activity on quality and quantity
- Identification of areas subject to development

Determining Biotic Factors (in conjunction with other data)

- Wildlife habitat potential
- Fisheries habitat potential
- Rare and threatened communities
- Sensitive communities
- Commercial uses such as shellfish harvesting and fishing
- Sport uses such as hunting, fishing, and bird watching
- Gains and losses in functional value (an example being fisheries production as a function of the relationship between wetlands and open water)

The FGDC's Wetlands Subcommittee found technical, legal, institutional, and economic impediments to developing a national digital wetlands data base. The problems vary in severity, but they all exist. They must be overcome for wetland data to be available for use in environmental planning and management.

The data base needs to be national in scope and should subscribe to strict standards for format, design, and compatibility with other data retrieval systems. This compatibility will prevent the fragmentation of data for different units of geography or by programs, and will ensure a common and uniform source of wetland maps and statistical data.

Federal agencies need to retain the ability to monitor wetlands. A national digital wetlands data base is necessary to support the Clinton administration's goal of no overall net loss of the Nation's remaining wetlands, and a long-term goal of increasing the quality and quantity of the Nation's wetlands resource.

Clearly, the data base should contain the best existing data. It must contain information on the method used to complete the inventory such as remote sensing design, field investigation and verification, scale and required accuracy of the geographic information, the method used in defining the wetlands (terminology, definitions, classification system), method of interpretation, quality control measures, and any other factors that might affect a person's ability to understand the data. Gaps in the data base need to be filled quickly. Wetland quantity and quality should be monitored with aerial photographs, multi-spectral scanners, advanced very high resolution radiometers, side-looking airborne radar and any other applicable remote sensing technology. Metadata (describing where the information is located, the type of system for which the data are formatted, where to look for ancillary data, etc.) must accompany the digital wetlands data.

While maps show the locations and characteristics of wetlands, the actual abundance and scarcity of wetlands throughout a project area, watershed, county, or state can be assessed only with acreage statistics. Maps are the graphic display, but the acreage summaries represent the actual accounting of wetlands. Acreage statistics on wetland types are invaluable to resource managers.

Maps can be combined with other GIS layered (thematic) information such as soils and land-use layers, and used for planning and management. For example, in selecting alternative sites for a commercial development, many locational criteria must be examined. These may include soil properties, adjacent land use, zoning, presence of environmentally sensitive resources (e.g., wetlands, endangered species, and water supplies), and transportation routes. All of this information can be analyzed with a GIS.

The wetland data base would facilitate compilation of these features and permit manipulation in various ways. The ability to manipulate data would be useful for both public policy analysis and natural resources management, as the scope of existing land-use policies and programs could be evaluated under various contingencies.

County planners should find these computerized products particularly valuable in assessing the status of their wetland resources and in guiding future land-use decisions in light of wetland values. The data base could produce wetland maps and statistics for different geographic areas, such as municipalities and watersheds.

III. Goal

Establish a national digital wetlands data base by supporting standard wetland mapping and digital data collection with an emphasis on data integration.

IV. Means to Achieve Goal

The FGDC's Wetlands Subcommittee will be the focal point for efforts to meet this goal. The responsibilities of the subcommittee include:

A. Facilitate the coordination of agency activities and the exchange of wetlands data.

B. Compile information on wetlands data activities from Federal agencies.

C. Participate in the development and evaluation of data definitions and standards used by the United Nations and other international agencies, and make recommendations for their inclusion in the wetlands data.

D. Determine the level of detail of wetlands data to be included in a coordinated national digital wetlands data base and recommend other levels of detail of wetlands data not currently being collected.

E. Assist the Department of the Interior, as the lead Department, in establishing standards and specifications for wetlands data.

F. Assist the Department of the Interior, as the lead Department, in establishing priorities for production of wetlands data sets.

G. Develop common standards for content, format, and accuracy of wetlands data for use by all Federal agencies. Encourage use of these standards by non-Federal organizations to increase the interchangeability of wetland data and enhance its potential for multiple use.

H. Promote Governmentwide use of defined and published transfer standards for wetlands data.

I. Establish mechanisms and reports to communicate with data bases of agencies participating in the national geographic data system.

J. Facilitate the application of wetlands data by sharing applications.

K. Support higher-order or crosscutting activities established or recognized by the FGDC.

L. Ensure that the disposition of wetlands data is carried out in coordination with the National Archives and Records Administration. This will provide for the preservation of historically valuable data and the timely disposal of data lacking historical value.

V. Plan to Coordinate and Integrate Wetlands Quantity Data from Status and Trends Studies and Mapping Efforts

Federal Agencies' Wetlands Programs

The FWS and the SCS collect and disseminate wetlands data in many areas throughout the United States. Additionally, the NOAA, through its Coastal Ocean Program (COP), initiated the C-CAP to monitor land cover and habitat change, including submerged aquatic vegetation, coastal wetlands, and adjacent uplands in the coastal region of the United States on a 1- to 5-year cycle.

The FWS, as the principal Federal agency responsible for protecting and managing the Nation's fish and wildlife, collects status and trends data on all wetland and deepwater habitats in the conterminous United States. The Emergency Wetlands Resources Act of 1986 requires the FWS to produce the National Wetlands Inventory, and to update reports on wetland status and trends every 10 years. The FWS last updated the report in 1991 for the period between the mid-1970's and the mid-1980's. The next report is due in 2000.

The Rural Development Act of 1972 authorizes the SCS to periodically conduct national inventories of soil, water, and related resources. The SCS's National Resource Inventory responds to the Soil and Water Conservation Act of 1977 and the Food Security Act (FSA) of 1985. Wetland data for non-Federal rural areas throughout the United States, except for Alaska, are included in the NRI. The Swampbuster provision, introduced in the FSA, and amended by the Food, Agriculture, Conservation, and Trade Act of 1990, denies farmers eligibility for most the U.S. Department of Agriculture's farm programs if they drain and cultivate wetlands. The SCS ascertains the effectiveness of its programs and policies by monitoring the status of wetland use and conversion. The SCS last updated the wetlands portion of the NRI in 1991.

The Magnuson Fishery Conservation and Management Act of 1976, with amendments, requires the NOAA to (1) identify and describe habitat requirements of fish stocks, (2) identify existing habitat conditions and sources of pollution and degradation, (3) conduct habitat protection and enhancement programs, and (4) recommend measures to protect and manage habitat, including all wetlands with living marine resources.

The Coastal Zone Management Act of 1972 requires the NOAA to work with States to (1) plan comprehensively for, and manage the development of, the Nation's coastal land and water resources; and (2) protect, restore, or enhance existing coastal wetlands, or create new coastal wetlands. The NOAA's interest is in monitoring land cover, including wetlands, and changes in land cover in the coastal region of the United States to determine effects on productivity of the coastal zone, particularly the abundance, distribution, and health of living marine resources.

In addition to determining extent of wetlands, the NOAA is interested in determining wetland health (i.e., biomass, productivity, and functional status) to ascertain functional changes in wetlands as habitat before these changes become apparent spatially through loss or gain of wetlands.

Recommendations for Federal Program Integration

In December 1990, the "Report of the Wetland Inventory Subgroup of the Domestic Policy Council Interagency Wetlands Task Force" recommended that the FWS and the SCS "coordinate/integrate" their wetlands data. The report further recommended a NOAA-coordinated program to detect wetland change for the coastal region of the United States.

Recommendation 2 of the Report states:

> 2. Coordinate/Integrate the Fish and Wildlife Service's Statistical Wetlands Status and Trends Surveys with the Soil Conservation Service's National Resource Inventory.
>
> The Fish and Wildlife Service's Statistical Wetlands Status and Trends Surveys collect status and trends data on all wetland and deepwater habitats of the conterminous United States. The Soil Conservation Service's National

Resource Inventory collects data on 60 items, one of which is non-federal, rural wetlands. Coordination and integration of these two statistical surveys will allow wetland acreage data to be correlated with the soils and other resource data collected by the National Resource Inventory reports on the status and trends of the Nation's wetlands.

Recommendation 6 of the Report states:

6. Coordinate/integrate the Fish and Wildlife Service's National Wetlands Inventory mapping program with the Soil Conservation Service's wetland determinations made for the wetland conservation (Swampbuster) provision of the Food Security Act.

The National Wetlands Inventory produces maps of wetlands and deepwater habitats at a scale of 1:24,000 on all lands. The exception is that the Fish and Wildlife Service maps only four types of farmed wetlands. The Soil Conservation Service presents its wetland information on 1:7,920-scale photographic bases. They focus on cropped wetlands and natural wetlands with a high potential for conversion. These two wetland efforts need to be coordinated and integrated for a full picture of the Nation's wetland resource.

Recommendation 3 of the Report states:

3. Establish a cyclic (1-5 years) coordinated program to detect wetlands change, particularly for coastal regions.

Quicker, more frequent updates (every 1-5 years) and specificity of change (i.e.,location, type and magnitude) would fulfill requirements for monitoring wetland changes in three areas:

First, the ability to store years of changes in the location of coastal wetlands in computer form in a GIS and to compare wetland data to other computerized map data would allow earlier warning and earlier, more focused management actions regarding loss or change in coastal wetlands and potential impacts on coastal zone productivity. Second, the ability to detect specific changes would enhance research efforts toward understanding the relationship between coastal wetlands (emergent wetlands as well as seagrass beds) and living marine and estuarine resources. Third, frequent updates would improve projections from predictive models of the effects of future coastal wetland loss or gains on living resources and coastal productivity. The data will be recent (within the last 1 to 5 years), and nearly synoptic (within 1 year) for the entire coastal region. Change analyses will be presented as digital maps showing specific changes for the entire coastal region as well as by summary tables. This effort is new.

NOAA, through its COP, has requested funds to initiate this program. Because the budget request was only partially funded, the NOAA is initiating change detection projects in selected coastal areas.

Strategy for Coordination and Integration

The subcommittee developed a strategy to coordinate and integrate wetlands data produced by the Federal Government for status, trends, and inventory estimates. Four tasks are structured sequentially so that decisions on the optimal degree of coordination and integration can be based on results obtained from earlier tasks. The first two tasks and the first part of the third task are underway. The second part of the third task and the fourth task require results from the earlier tasks.

Task 1: Integration of Terminology, Definitions, and Classification Systems

The FWS, the SCS, and the NOAA should work together to ensure that terminology, definitions and classification systems in their respective reports are consistent. Differences in terminology should be documented and explained to avoid misinterpretations.

The issues to be addressed in Task 1 are:

A. Classification System and Definition of Wetlands

All three organizations started using the "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin, et. al. 1979) in 1992. The classification system was adopted by the FWS in 1979. The SCS used the classification system in FWS Circular 39 in the 1982 and 1987 NRI and in the 1991 wetlands update; the Cowardin et. al. system was used in the 1982 NRI and is being used again in the 1992 NRI.

The NOAA is using a system, recently worked out between the FWS, the EPA, the USGS, and the NOAA, based on the Cowardin et. al.'s classes for wetlands (Klemas et. al., 1992). The classification systems are identical at the highest levels and consistent at the lower levels of the classification hierarchy.

B. Classification of Wetlands

The FWS and the NOAA view wetlands differently from the SCS because of their different missions. The FWS and the NOAA consider wetlands to be a discrete land cover that serves as habitat for fish and wildlife. The SCS, on the other hand, considers wetlands to be a condition of the land, and may have various "earth cover."

C. Wetland to Open Water Conversion

The FWS and the SCS draw different conclusions when wetlands are converted to open water. The FWS considers the change of a vegetated wetland to an open-water area to be a conversion of wetland type if the open water area is less than 20 acres. It is considered to be a loss of wetland and a gain of deepwater habitat if the open water area is greater than 20 acres. The SCS relies on a site evaluation to determine whether the open water area continues to meet wetland criteria. If the area retains wetland characteristics then no conversion is recorded; if it is determined that the area no longer meets wetland criteria then the area is considered to have been converted to open water.

Task 2: Coordination of Data Collection Processes and Reports

The FWS, the SCS, and the NOAA should coordinate their wetlands data collection processes and reports. Data should be presented in similar formats to facilitate comparisons. Coordination of the FWS's and the SCS's report schedules will ensure that users will be aware of these activities to collect wetlands data and will make it easier for the FWS and the SCS to benefit from the each other's data. The FWS and the NOAA have signed a memorandum of understanding to coordinate their programs.

The issues to be addressed in Task 2:

A. Legislative Requirements

The Emergency Wetlands Resources Act of 1986 requires the FWS to report to Congress on the status and trends of the wetlands and deepwater habitats in the conterminous United States on a 10-year cycle, with future reports due in 2000, 2010, 2020, etc. The Rural Development Act of 1972 requires the SCS to report to Congress on soil, water, and related resource conditions at not less than a 5-year interval. Reports are due in 1992, 1997, and 2002. No schedule is established for the NOAA.

B. Mission Responsibilities of the FWS, the SCS, and the NOAA

There are fundamental differences in the missions of the FWS, the SCS, and the NOAA. The FWS is interested in habitat availability and trends as they relate to fish and wildlife populations. Consequently, the FWS has developed a wetland classification system, monitoring network, and statistical sampling design geared specifically to measure wetland acreage changes.

The SCS is responsible for conserving, sustaining, and enhancing the Nation's natural resources and environment. The NRI is structured to provide status, condition, and trend information on soil, water, and related resources. Study design and statistical sampling are structured to address these needs and are limited to non-Federal, rural lands.

As steward for the Nation's living marine resources, the NOAA is interested in a link between development in the coastal zone (i.e., land cover and changes in land cover) and loss or degradation of habitat (including wetlands), and subsequent effects on living marine resources, including their abundance, distribution, and health. As a consequence, like the FWS, the NOAA is interested in wetlands classification and in the determination of acreages of change in submerged aquatic vegetation and emergent coastal wetlands. Additionally, the NOAA is interested in upland cover, because its condition is a significant determinant of water quality affecting the critical habitats (i.e., wetlands and deepwater habitats) of living marine resources.

Task 3: Consistency of Data and Results

The FWS, the SCS, and the NOAA should compare and calibrate their respective data and results and work toward a report easily understood by the public.

Sub-Task 3A. Consistency of Data

For selected test areas, the FWS, the SCS, and the NOAA should evaluate data from the NWI, the NRI, Swampbuster determinations, and the C-CAP to determine where the data are inconsistent. Test areas should cover multiple areas with varying wetland density and complexity, and data should be geographically referenced. Where the data are inconsistent, it should be determined whether the inconsistencies are caused by:

(1) different classification of wetlands (see Task 1 issues);
(2) different data collection methods (see Task 4 issues); or
(3) different levels of quality control (see Task 3 issues).

The results of this evaluation will enable the FWS, the SCS, and the NOAA to calibrate their respective data, to better understand the causes of possible data inconsistencies, and to develop improved methodologies as appropriate. This evaluation requires the use of a GIS to compare the agencies' data, as well as verification in the field. The USGS will support the GIS activities. Other organizations that collect wetlands data, such as the EPA, also should participate in this effort.

Sub-Task 3B. Consistency of Results

The FWS, the SCS and the NOAA should evaluate the consistency of their respective wetlands acreage findings by using their respective statistical methodologies with wetlands data that were calibrated in Sub-Task 3A. This evaluation will include the development and testing of a methodology for making adjustments for the different study areas for which the organizations have responsibility. The results from this analysis will facilitate improved methods by allowing each organization to identify weaknesses in its approach and make appropriate changes.

The issues to be addressed in Task 3 are:

A. Study Area

The FWS evaluates the 1.94 billion acres of the surface of the conterminous United States. The SCS evaluates 1.41 billion acres of non-Federal, non-urban, non-open-water land surface in the conterminous United States, Hawaii, and the Caribbean. The NOAA looks only at the coastal United States, but proposes to do the entire coastal strip nearly synoptically each 1 to 5 years.

B. Wetland Base Monitored

The FWS monitors 103.2 million acres of wetlands; the SCS monitors 82 million acres.

C. Focus of Sampling

The FWS samples wetlands and deepwater habitats, while the SCS samples 60 different soil, water, and related resource conditions. The NOAA looks at all discernible land cover and habitat classes in the coastal region, including submerged aquatic vegetation, emergent coastal wetlands, and adjacent uplands.

D. Sampling technique

The FWS uses a stratified random sampling design with sample plots allocated by expected wetland acreage and diversity. Stratifications are formed by the Hammond Land Surface Forms and state boundaries.[1] The SCS uses a two-phase stratified area sampling scheme. The 3,300 counties in the conterminous States, Hawaii, and the Caribbean are subdivided into strata using geographic proximity and broad land use patterns. The primary sampling units (PSU's) are selected randomly within the strata. Data are collected on three randomly selected points, using a procedure to assure dispersion, within the PSU.

NOAA proposes to address the entire coastal region and to compare it from one nearly synoptic period (a single growing season if possible) to another equally synoptic time period to determine coastal habitat change.

[1] Hammond Land Surface Forms were developed by Edwin H. Hammond from an empirical analysis of the land surface. Hammond maps show the occurrence of landform types defined in terms of a selected group of land surface characteristics such as Gulf Atlantic Coastal Flats and Lower Mississippi Alluvial Plain.

E. Sample Sites

The FWS has 3,629 sample plots, each of 2,560 acres. The NRI uses 800,000 points. When fully operational, the NOAA will process approximately 325 Thematic Mapper scenes of the coastal region, with each scene representing an area of 180 km by 180 km at a spatial resolution of 30 meters.

F. Data Collection

The FWS data are collected by stereoscopic photointerpretation with approximately 10 percent field verification. Collateral data sources include published soil surveys, topographic maps, and NWI wetland maps. The NRI collects data through a combination of ground visits, and monoscopic or stereoscopic photointerpretation. The NOAA follows a protocol that includes use of satellite imagery, aerial photography, ground surveys, and collateral data to generate a digital data base for use with a GIS. The protocol was developed through national workshops. The protocol also will include a rigorous accuracy assessment that is still being developed.

G. Geographic Referencing

The FWS uses the 1:24,000-scale USGS base maps to geographically reference to the surface of the Earth all sample plots and wetlands. The SCS locates PSU's on photographs or base maps of varying accuracy and geographic fidelity. These include published SCS soil survey maps and completed soil survey atlas sheets, current soil survey field sheets, aerial photographs, and USGS 1:24,000-scale base maps. The SCS is working with the USGS to produce digital orthophotoquadrangles (DOQ's) at 1:12,000-scale. These will become the spatial basis for its soils data. The FWS also has shown interest in using DOQ's for displaying NWI data. The NOAA uses the 1:24,000-scale USGS topographic maps to geographically reference the scene.

H. Quality Assurance

The FWS uses a quality control review for national consistency with expert photointerpreters using written conventions. All work is done at one location. The SCS has a full quality assurance program, starting with State leaders and technical specialists at its National Technical Centers and the Iowa State University. The NOAA will follow the quality assurance procedures to be developed for its protocol.

I. Quality Control of Data

The FWS performs quality control of data by using logic checks related to possible wetland changes.[2] The SCS uses many internal and external logic checks; these include computerized checks involving other NRI data elements, soils data bases, and changes documented in FSA activity progress reports. The NOAA's protocol will contain procedures to assure quality control of data.

Task 4: Evaluation of Opportunities for Additional Coordination/Integration

At the completion of Tasks 1, 2, and 3, the FWS, the SCS, the NOAA, and other interested agencies should work together to evaluate the feasibility and the public policy implications of further wetlands data coordination and integration. This evaluation should consider existing agency missions and mandates.

It should also consider how information collected by each agency complements the work of others and how the work can be integrated to reduce costs, improve accuracy, and increase the value of reports. In addition, this evaluation should address benefits and costs associated with various levels of wetlands data accuracy and timeliness, so that these issues can be incorporated into a comprehensive wetlands strategy.

The tasks provide a sequential process to coordinate and integrate Federal wetlands data collection activities for status and trends and inventory. The strategy includes determining the appropriate level of wetlands data that should be collected by the Federal Government so that coordination and integration decisions can be addressed in a broad policy context. The tasks will require an estimated 36 months to complete. Tasks 1, 2, and 3A can be completed within two years. Following their completion, Tasks 3B and 4 will each require an additional year to complete.

VI. Integration of Information on Functional Health and Value of Wetlands

Background

Coastal wetlands with emergent and submerged aquatic vegetation (salt marshes, mangroves, macroalgae, and submerged aquatic vegetation) support a majority of marine finfish and shellfish resources in the coastal United States. Yet coastal wetlands are being destroyed by dredge and fill operations, impoundments, toxic pollutants, eutrophication, and, for submergents, excessive turbidity. Projections of population

[2] Examples of logic checks include examinations to ensure that no marine or estuarine wetlands are formed inland, or deepwater or upland areas did not become classified as palustrine forested wetlands in the span of 10 years.

growth in the coastal zone suggest accelerating losses of wetlands and adjacent habitats as waste loads and competition for limited space and resources increase. Continued loss of these wetlands may lead to a collapse of coastal ecosystems and associated fisheries. Documentation of loss or gain of coastal wetlands is critical to their conservation and to effective management of marine fisheries. Agencies responsible for coastal management must know the extent and status of wetlands and adjacent uplands. Therefore, timely quantification of wetland area, location, and rate and cause of loss is needed now.

The goal of the NOAA's C-CAP is to develop a comprehensive, standard information system for land cover and habitat change in the coastal region of the United States. Satellite images, aerial photographs, and surface-level data will be interpreted, classified, analyzed, and integrated within a GIS. The program will delineate coastal wetland habitats and adjacent uplands and monitor changes in these habitats on a 1- to 5-year cycle. This type and frequency of information is required to improve understanding of the linkages of emergent and submerged aquatic vegetation with adjacent uplands, and with the distribution, abundance, and health of living marine resources. The program directly supports the NOAA's legal responsibilities in estuarine and marine science, monitoring, and management contained in the Fish and Wildlife Coordination Act; the Magnuson Fishery Conservation and Management Act; the Coastal Zone Management Act; the Clean Water Act; the Marine Protection, Research and Sanctuaries Act; the National Environmental Policy Act; and others.

To respond to recommendation 8 of the Wetland Inventory Subgroup of the Domestic Policy Council Interagency Wetlands Task Force, the NOAA has begun research with the EPA to develop methods for analyzing remotely sensed images to assess wetland health changes. Therefore, in addition to determining land cover and habitat cover changes in coastal regions, the NOAA, in cooperation with the EPA, proposes to sponsor research in remote sensing techniques to help meet the following requirements:

1. To see early functional change before areal change in habitat.

2. To be able to assess large areas rapidly for an early response to stress or impending degradation.

This work will be carried out in close cooperation with the EPA's Environmental Monitoring and Assessment Program (EMAP). The EMAP was initiated in 1988 for improved information on the status and long-term trends in the condition of the Nation's ecological resources. The goal is to assess the status and long-term trends in ecological conditions on regional and national scales.

In the short term, the EMAP will establish protocols for measuring and describing wetland conditions, will provide estimates of wetland conditions in several regions, and will develop formats for reporting program results. Trend detection clearly will require longer periods of data collection and evaluation, and therefore is an intermediate goal. Diagnostic analyses to identify or eliminate plausible causes for degraded or improved wetland condition is the long-term goal of EMAP-Wetlands. EMAP-Wetlands,

therefore, will be a national-scale monitoring network for developing quantitative answers (with known levels of confidence) to policy questions.

Objectives

Airborne remote sensors have been used for several decades to map the loss of wetlands caused by natural processes and human activities. Determining only the area of marsh lost, however, may not accurately describe environmental degradation. For example, activities may cause a marsh to loose only 20 percent of its area, but may disturb the hydrology seriously enough to cause the biological productivity of the remaining 80 percent to be only a small fraction of its previous level. New remote sensing techniques need to be developed for researchers to determine not only the change in marsh area but also its biomass production and other indicators of condition.

The objective of the proposed work is to use remote sensing and field techniques for monitoring indicators of wetland condition and health over large wetland areas for the NOAA's C-CAP and the EPA's EMAP.

Approach

Data from EMAP field surveys and aircraft flights will be combined with satellite data from the NOAA to develop techniques for monitoring health and condition over large wetlands areas. Close cooperation between NOAA and EPA programs will insure better coverage, precision, and resolution than either program alone can achieve. To insure compatibility of the data, NOAA scientists will join EPA teams in the field and EPA scientists will join NOAA researchers performing the satellite image analysis. This research will emphasize remote sensing techniques that can answer the following questions:

- What proportion of mapped wetlands are in what condition?
- Are conditions improving or degrading? In what proportion of the wetland resource are conditions continuing to decline and at what rate?
- What are the most likely causes of poor or degrading condition? Which stresses seem to be most important, affecting the greatest numbers or area of wetlands?

Even though remote sensors can directly detect only the floral and not the faunal component of marsh productivity, we expect that these techniques will significantly enhance our ability to determine marsh condition over large areas and at various intervals.

Biomass is the most widely used indicator of wetland health. Scientists have developed remote sensing techniques using canopy spectral reflectance to estimate biomass in the marsh plant *Spartina alterniflora.* They have used these models with satellite data to estimate both above- and below-ground biomass for *Spartina* over a latitudinal area extending from the Bay of Fundy in Nova Scotia to Sapelo Island, Georgia. The proven

ability to sense varying quantities of biomass suggests that remote sensing should be a useful tool in assessing the health of coastal *Spartina* marshes.

A literature review and summary of the status of remote sensing of biomass, productivity, and health of coastal wetland habitats has been performed. Further proposed research includes modeling and field studies. A pilot study in Louisiana marshes is being conducted jointly by scientists funded by the NOAA and the EPA. The research is being carried out jointly by teams from the University of Delaware and Louisiana State University (LSU) with C-CAP and EMAP support, respectively. The goal is to relate spectral data to biomass, plant density, hydrologic characteristics, or other environmental factors as appropriate.

Once the remote sensing techniques have been tested at the Louisiana pilot test site, two more pilot sites will be selected -- one on the Atlantic coast and one on the Pacific coast or in the Great Lakes region. Finally, a monitoring system for all coastal areas will be established. The proposed system for monitoring wetlands condition indicators and health will use much of the same satellite data collected by the C-CAP and some of the field data gathered by the EMAP. Therefore, the success of this proposed effort depends heavily on the existence and cooperation of these two programs.

Tasks

Year 1 (Planning Phase)	Perform literature review of wetland health assessment techniques.
	Conduct workshops with a broad range of scientists to define health indicators and pilot experiments.
	Prepare memorandum of understanding between the NOAA and the EPA to insure that scientific data are shared by all components of the C-CAP and the EMAP.
	Design pilot site experiments for developing remote sensing techniques for determining wetland health.
Year 2-4 (Pilot Phase)	Conduct research at pilot test sites to select wetland health indicators and develop algorithms and models for measuring these indicators with remote sensors.
Years 4-6 (Demonstration Phase)	Expand pilot test site research to demonstration projects on the East Coast and the West Coast or Great Lakes.
	Determine what modifications are needed for models and algorithms to apply remote sensors at other sites having different environmental conditions.

(Demonstration Phase continued)	Expand remote sensing to determine changes of biomass and wetland health indicators over large coastal areas.
Years 7-10 (Implementation Phase)	Define accuracy, quality control, and other necessary procedures. Prepare a user manual for measuring changes in coastal wetland health with remote sensors.
Years 10+ (Implementation Phase)	Establish a program for mapping and inventory of functional health and value of coastal wetlands on a national scale using remote sensing.

Special Considerations

- Frequent cloud cover in some coastal areas will be an impediment. This problem is being solved by using data from other satellites.

- A formal memorandum of understanding between the NOAA and the EPA will be required to insure that scientific data are shared by all components of the C-CAP and the EMAP. The complementary field work and data analysis at the Louisiana pilot test site being performed by the LSU team is tentatively supported by the EPA through EMAP-Wetlands. The proposed system for monitoring wetland condition indicators and functional health will use much of the same satellite data collected by the C-CAP and some of the field data gathered by EMAP-Wetlands. Therefore, the indicated low cost for this proposed program can be attained only if both the C-CAP and the EMAP are adequately funded and cooperate fully in data sharing.

- The cost of the NOAA operational programs covering all U.S. coastal regions is estimated at $1.5 million per year. This budget does not include support for complementary EMAP activities such as field data required for analyzing and quantifying the satellite images.

VII. Integration of Wetland Quality and Quantity

The integration of wetland quality and quantity data will take a long time. In the short term, protocols integrating quality and quantity data will be developed based on the results of research on the health (i.e., quality) of wetlands (Section VI). Early results from this research will show the status and causes of change for selected areas only. Intermediate goals will be to make use of these new protocols to subclassify large areas of wetlands efficiently to determine their health status, changes in that status, and causes of the changes. These subclassifications will continue to be compatible with Cowardin et. al. Therefore, data on changes in quality will be a subset of, and be directly related to, quantitative measurements of wetlands area. In the long term, not only will trends be determined, but, through continued refinement of the protocol and additional research on causation, there will be more detailed subclassifications and improved ability to define the causes of changes observed by satellite or airborne sensors.

VIII. Supporting Activities

The Federal Government is involved in three major activities needed to develop a national digital wetlands data base: improved means of finding and accessing data, production of orthophoto data, and the COE's Regulatory Analysis and Management System.

Improved Means of Finding and Accessing Data

The FGDC's "Manual of Federal Geographic Data Products" describes Federal products that are national in scope and distributed to the public. The products include maps, digital data, aerial photographs and multispectral images, and geographically referenced statistical data sets. The products are described in a standard format and grouped by agency. A cross-reference matrix helps users find products by data type. While much effort was made to ensure that the manual is comprehensive, some products may have been overlooked. In addition, rapidly changing geographic data technologies, especially digital technologies, are resulting in new products and new forms of existing products. The FGDC intends to revise the manual.

The manual is a valuable reference for those seeking remotely sensed data and data products. It should reduce duplication in resource mapping not only among the Federal agencies, but between Federal and non-Federal organizations as well. The efforts to reduce duplication may lead to standard criteria, definitions, and classification and may help establish the framework for a national digital wetlands data base.

The FGDC also is developing a clearinghouse for geographically-referenced data sets. The clearinghouse will help users to know what data exist, the condition of these data, and instructions for accessing these data. On April 11, 1994, President Clinton issued Executive Order 12906, "Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure," which requires Federal agencies to document new data using the FGDC's metadata standard and to provide this documentation to the clearinghouse.

National Orthophoto Data Effort

Overview

The USGS has produced orthophoto quadrangles since 1971. An orthophoto is an aerial photograph that has been processed to remove distortions caused by the orientation of the sensor and the terrain. The resulting image has geometric characteristics similar to maps and can serve as a base from with information can be interpreted or on which information can be registered geographically.

The growing use of GIS by resource managers has increased the demand for high-resolution digital image data that can be used as a base for the registration or compilation of resource data. In 1990, the USGS, the SCS, the National Governors'

Association, and the National Association of Counties sponsored a Forum on Orthophotography. The forum was followed in 1991 with a survey of user requirements for orthophotos. The forum and the survey showed an increased need for 1:12,000-scale, quarterquad-centered orthophoto data in digital and paper forms. Users having applications and jurisdictions that have cover a small require higher resolution data; agencies with large rural, rangeland, forest, or wetland areas in their jurisdictions require lower-resolution (1:24,000-scale) data. Most users agreed that a 4- to 5-year photo acquisition cycle is essential.

The USGS, working with other Federal agencies and non-Federal organizations, developed a specification for digital orthophoto quadrangle (DOQ) data. The USGS produces DOQ's from aerial photography collected through the National Aerial Photography Program (NAPP), which provides 1:40,000-scale black-and-white aerial photographs that are centered on the quarters of USGS 7.5-minute maps. The DOQ's have a resolution of 1 meter, and a positional accuracy commensurate with 1:12,000-scale line maps. A joint initiative of the USGS, the SCS, and the Agricultural Stablilization and Conservation Service proposes the generation of digital orthophotos from NAPP photography for the conterminous United States over a 5-year period.

Support for Wetland Data

The 1991 survey provided a profile of the needs of users having an interest in wetlands and coastal processes. The users' responsibilities ranged from county level to national in scope. The users agreed that maps and images provide an indispensable base on which wetland and habitat information can be recorded. The scale of choice was 1:24,000, but users indicate that 1:12,000-scale maps and images will be needed, especially by programs that are countywide and statewide. Leaf-off (color infrared) photography is preferred for the photointerpretation of wetlands.

The proposed initiative could have a beneficial, albeit indirect, benefit to wetlands programs throughout the country. Some of the overall planning considerations and assumptions would address many of the needs of wetland program managers, but the needs of wetlands programs must be factored into the production schedule. This will require more active participation by wetland data users in image data activities.

COE's Regulatory Analysis and Management System (RAMS)

The Corps of Engineers (COE) regulates discharges of dredged or fill material into the waters of the United States, pursuant to Section 404 of the Clean Water Act. RAMS was developed to help evaluate permit applications and program performance. Several versions of RAMS operate in 26 of the 38 COE field offices, and the COE is standardizing the RAMS program nationally. Depending on funding, a standard version of RAMS is expected to be operational at all levels of the COE within 5 years. The COE also is linking the RAMS program to the Geographic Resources Analysis Support System (GRASS), a GIS developed by the COE. The COE will use the RAMS/GRASS system to assist to analyze regulatory actions and determine acreage amounts and

locations for wetlands affected by regulatory decisions. The COE is coordinating the RAMS/GRASS effort with agencies involved in wetlands mapping to assure compatibility of program approach.

For consistency with the Interagency Wetlands Task Force recommendations, RAMS will eventually be modified to include additional data elements relating wetlands impacts and regulatory actions. A full RAMS program will help to: (1) track cumulative impacts of permitted activities, (2) identify areas of intense wetland activity, (3) evaluate wetland condition, (4) evaluate wetland gains and losses, and (5) identify wetland maps that need to be updated.

IX. Data Exchange

In 1992, the Secretary of Commerce approved the Spatial Data Transfer Standard (SDTS) as Federal Information Processing Standard (FIPS) 173. The standard provides specifications for the structure of digital spatial data transfer, definitions of spatial features and attributes, and data transfer encoding. The objectives of SDTS are to:

- provide a mechanism for transferring digital spatial information between dissimilar computer systems while preserving information meaning, and limiting the need for information external to this standard;

- provide, for the purpose of transfer, a set of clearly specified spatial objects and relationships to represent spatial entities, and to specify the ancillary information necessary to accomplish the transfer; and

- provide a transfer model to facilitate the conversion of a user-defined to a standardized set of objects, relationships, and information.

The use of SDTS does not apply to the transfer of digital geocoded data files that are not intended to represent spatial entities as digital geographic or cartographic features. The SDTS should help to overcome the difficulties of transferring digital spatial data collected by Federal agencies.