

WETLANDS MAPPING IN THE COASTAL ZONE:
PROGRESS TOWARDS A NATIONAL DIGITAL DATA BASE

THOMAS E. DAHL*

To date approximately 90 percent of the coastal zone of the lower 48 states has been mapped by the National Wetlands Inventory (NWI). A number of Federal and State agencies have expressed an interest in having this information available in digital map form with corresponding acreage summaries and statistics. This paper presents the status of NWI mapping in the coastal zone and describes steps which are underway to construct a coastal wetlands data base for the Great Lakes as a precursor to a National coastal wetlands data base.

Introduction

The National Wetlands Inventory (NWI) was established by the Fish and Wildlife Service (FWS) to generate scientific information on the characteristics and extent of the Nation's wetlands. This information is developed in two stages: 1) the creation of detailed wetland maps; and 2) research on historical status and trends. The maps, developed using high altitude aerial photography, are based on 1:24,000 scale U.S. Geological Survey (USGS) quadrangles and delineate wetland habitats as defined by Cowardin et al., (1979). A more detailed description of the National Wetland Inventory Project is given by Wilen (1984).

It has long been recognized by the NWI that acreage summaries for both wetland habitat types and for political units (i.e., counties and states) are necessary for effective wetland resource management. But because quantification of detailed wetland information is very expensive and time consuming, computerization of the wetland map information which would generate the acreage summaries, has taken a back seat to traditional map production. Consequently, there is no National wetland digital database for the United States.

The need for this kind of information has been identified by FWS, and specifically for coastal wetlands, by both the National Oceanic and Atmospheric Administration's (NOAA) Strategic Assessment Branch and by the 1985 version of the Federal Plan for Ocean Pollution Research, Development and Monitoring (NOAA, 1985).

* Assistant National Coordinator, National Wetlands Inventory
U.S. Fish and Wildlife Service, Washington, DC 20240

Although NWI wetland maps have been completed for about half (45.5%) of the lower 48 states, only a fraction have been digitized by the NWI. The NWI policy for creating digital map data has been to produce this information on a user-pays basis. Under this policy, statewide NWI digital data bases have been constructed for New Jersey, Delaware and Maryland with Illinois and Indiana in progress. Other areas of the country where digitized NWI maps have been prepared include the coastal zone of Texas, Louisiana, Mississippi, Alabama and the Florida Panhandle. Tampa Bay, San Francisco Bay, the Potomac River portion of Virginia and portions of Oregon and Washington State also have some digital data. The States of Massachusetts, Pennsylvania and North Carolina plan to digitize the NWI maps and there is interest in digitizing Puget Sound when funds become available.

The policy of "user-pays" for creating digital data will not change in the near future. However NWI now needs a more comprehensive operational plan to start to compile a National wetlands data base. This is an attempt to present a plan to generate digital wetlands data for the coastal zone of the conterminous United States.

The Importance of Monitoring Coastal Wetlands

The National Wetlands Inventory estimated that as of the mid 1970's over half of the coastal wetlands in the lower 48 states had been destroyed. In some areas of the country, losses of coastal wetland resources continue at a staggering rate with California, Florida, Louisiana, New Jersey and Texas exhibiting the greatest rate of loss (Frayer et al. 1983). It is estimated that Louisiana is losing its coastal wetlands at a rate of 25,000 acres per year due to coastal subsidence and a combination of other factors (Früge 1982).

The reasons for the decline in coastal wetlands vary from state to state but recent studies have indicated that between 70-90 percent of coastal wetland losses are directly related to population density i.e., urbanization (Gosselink and Baumann 1980; Frayer et al. 1983; Tiner and Anderson 1986). The National Oceanic and Atmospheric Administration estimates that more than 75 percent of the United States population will live within 50 miles of the coastline by 1990 (NOAA 1984). Pressure on wetland resources brought on by population shifts to coastal areas and associated industrial and municipal expansion will continue to erode coastal wetland resources. Consequently, monitoring these changes to assess not only the impacts to the resource base but to gauge the effectiveness of regulatory and management programs will be essential. There is an immediate need to know such things as: 1) Existing acreages of various wetland habitat types in the coastal zone; 2) Areas where coastal wetlands may be increasing or decreasing and (at what rate this change is taking place); and 3) High resolution information (1-5 acres) for land-use planning and project review. It is anticipated that by creating a comprehensive national coastal wetlands database these information requirements can be met.

Status of Wetlands Mapping in the Coastal Zone

The Fish and Wildlife Service has always identified the coastal zone, including that of the Great Lakes, as a high priority for wetlands mapping. To date, 90 percent of the coastal zone in the lower 48 states has been mapped by NWI*. Wetlands were identified by use of aerial photography and classified by habitat type following the classification system of Cowardin et al. (1979). Maps depicting the wetland polygons overlay the U.S. Geological Survey base maps at a scale of 1:24,000 or 1:64,500 for the coastal areas. (Information on obtaining NWI maps is found in the Appendix). The status of wetland map availability by coastline is as follows: The Gulf Coast is 87 percent complete lacking only portions of Louisiana and Florida; Atlantic Coast is 80 percent complete missing maps in North Carolina and Florida; Pacific Coastline is 100 percent complete; and the Great Lakes coastline is 90 percent complete missing a portion of the Lake Michigan shoreline of the State of Michigan.

The coastal zone also lends itself to the development of a National data base since it includes portions of 28 states (not including Alaska and Hawaii) and can be fairly easily defined by either physical or political boundaries. In addition, coastal wetlands are tremendously important to fish and wildlife resources. Numerous studies have demonstrated the value of these wetlands for commercial and recreational fisheries migratory bird habitat, and as buffers against storm damage in coastal areas (Sather and Smith 1984).

The Strategic Assessment Branch (SAB) of the National Ocean Service at NOAA is in the process of compiling a national coastal wetland data base for estuarine drainage areas of the United States. The initial objectives of this inventory are to: 1) compile available coastal wetland information by county, state, or estuary; 2) evaluate the adequacy of these data for strategic planning and assessment; and 3) to provide an initial data base on wetlands for the assessment of available fisheries habitat (Alexander et al. 1986). To accomplish this, SAB is using the National Wetlands Inventory maps and cataloging 13 different wetland types by a 45 acre grid sampling method (NOAA 1986). This procedure was deemed to be the most cost effective approach for the level of data resolution required by NOAA. This will also allow SAB to complete their coastal data base by 1988.

What the FWS is proposing by no means duplicates the SAB effort. Rather, it would retain the polygonal integrity of wetland boundaries and replicate all wetland types as they appear on NWI maps. However this is a more time consuming and costly effort and final digital products for a single coastline could not be completed until 1990. Consequently while the ultimate goal is a digital data base of the NWI map products, the SAB inventory should meet the immediate needs for coastal wetland acreage statistics into the next decade.

*Includes Wisconsin coastal areas mapped by the Wisconsin Department of Natural Resources.

Proposed Pilot Study in the Great Lakes

While assessing the feasibility of creating a National coastal data base, NWI recognized the need to develop digital map products, simulate data base layers, look at existing Geographical Information Systems (GIS) compatibility and evaluate costs. The Great Lakes region was selected as the area to conduct a pilot study. This decision was related to four considerations. These are as follows:

1) The coastal wetlands of the Great Lakes are tremendously important from both a regional and a National perspective. These wetlands are also threatened by development. A Great Lakes River Basin Commission report (1975) projects a 40 percent increase in industrial shoreline use and a 26 percent increase in residential shorelands development by the year 2020. Consequently, land use changes and acreage statistics on the abundance or scarcity of wetland types is needed by resource managers in this region.

2) The coastal zone of the Great Lakes is not being addressed by NOAA's Strategic Assessment Branch, Coastal Wetlands Inventory.

3) This area presents a challenge for data base development as NWI map production has been spread over a considerable time period from the late 1970's to the present. If the procedures and techniques developed during a pilot effort in the Great Lakes worked, NWI personnel feel they could work anywhere in the country.

4) There is a diversity of State-operated geographical information systems located in this region.

During 1987 the FWS and NOAA entered into a cooperative agreement to determine the logistical needs and data requirements for creating a comprehensive digital database for the coastal wetlands of the Great Lakes. With help from the states, five coastal counties were selected to make up the study area for the pilot. These areas include: Oswego County, New York on Lake Ontario; Ottawa County, Ohio on Lake Erie; Macomb County, Michigan on Lake St. Clair; the watershed boundary of St. Louis County, Minnesota on Lake Superior and Brown County, Wisconsin on Lake Michigan.

For each of these areas either the existing state digital information (derived from NWI maps)* will be used or, FWS will digitize the wetland information from hard copy maps.

*In Wisconsin, the Wisconsin state wetland inventory data would be used.

Data Base Structure

The overall objective for creating a National data base of coastal wetlands is to conduct various assessments of the status and trends in coastal regions. To accomplish this it is necessary to retain the integrity of NWI polygonal boundaries and wetland classifications, transport that information to a computer tape and combine it with compatible land resource information of interest to the user.

Three major systems currently comprise the Service's geoprocessing capability for constructing the national coastal wetland data base. These are: (1) the Wetland Analytical Mapping System (WAMS), (2) the Map Overlay and Statistical System (MOSS) and (3) the Cartographic Output System (COS).

WAMS is the digitizing system which converts map data to a computer compatible form (Pywell and Niedzwiedek 1980). Since the majority of coastal wetland maps have been drafted by conventional means, input to digital form will be done on a standard X-Y digitizing table from hard copies. WAMS includes a rigorous on-line data verification and editing capability which notifies the operator of errors as they are encountered and ensures topological validity of the data. All map data is stored in a "geounit" which represents a predefined portion of the earth's surface. For the NWI data, the "geounit" is a 1:24,000 scale map. All digital data must be tied between geounits during digitizing or else it cannot be databased. All of the data can then be retrieved in geographic coordinates, i.e., latitude and longitude. NWI map data can be converted to any map projection through use of U.S. Geological Survey's map projection package. (Tiner and Pywell 1983)

MOSS represents the geographic information system which allows input of digital geographic data, construction of a database of one or more themes or planes, and manipulation and analysis of the data. Geoprocessing functions include area, length, frequency, overlay, proximity and buffer, plus many others (Reed 1981). The NWI uses MOSS to determine wetland area by type for each map, county, state or other project area. For example, county wetland acreages can be determined by MOSS by overlaying digital wetland polygon data with digitized county boundaries. This can be done for any physical or political boundary digitized into the system. Hard copy products are produced through COS which allows users to select data from WAMS or MOSS. For computer drawn maps, scale, rotation, shading symbology and map projection may be specified. COS also permits construction of a map collar with such information as title, legend, distance scales and other graphics. A wide selection of typefaces and line styles is also offered, which can produce a more attractive map product.

Data Base Utility and Products

The main advantages of a georeferenced wetland data base include its storage capacity and its flexibility for producing information in a variety of forms to meet user needs (Tiner and Pywell 1983). Coastal wetland data can be used to provide information in either maps or statistical form or it may be merged with other data bases within a geographic information system. This flexibility permits a wide range of uses for impact analysis and resource planning activities.

While maps provide information on the location and characteristics of wetlands, the actual abundance and scarcity of wetlands throughout a project area, watershed, county or state can only be assessed through 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. For example, coastal zone managers require information on tidal wetlands for guiding economic development along the coast, while preserving environmental values. Fish and game managers need to know the status of wetlands important to fish and wildlife species.

The graphic map products generated can be combined with other GIS layered information such as soils and land-use, for planning and management decisionmaking. For example, in selecting alternative sites for a commercial development, many locational criteria must be examined, including soil properties, adjacent land-use, current zoning, presence of environmentally sensitive resources (e.g., wetlands, endangered species, and water supplies), transportation routes and numerous others. All of this information can be analyzed either manually by a planner or automatically through use of a GIS.

The wetland data base facilitates compilation of these figures and permits manipulation in various ways. This is useful for both public policy analysis and natural resource management since the scope of existing land-use policies and programs can be evaluated given a variety of impact scenarios.

County planners should find these products particularly valuable in assessing the current status of their wetland resources and in guiding future land-use decisions in light of wetland values. The data base has the capacity to produce wetland maps and statistics for variable sized areas, such as municipalities and watersheds.

Challenges of Creating a National Data Base

One of the major drawbacks to proceeding with the development of the National data base is that it is an expensive program. The preliminary cost estimate to digitize existing wetland maps with only the essential georeferenced layering (e.g., country boundaries) is \$2.5 million for the lower 48 states. Costs escalate as more information layers are added, map updates become necessary, or more of the coastal zone is completed by NWI and would need to be data based. Presently, the FWS believes that the cost of the data base construction is not unreasonable given the potential uses. Cost sharing opportunities with other Federal and State agencies would also help defray the cost constraints.

A second major consideration is data storage and maintenance. To date there is no public entity which might act as the depository for the coastal wetlands data base once completed. While the Fish and Wildlife Service is willing to undertake development of the data base, the Service is not capable of responding to user requests for analysis of the information on a regular basis. Currently FWS and NOAA are exploring the possibilities of locating a data base storage and maintenance facility which would be capable of data reproduction and distribution to the user with little or no analysis of the data. Analysis would be the responsibility of the end user.

Additional concerns are related to the fragmentation of existing wetland data into autonomous but noncompatible pieces. Transfer of computer technology and data bases to Federal and State agencies and other interested organizations is crucial. By transferring the wetland data base to the States, in particular, wetland information should be more readily available for use in project and environmental planning and management by State and local authorities. Both Federal and State resource agencies have proceeded with acquisition of automated data processing systems with little consideration for compatibility with counterpart systems. On the Federal level, bureau or departmental consistency is hard enough to achieve let alone compatibility with other Federal, State or university systems. The problem then arises as to how to create a data base that 28 states and a dozen Federal agencies can use. While NWI has had considerable experience in creating wetland data bases which can be used effectively by a variety of users, this issue is still not something to take for granted. Hopefully, the pilot project in the Great Lakes region will help address some of the concerns with system compatibility.

The other side of this issue is that there is no National data base and in order to meet their needs, the States proceed to develop State-specific wetland data bases some or all of which are unique. The ability to monitor the coastal zone on a National or regional level is then lost.

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APPENDIX

Information On How To Order NWI Maps

The U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) and the National Cartographic Information Center (NCIC) have a cooperative agreement for the sale and distribution of NWI maps. NCIC offices accept orders for NWI maps by mail. The NWI Central office in St. Petersburg, Florida reproduces and ships the maps within 5 working days of receipt of the orders.

To order National Wetlands Inventory maps, write to one of the NCIC offices. For information, call NCIC's toll free number: 1-800-USA-MAPS.

NWI maps are also available by State-run distribution centers. A list of active state distribution centers is as follows:

ALABAMA: Alabama Geological Survey
P.O. Box 0
Tuscaloosa, Alabama 35486
(205) 349-2852

CALIFORNIA: CA Dept. of Fish and Game
Natural Heritage Section
1416 Ninth Street
Sacramento, California 95814
(916) 322-2493

CONNECTICUT: Dept. of Environmental Protection
Natural Resources Center
State Office Building
Hartford, Connecticut 06115
(203) 566-3540

DELAWARE: State of Delaware
Dept. of Natural Resources and Environmental Control
Wetlands Section
Edward Tatnall Building
P.O. Box 1401
Dover, Delaware 19903
(302) 736-4691

GUAM: Director
Bureau of Planning
Government of Guam
Agna, Guam 96910

HAWAII: Board of Land and National Resources
Div. of Forestry and Wildlife
Technical Services
P.O. Box 621
Honolulu, Hawaii 96889

MAINE: Maine Geological Survey
Maine Station 22, State House
Augusta, Maine 04333
(207) 289-2801

MARYLAND: Maryland Dept. of Natural Resources
Wetlands Division
Water Resources Administration
Tawes State Office Building
Annapolis, Maryland 21401
(301) 269-3871

MASSACHUSETTS: MA Association of Conservation Commissions
Lincoln Filene Center
Tufts University
Medford, Massachusetts 02155

MISSISSIPPI: Tech. Transfer Office
Building 11000
NSTL Station
Mississippi 39529
688-3008
FTS 494-3008

NEBRASKA: Director
Conservation and Survey Division
University of Nebraska
113 Nebraska Hall
Lincoln, Nebraska 68588
(402) 472-3471

NEW HAMPSHIRE: Office of State Planning
State of New Hampshire
2½ Beacon Street
Concord, New Hampshire 03301
(603) 271-2155

NEW JERSEY: NJ Dept. of Environmental Protection
Bureau of Collections
and Licensing
Maps and Publications
CN-402
Trenton, New Jersey 08625
(609) 292-2578

NEW YORK: CLEARS
Resources Information Laboratory
464 Hallister Hall
Cornell University
Ithaca, New York 14853
(607) 256-6520

OREGON: Oregon Dept. of Fish and Wildlife
506 Southwest Mill Street
Portland, Oregon 97208
(503) 229-5249

PENNSYLVANIA: Coastal Zone Management
Office of Resource Mgmt.
Dept. of Envir. Resources
P.O. Box 1467
Harrisburg, Pennsylvania 17120
(717) 783-9500

RHODE ISLAND: Department of Environment Management
Freshwater Wetlands Section
38 State Street
Providence, Rhode Island 02908
(401) 277-6820

SOUTH CAROLINA: State of South Carolina
Cartographic Information Center
Land Resources Conservation Comm.
2221 Devine St. Suite 222
Columbia, South Carolina 29205
(803) 758-2823

TEXAS: Texas Natural Resource Information System
P.O. Box 13231
Austin, Texas 78711
(512) 463-8406

VERMONT: Vermont Department of Water Resources
Montpelier, Vermont 05602
(802) 828-2761

WASHINGTON: Chief Cartographer
Washington Dept. of Ecology
Mail Stop PV-11
Olympia, Washington 98504
(206) 459-6201