

NCDENR Division of Coastal Management GIS Data Guidance Document GIS Wetland Type Mapping for the North Carolina Coastal Plain



Background

Much of the North Carolina Coastal Plain is occupied by wetlands, which, in many areas, comprise 50 percent or more of the landscape. These wetlands are of great ecological importance, in part because they occupy so much of the landscape and are a significant component of virtually all coastal ecosystems. They are also important because of their relationships to coastal water quality, estuarine productivity, wildlife habitat, and the overall character of the coastal area. Historically, approximately 50 percent of the original wetlands of the coastal area have been drained and converted to other land uses (Hefner and Brown, 1985; Dahl, 1990; DEM, 1991).

Since wetlands are such a dominant part of the coastal landscape and are vitally important to many aspects of the area's ecology, their management and protection is a major priority for the North Carolina Division of Coastal Management (DCM). DCM developed a strategy for improving wetlands protection and management in the coastal area using funds provided by NOAA's Office of Ocean and Coastal Resource Management (OCRM) under the Coastal Zone Enhancement Grants Program established by 1990 amendments to §309 of the federal Coastal Zone Management Act. The key element of DCM's strategy for improving wetlands protection is the development of a Wetlands Conservation Plan for the North Carolina coastal area. The main objective of DCM's Wetland Conservation Plan is to improve the management and protection of freshwater wetlands in North Carolina. The Plan has several components.

***Wetlands Mapping & Inventory
Functional Assessment of Wetlands
Wetland Restoration Identification & Prioritization
Coordination with Wetland Regulatory Agencies
Coastal Area Wetland Policies
Local Land Use Planning***

The primary objective of DCM's wetland type mapping is to provide users with information about the location and types of wetlands for use in planning and the overall management of wetlands. DCM mapped wetland types in 37 North Carolina Coastal Plain counties.

Wetland Definitions

Section 404 of the Federal Water Pollution Control Act ("the Clean Water Act) defines wetlands as "areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation adapted to life in saturated soil conditions." A general difficulty of relating mapped wetlands to jurisdictional boundaries is that jurisdictional boundaries are the result of political decisions and are subject to change.

The question of the relationship of mapped wetlands to jurisdictional wetlands under the §404 Program is significant. If the primary interest in avoiding wetland impacts is to avoid the difficulties and limitations of the wetlands regulatory program, then this is a very pertinent question. DCM conducted an accuracy assessment to provide users with the accuracy of the wetland type data. The accuracy assessments used to evaluate the data indicate that it is highly probable that any area identified as a wetland by DCM will be functioning as a wetland and that portions or all of the area will, indeed, be a jurisdictional wetland as defined in the 1987 *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory, 1987).

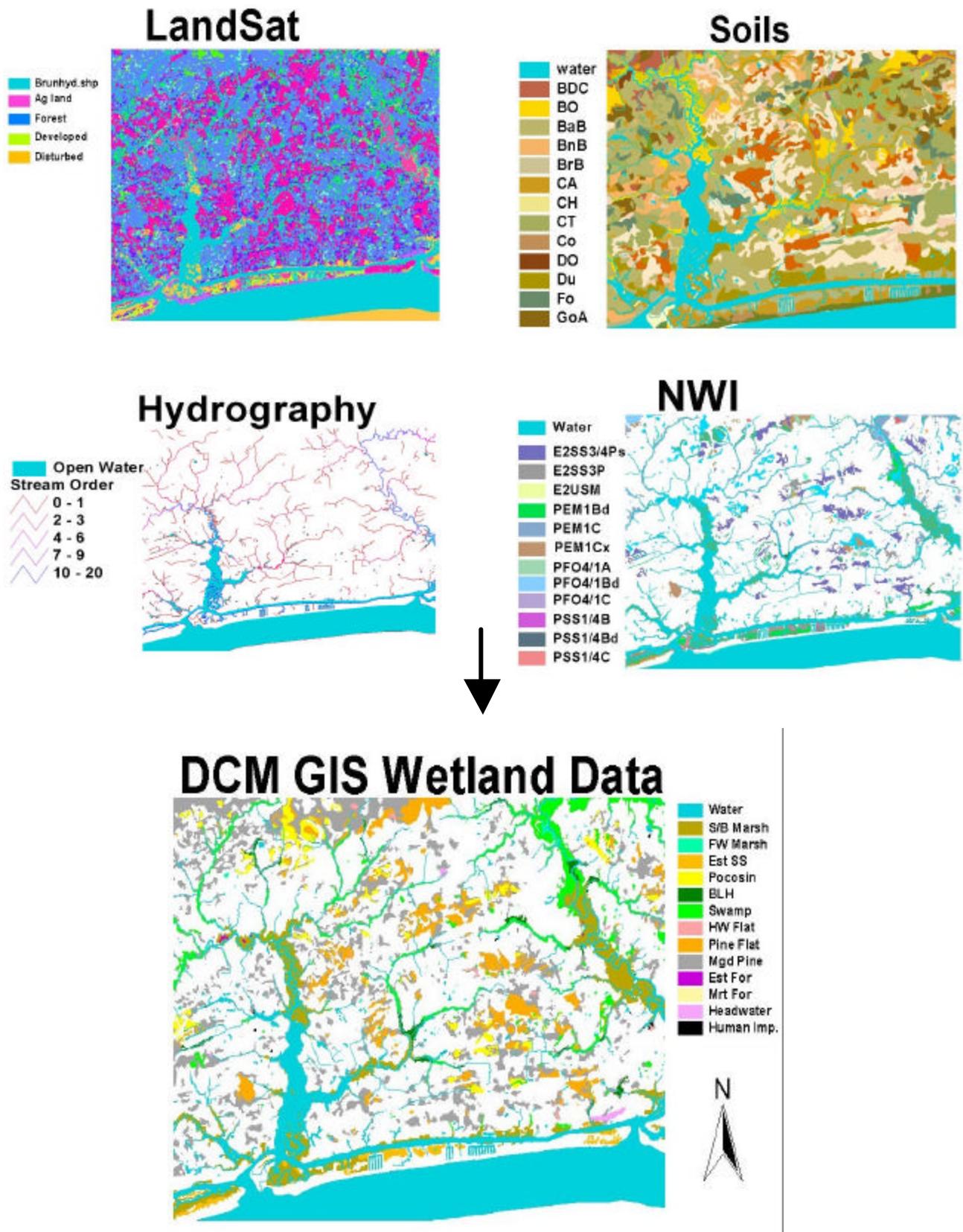
Using GIS Data

Since the procedure uses GIS analysis, it requires digital information in GIS format. DCM combined three primary data layers and extracted the most useful information from each one. The three primary digital data layers selected for use were the US Fish and Wildlife National Wetlands Inventory (NWI), the county soil surveys in digital format, and 30 meter Thematic Mapper (TM) satellite imagery. DCM chose to incorporate the benefits of each of these data sources into its mapping techniques. Users should be aware that the method chosen was an overlay analysis, and the final data can only be considered as accurate as the least accurate data used as source input.

Before the overlay analysis, several steps were taken to prepare the data for the mapping procedure. The Cowardin classifications used in the NWI were placed into DCM's wetland types. Some Cowardin types fit into more than one DCM wetland type and were later classified during the automated procedure based on soil type or hydrologic regime. The soil data were also classified and a look up table was created. The look up table contains information such as whether a soil is hydric or not and also identifies which soils are those found in pocosins.

The hydrogeomorphology of a wetland is unique in defining the wetland's function (see Brinson, 1993). DCM uses four hydrogeomorphic (HGM) classifications to describe wetlands in the North Carolina Coastal Plain: riverine, headwater, estuarine and non-riverine/flat. Polygons are assigned an HGM class of 'r', 'h', 'e' or 'f', respectively. Digital line graphs of hydrography are used in this step of the procedure. All wetlands that are adjacent to streams or rivers are considered to be in the riverine HGM class and are designated as riverine polygons. This class includes all bottomland hardwood forests and some swamp forests.

Figure 1. GIS Data layers for DCM Wetland Type Mapping



Headwaters are defined as areas adjacent to riverine areas that do not have a stream designated on the hydrography data layer. Estuarine wetlands are those wetlands types found along the coast including estuarine shrub, estuarine forest and salt/brackish marsh. Finally, polygons that exist on interstream divides are designated as non-riverine/flat wetlands. No wetlands along streams should be found in this class, unless field verification showed otherwise.

Overlay Analysis

DCM's wetland type mapping procedure is based on an overlay analysis of GIS data (Figure 1). The Landsat landcover data, NWI data, and digital soil data were "unioned" to begin the wetland mapping process. LandSat TM imagery was used to identify NWI wetlands that were unvegetated (e.g., classified as developed, agriculture, or other bare land or grassland). DCM used both 1988 and 1994 land cover data. The two land cover datasets were compared to identify areas that were cleared in 1988 and in 1994 and areas that were cleared in 1988, but vegetated in 1994. These polygons were classified as "cleared and "cutover" respectively. Cleared wetlands are not mapped as wetlands in DCM's wetland type data because they are not likely to contain wetland vegetation.

The NWI data and the soil data were used to eliminate some NWI polygons from the dataset. Polygons classified as temporarily flooded that are not on hydric soils are not likely to meet the definition of a wetland and were, therefore, eliminated as wetland sites. Other areas considered uplands by NWI, identified as pine monocultures on the landcover imagery, and occurring on hydric soil were mapped by DCM as managed pine wetlands.

An Arc Macro Language (AML) routine assigns each polygon to one of DCM's wetland type classes based on its characteristics. This part of the procedure is complex. It uses soil characteristics and NWI names to classify polygons by wetland type. After this automated procedure, an interactive session is initiated where the user finalizes the classification. During this interactive session, NWI types that fit both the bottomland hardwood and the hardwood flat wetland types, for example, are classified according to their hydrologic regime using hydrography data. Headwater swamps are also identified during this portion of the procedure.

Wetland Types

DCM's wetland type data are an integral component of the Wetland Conservation Plan. Since the Plan was developed to improve wetland planning and management in coastal North Carolina at local, state, and federal levels, the wetland classification system used by DCM needed to be accurate and easy to use for persons with varying levels of wetland expertise. DCM staff worked with staff from state and federal agencies to develop a classification scheme that met the needs of its clients without introducing conflict into the existing classification schemes (Figure 2).

The classes currently recognized by DCM are listed in Table 1.

Table 1. DCM Wetland Types

Wetland Type	W-Type	General Definition
Salt/Brackish Marsh	1	Any salt marsh or other marsh subject to regular or occasional flooding by tides, including wind tides. Also called "coastal marsh."
Estuarine Scrub-Shrub	3	Shrub/scrub dominated community subject to flooding by tides, including wind tides.
Estuarine Forest	15	Forested wetlands subject to flooding by tides, including wind tides.
Maritime Swamp Forest	16	Forested wetlands with stunted growth imposed by salt spray from the ocean.
Freshwater Marsh	2	Herbaceous areas that are flooded for extended periods during the growing season.
Pocosin	4	Evergreen scrub/shrub communities. Typically occur on saturated, acid, nutrient poor, sandy or peaty soils.
Bottomland Hardwood/ Riverine Swamp Forest	6/7	Riverine and non-riverine forested or scrub/shrub communities that are seasonally to semi-permanently flooded. Riverine Swamp Forests have a w-type of 7 and an hydrogeomorphic (hgm) class of riverine (r).
Non-riverine Swamp Forest	7	Very poorly drained non-riverine forested or occasionally scrub/shrub communities that are semi-permanently or temporarily flooded. These are distinguished from riverine swamp forests in the data by having a hydrogeomorphic (hgm) class of flat (f).
Headwater Swamp	17	Wooded systems along first order streams. Receive water from overland flow and rarely overflow their own banks
Hardwood Flat	9	Poorly drained interstream flats. Seasonally saturated by high water table or poor drainage.
Pine Flat	10	Seasonally saturated pines on hydric soils (often quite dry for part of the year). Generally on flat or nearly flat interfluves.
Managed Pineland	11	Seasonally saturated, managed pine forests occurring on hydric soils.
Human Impacted	40	Human impacts have physically disturbed the wetland. Impoundments, some cutovers and other disturbed areas are included in this category.
Modifiers	Note: Codes for modified wetland types are calculated by adding 20, 40, or 60 to W-type code. Drained Swamp, for example is $7 + 20 = 27$, cutover pine flat is $10 + 60 = 70$	
Drained	21-39	Any wetland system described above which is or has been effectively drained.
Cleared	41-59	Areas of hydric soils for which satellite imagery indicates a lack of vegetation in 1988 and 1994. Likely not a wetland today. Cleared wetlands are not typically included in our data.
Cutover	61-79	Areas for which satellite imagery indicates a lack of vegetation in 1994. These areas are likely to still be wetlands, however, vegetation has been removed.

Table 2. Wetland Acreage in 37 NC Coastal Plain Counties

Wetland Type	Area (acres)			Total	Percent of total
	Unaltered	Drained	Cutover		
Salt/Brackish Marsh	198,999	29,230	0	228,229	5.2%
Freshwater Marsh	33,397	2,916	0	36,313	0.8%
Estuarine Shrub Scrub	28,326	2,195	571	31,092	0.7%
Pocosin	522,678	106,225	6,815	635,718	14.5%
Bottomland Hardwood	245,844	16,572	8,510	270,926	6.2%
Riverine Swamp Forest	937,981	27,830	7,490	973,301	22.3%
Depressional Swamp Forest	223,044	62,559	6,154	291,757	9.2%
Hardwood Flat	182,504	78,110	14,480	275,094	6.2%
Pine Flat	322,804	115,775	17,120	455,699	10.4%
Managed Pineland	1,081,597	n/a	n/a	1,081,597	24.7%
Estuarine Forest	965	19	5	989	0.03%
Maritime Swamp Forest	3,558	17	138	3,713	0.08%
Headwater Swamp	33,855	2,719	3,034	39,608	0.9%
Human Impacted	38,578	n/a	n/a	38,578	0.8%
Total	3,854,130	444,167	64,317	4,362,614	
Percent of Total	88.0%	9.8%	1.4%		

Counties Mapped:

- | | | | | |
|-----------|------------|----------|-------------|------------|
| Beaufort | Craven | Halifax | New Hanover | Sampson |
| Bertie | Cumberland | Hertford | Northampton | Tyrrell |
| Bladen | Currituck | Hyde | Onslow | Washington |
| Brunswick | Dare | Johnston | Pamlico | Wayne |
| Camden | Duplin | Jones | Pasquotank | Wilson |
| Carteret | Edgecombe | Lenoir | Pitt | |
| Chowan | Gates | Martin | Pender | |
| Columbus | Greene | Nash | Perquimans | |

Accuracy Assessment

The results of DCM's wetland type mapping effort are shown in Table 2. DCM staff conducted an accuracy assessment of the wetland type data between July 1995 and November 1996. Sample sites for each wetland type were chosen by the Computer Graphics Center at North Carolina State University using a stratified random sampling technique. Over 625 sites were sampled to determine the accuracy of the data. Several statistical analyses were run on the data to assess various types of accuracy. The document *An Accuracy Assessment of GIS Wetland Mapping in the Coastal Counties of North Carolina (1999)* describes the analyses in detail. The assessment showed that the DCM mapping procedure maps wetland locations with a great deal of accuracy.

The assessment calculated the probability that if a user visits a wetland polygon on DCM's maps that they would find a jurisdictional wetland. The probability was nearly 90% overall and varied by wetland type. Marshes, bottomland hardwoods, swamps and pocosins were mapped with the greatest accuracy (97% or higher), while headwater forests, hardwood flats and managed pine wetlands were less accurate (between 65% and 75%). The assessment detected some errors of exclusion where sites that really were wetlands were not included on DCM's maps. It was determined that much of this error resulted from errors in the NWI data and from changes that had occurred in the coastal area

Strengths of DCM's Wetland Maps

- Easy to use
- Comprehensive
- Ability to manipulate and query

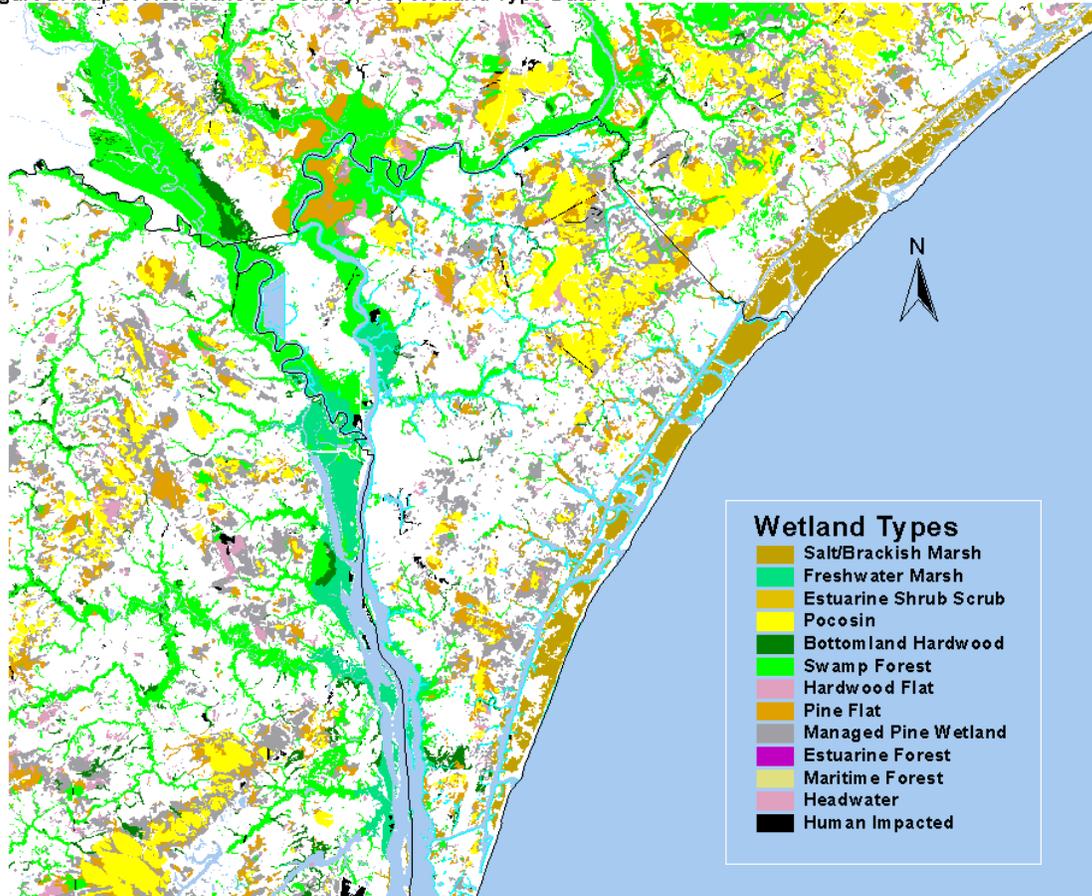
Limitations of DCM's Wetland Maps

- Cannot be used for jurisdictional calls
- Minimum mapping size is one acre
- Errors in source data

Summary

DCM wetland type data were developed as part of DCM's Wetland Conservation Plan. The data were developed for use as a planning tool. The validity and accuracy of the GIS data have been verified to the greatest extent possible. While the accuracy assessment of the data indicates a certain amount of error, use of the data for the intended purposes for which it was created is still recommended. The data were originally developed to be used as a tool to 1) give DCM the ability to determine the range and extent of wetlands in the coastal area, 2) allow DCM to track wetland losses and conversions, and 3) be used by local governments in land-use planning to help increase wetland protection. While not a substitute for on-site jurisdictional delineations, DCM's wetland maps are expected to make significant contributions toward improved wetland management in the North Carolina coastal area. More details about the wetland type mapping procedure can be found in DCM's publication *DCM Wetland Mapping in Coastal North Carolina (1999)* and in *An Accuracy Assessment of GIS Wetland Mapping in the Coastal Counties of North Carolina (1999)*. These documents describe the data inputs, the procedure itself, and results in detail.

Figure 2. Map of New Hanover County, NC, Wetland Type Data



Literature Cited

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- DEM, 1991. *Original Extent, Status and Trends of Wetlands in North Carolina*. Report No. 91-01. NC Department of Environment, Health and Natural Resources, Division of Environmental Management, Raleigh, NC.
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- Hefner, J.M. and J.D. Brown. 1985. Wetland Trends in the Southeastern United States. *Wetlands* 4:1-12.
- Shull, L.N., III. 1999. *An Accuracy Assessment of GIS Wetland Mapping in the Coastal Counties of North Carolina* North Carolina Division of Coastal Management, Department of Environment and Natural Resources.
- Sutter, L. 1999 DCM Wetland Mapping in Coastal North Carolina. North Carolina Division of Coastal Management, Department of Environment and Natural Resources.

For more information on DCM's GIS data or to get copies of detailed documents about these data contact DCM at 919-733-2293 or visit our website at www.nccoastalmanagement.net.
