NCDENR Division of Coastal Management

GIS Data Guidance Document

NC-CREWS: The North Carolina Coastal Region Evaluation of Wetland Significance

What is NC-CREWS?

NC-CREWS, or the North Carolina Coastal Region Evaluation of Wetland Significance, is a watershed-based wetland functional assessment model that uses Geographic Information Systems (GIS) software and data to assess the level of water quality, wildlife habitat, and hydrologic functions of individual wetlands.

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 significant components of virtually all coastal ecosystems, and also 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 in the coastal area have been drained or converted to other land uses (Hefner and Brown, 1985; Dahl, 1990; DEM, 1991).

Since wetlands are such a dominant part of the coastal area and are vitally important to many aspects of the area's ecology, their management and protection is a major component of the North Carolina Coastal Management Plan. The North Carolina Division of Coastal Management (DCM) developed a strategy for improving wetlands protection and management in the coastal area using funds provided 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 the NC-CREWS wetland functional assessment is to provide users with information about the relative ecological importance of wetlands for use in planning and management of wetlands. It is intended to be used as a planning and decision support tool rather than a decision making tool. Using NC-CREWS as a planning tool can enable the public, planners, developers, and managers to define suitable classes, types, or categories of development or conservation practices to maintain and protect the biological, chemical, and physical integrity of those ecosystems. This information would then be useful in determining where development should not be planned, or where certain types of development are best suited to the habitat. Where wetland impacts are unavoidable, NC-CREWS can significantly improve avoidance and minimization of significant and adverse impacts to the most valuable wetland ecosystems. Matching wetland types with the activities permitted, or avoiding impacts entirely, are vitally important means of ensuring that future generations inherit functional communities of native and endemic plants and animals. An accurate functional assessment of wetland significance, then, is the most valuable component of the Wetlands Conservation Plan.

Since the procedure uses GIS analysis, it requires digital information in GIS format. GIS data layers used in the procedure include the following.

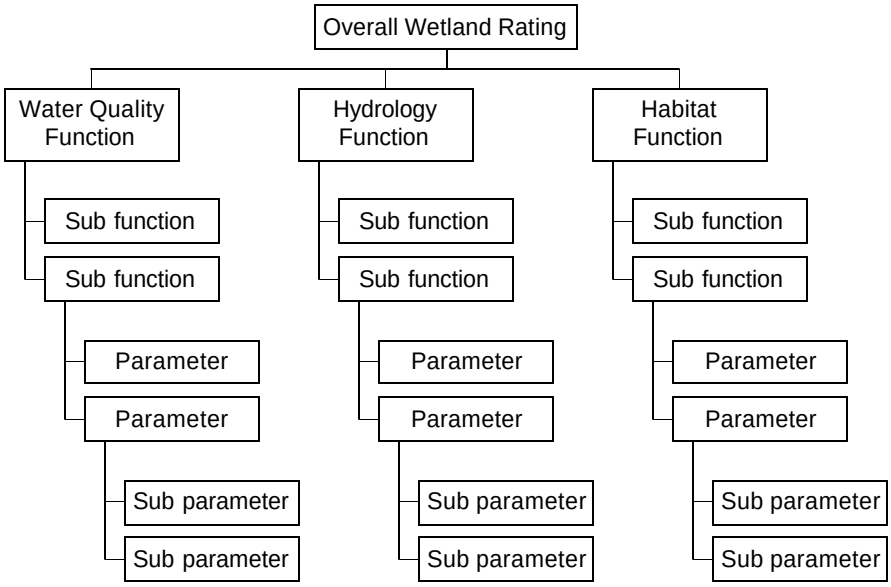
(1) DCM wetland type data
(2) digital soils data
(3) land use/land cover types
(4) hydrography
(5) watershed boundaries (14- and 11-digit Hus)
(6) endangered species occurrences
(7) estuarine primary nursery areas
(8) water quality classifications
(9) NC unique natural ecosystem and special wildlife habitat areas
(10) anadromous fish spawning areas

The NC-CREWS Procedure

The structure of NC-CREWS is hierarchical (Fig. 1). The model consists of four levels: (1) overall functional significance; (2) specific functions and potential risk of wetland loss; (3) subfunctions; and (4) parameters and subparameters evaluated to determine the level and extent of functions. The model evaluates 39 separate characteristics of the wetland and its watershed (14-digit Hydrologic Units). Using GIS analysis, a High, Medium, or Low rating is assigned to each of the subparameters that describe the landscape and internal wetland characteristics. The subparameter ratings are successively combined to produce ratings for parameters; parameter ratings are combined to produce ratings for subfunctions; subfunction ratings are combined to produce ratings for primary functions. The primary functions are combined to form an overall wetland rating of the wetland's ecological significance. NC-CREWS produces 3 possible overall wetland rating scores: Exceptional Significance, Substantial Significance, or Beneficial Significance.

More details about the NC-CREWS procedure can be found in DCM's publication *NC-CREWS: North Carolina Coastal Region Evaluation of Wetland Significance* (1999). This document describes the data inputs, the procedure itself, and results in detail.

Figure 1: NCCREWS Hierarchy



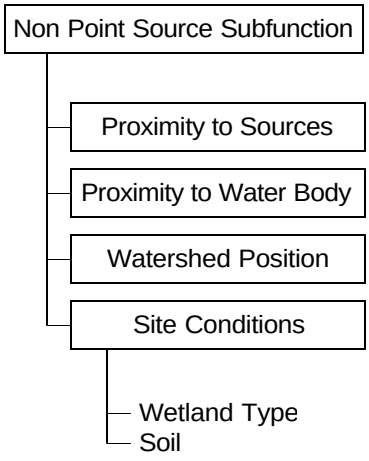
Potential Risk

In addition to the overall wetland rating NC-CREWS calculates "Potential Risk of Wetland Loss" at the function level, but it is not used in the determination of the overall functional significance of individual wetlands because it is an abiotic function of wetlands. Potential Risk is an estimation of the potential loss of function and risk to a watershed if individual wetlands ceased to continue to perform existing functions. Potential Risk is calculated and designed to be used in conjunction with the overall functional significance ratings. Wetland managers, local governments, developers, and others who use the results of NC-CREWS are encouraged to consider both the Overall Functional Significance and the Potential Risk ratings whenever evaluating wetland management opportunities.

Opportunity and Capacity

The NC-CREWS model contains "opportunity" parameters and "capacity" parameters. An "Opportunity" parameter, for example, determines whether a wetland has the opportunity to remove pollutants from surface runoff by considering how likely the runoff water is to be polluted. "Capacity" parameters measure the wetland's ability to perform the function if the opportunity is present. Opportunity and capacity parameters are treated differently in determining a wetland's overall significance. Wetlands are never downgraded in functional rating because of present lack of opportunity; however, if an opportunity is shown to exist the wetland may be upgraded.

Figure 2. Subfunction Example



Rating System

Figure 2 illustrates one of the subfunctions under the water quality function. The table below illustrates how the ratings from the subparameters Wetland Type and Soil are combined into a rating for the parameter Site Conditions that is then combined with three other parameters to get a rating for the Non Point Source subfunction.

The process of successively combining ratings up the structural hierarchy is the most complex aspect of the NC-CREWS procedure. The combining, as well as the evaluation of individual parameters, is based on fundamental ecological principles about how wetlands and watersheds function. Since the ecological processes themselves interact in complex ways, combining ratings in NC-CREWS is much more complex than a simple summation of individual ratings. Some parameters are normally more important than others in determining the level at which a wetland performs a specific function and, thus, must be weighed more heavily in determining the combined value. In some cases, there are different combinations of individual parameter ratings that result in the same level of functional significance. Each of the possible combinations of parameters must then be considered.

The automated version of NC-CREWS maintains all of the individual parameter ratings and combinations in a database. Since the combining process is complex, it may not be obvious why a wetland receives an overall Exceptional, Substantial, or Beneficial rating. The database makes it possible to trace through the subparameter, parameter, subfunction, and primary function ratings that result in a wetland's overall rating.

This database also makes it possible to consider specific wetland functions individually. For example, in a watershed targeted for nonpoint source pollution reduction, it might be a management objective to give the highest level of protection to wetlands most important in performing this function. The database makes it possible to examine each wetland for its significance in nonpoint source removal and to produce a map of wetlands rated according to their significance for this single function.

Table 1

A. Nonpoint Source Function

1. Proximity to Sources

H > 20% perimeter agriculture + developed

M > 20% perimeter agriculture + developed + pine plantation

L less than or equal to 20% perimeter agriculture + developed + pine plantation

2. Proximity to Water Body

H Within 300 ft. of permanent surface water

M Within 300 ft. of intermittent stream

L > 300 ft. from permanent or intermittent surface water

3. Watershed Position

H Intermittent or first order stream

M Second or third order stream

L Higher than third order stream

4. Site Conditions

a. Wetland Type

H Bottomland hardwood, swamp forest, headwater swamp

M Freshwater marsh, pine flat, hardwood flat, pocosin maritime forest

L Pine plantation, altered sites

b. Soil

H Histosol or frequently flooded mineral soil with high clay and organic matter

M Infrequently flooded mineral soil with high clay and organic matter

L Infrequently flooded mineral soil with low clay and organic matter

RATING SYSTEM FOR SITE CONDITIONS

H Both (a) & (b) rated H

M Other combinations

L At least one L and neither H

RATING SYSTEM FOR NPS FUNCTION

H (1) and (2) H and (4) at least M **or** (3) and (4) H and (2) at least M

M Other combinations

L Any two of (2), (3) & (4) rated L

Overriding Considerations

Several ecological factors are of such importance in the North Carolina coastal area that their presence alone will result in an overall wetland rating of Exceptional functional significance. There are three categories of wetlands meeting the criteria for overriding considerations:

1. Estuarine wetlands including, salt and brackish marsh, estuarine shrub scrub wetlands, and estuarine forests
2. Primary Nursery Areas
3. Wetlands containing threatened or endangered species or that include all or part of an exemplary or unique natural ecosystem or special wildlife habitat as designated by the NC Natural Heritage Program

NC-CREWS Attribute Table

The complexity of the NC-CREWS data makes the attribute table a challenge to interpret. Most NC-CREWS data users are interested in several attributes:

OWR1- Overall Wetland Rating
HGM- Hydrogeomorphic Class
W_Type- Wetland Type
WQF01, HYF01, HAF01- rating for primary functions
ORC- Overriding Consideration

ArcGIS software users can obtain a customized query tool from DCM that will assist in the interpretation of the data.

Summary

NC-CREWS is intended for use a planning tool to help steer development away from areas that are not suitable for certain types of development and to identify wetlands that are ecologically important to the watersheds in which they are located. The complex hierarchical structure of NC-CREWS is based on the best wetland science available in scientific literature and extensive review by a team of wetland scientists. The validity and accuracy of the GIS databases used to apply the procedure have been verified to the greatest extent possible. Members of an advisory panel of wetland scientists familiar with the wetlands of coastal North Carolina and representatives of several state and federal wetland-related agencies have reviewed every step of the procedure's development. While this does not represent an endorsement of the procedure or its results by the agencies or individuals on the advisory panel, it does indicate the level of peer review to which the procedure has been subjected.

The complexity of the automated procedure (Figure 3) can be daunting for some users, but the use of a hierarchical structure resulting in a single overall wetland rating for each wetland is easy to understand and apply to planning practices (Figure 4). Projects are ongoing in which NC-CREWS data are being used to identify high quality wetlands for the North Carolina Department of Transportation and for use in alternatives analysis for transportation projects. DCM hopes that use of NC-CREWS data and other GIS data DCM has produced will result in increased avoidance and minimization of wetland impacts and better watershed planning.

Figure 3: NCCREWS Hierarchy with all Functions, Subfunctions, Parameters, and Subparameters

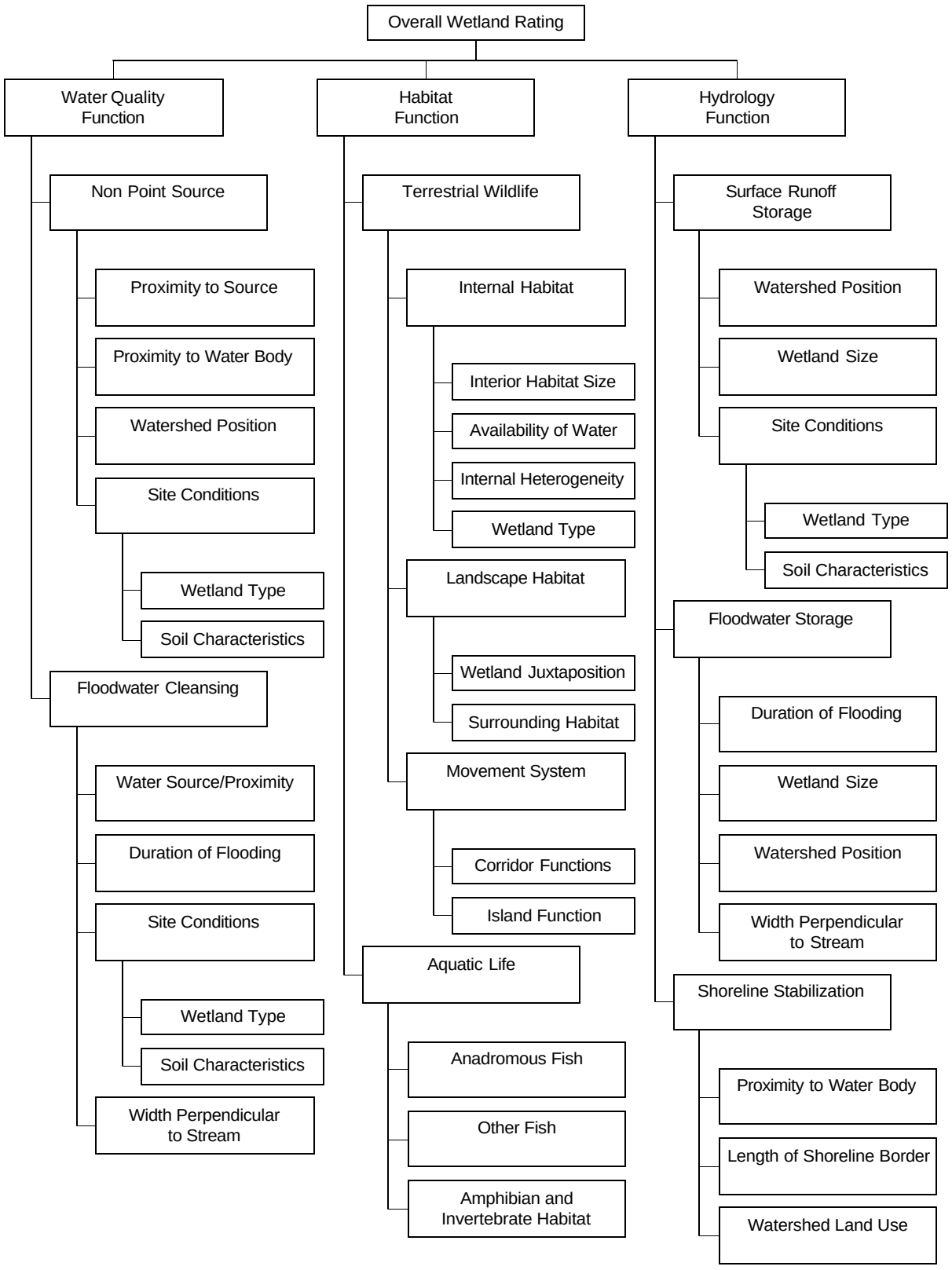
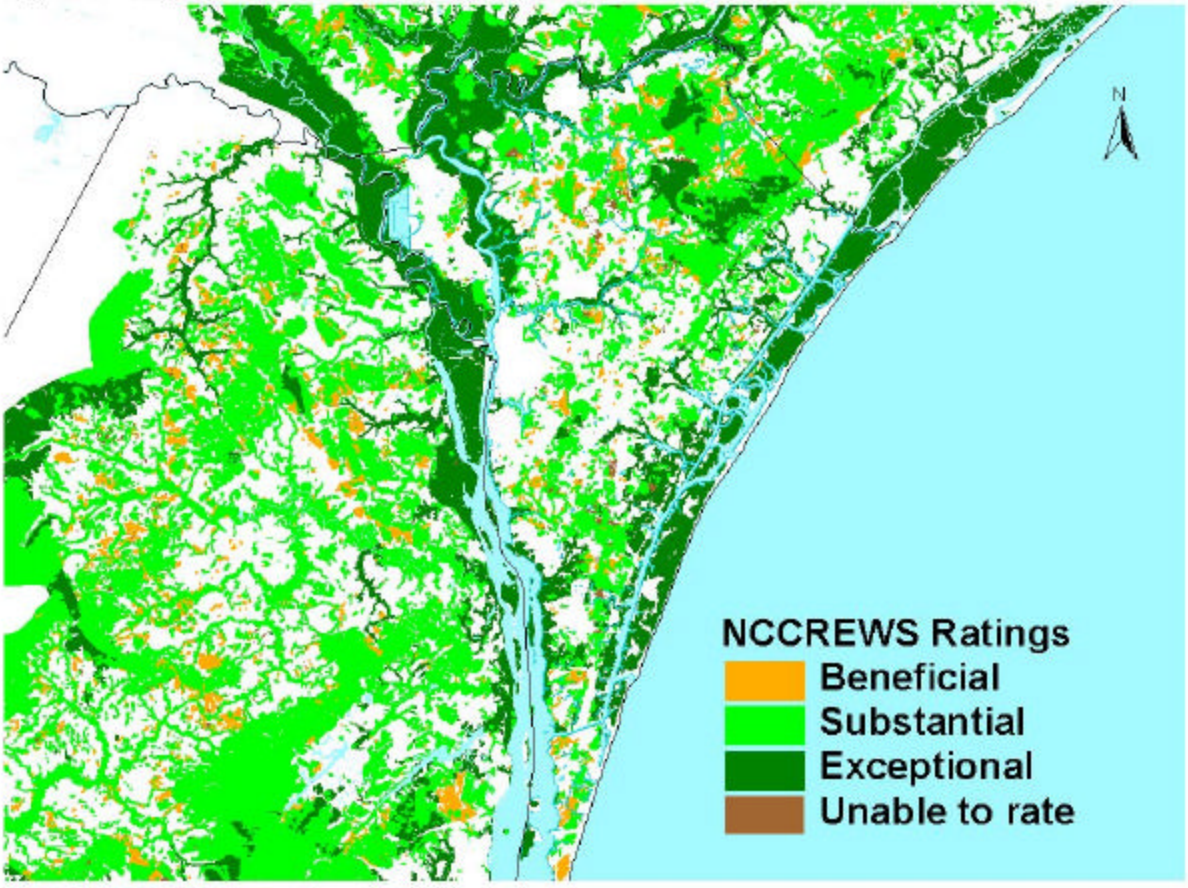


Figure 4. Map of New Hanover County, NC, NCCREWS Data



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.

Hefner, J.M. and J.D. Brown. 1985. Wetland Trends in the Southeastern United States. *Wetlands* 4:1-12.

Sutter, L. 1999 NC-CREWS: North Carolina Coastal Region Evaluation of Wetland Significance. 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.