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Hydrogeomorphic Approach to Assessing Wetland Functions: Guidelines for Developing Regional Guidebooks

Chapter 8
Developing the Assessment Protocol

Chris V. Noble and Lili Carpenter

July 2009

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Environmental Laboratory

Ecosystem Management and Restoration
Research Program

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Hydrogeomorphic Approach to Assessing Wetland Functions: Guidelines for Developing Regional Guidebooks

Chapter 8
Developing the Assessment Protocol

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Abstract: This chapter of the Guidebook describes how to develop an Assessment Protocol, which is a chapter in all HGM Regional Guidebooks. It provides specific information necessary to develop an Assessment Protocol for a new regional guidebook using examples from existing regional guidebooks. The chapter describes how to collect data including red flag features, office and field equipment needs, plot layout, data collection procedures, and field data sheets used to collect the data used to compute model outputs.

Corps of Engineers Research Report Summary, July 2009

Assessing Wetland Functions

Hydrogeomorphic Approach to Assessing Wetland Functions: Guidelines for Developing Regional Guidebooks;Chapter 8 – Developing the Assessment Protocol (ERDC/EL TR-09-6)

ISSUE: Section 404 of the Clean Water Act directs the U.S. Army Corps of Engineers to administer a regulatory program for permitting the discharge of dredged or fill materials in "waters of the United States." As part of the permit review process, the impacts of discharging dredged or fill material on wetland functions must be assessed. On 16 August 1996, a National Action Plan to Implement the Hydrogeomorphic Approach for developing Regional Guidebooks to assess wetland functions was published. A series of Regional Guidebooks will be published in accordance with the National Action Plan.

To facilitate development of Regional Guidebooks and ensure consistency and quality control, a set of guidelines were prepared. These guidelines are provided in the report, "Hydrogeomorphic Approach to Assessing Wetland Functions: Guidelines for Developing Regional Guidebooks." It provides detailed information for anyone wishing to develop Regional Guidebooks and consists of nine chapters. Each chapter is briefly described below.

Chapter 1, "Introduction and Overview of the Hydrogeomorphic Approach." This report introduces the Hydrogeomorphic Approach and outlines steps necessary to prepare Regional Guidebooks. It also provides the format for each Regional Guidebook and consistent terminology.

Chapter 2, "Identifying and Characterizing Regional Subclasses." This chapter provides further guidance on classifying wetlands into classes using geomorphic setting, water source, and hydrodynamics and further subdivides classes into subclasses using other region-specific characteristics.

Chapter 3, "Identifying Reference Wetlands." This chapter defines key terms related to reference wetlands. It also describes their purpose and gives guidance on how to select reference wetlands.

Chapter 4, "Developing Assessment Models." This chapter provides guidance for selecting and defining wetland functions, developing the initial conceptual models and variables for each function and refining the conceptual models. Guidance is also provided for developing variable subindexes and for aggregating variables into final models.

Chapter 5, "Collecting and Managing Reference Data." This chapter includes guidance

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for maintaining quality control when collecting reference data, determining minimum sample requirements, selecting different types of field measures, and entering and analyzing data.

Chapter 6, "Calibrating Assessment Models Using Reference Wetland Data." This chapter includes different options for calibrating reference data and converting reference data to subindices for each model variable.

Chapter 7, "Verifying, Field Testing, and Validating Assessment Models." This chapter defines each of the three title components and discusses steps necessary to conduct each activity. It also provides guidance for conducting a sensitivity analysis to test the influence of each variable on model outputs.

Chapter 8, "Developing the Assessment Protocol." The Assessment Protocol is one chapter of every regional guidebook. It provides the specific information necessary to collect data including red flag features, office and field equipment needs, plot layout, data collection procedures, and field sheets. Data collected are used to compute model outputs. This chapter includes guidance for preparing a list of red flag features, alternatives, and examples for collecting data for each model variable, and developing field sheets.

Chapter 9, "Application of the Hydrogeomorphic Approach." This chapter provides examples of how the results of an HGM analysis can be used to compare multiple wetlands of the same subclass, compute present and future potential project impacts, and determine mitigation requirements.

RESEARCH OBJECTIVE: The objective of this research was to develop a consistent framework for developing Regional Guidebooks. This report represents one of nine chapters in "Hydrogeomorphic Approach to Assessing Wetland Functions: Guidelines for Developing Regional Guidebooks." Each chapter is published separately.

SUMMARY: The Hydrogeomorphic (HGM) Approach is a collection of concepts and methods for developing functional indices, and subsequently using them to assess the capacity of a wetland to perform functions relative to similar wetlands in a region. The Approach was initially designed to be used in the context of the Clean Water Act Section 404 Regulatory Program permit review sequence to consider alternatives, minimize impacts, assess unavoidable project impacts, and monitor the success of mitigation projects. However, a variety of other potential applications for the Approach have been identified, including determining minimal effects under the Food Security Act, designing mitigation projects, and managing wetlands. This report is one of nine chapters of a larger report designed to provide consistent guidelines for developing regional guidebooks for implementing the HGM Approach.

AVAILABILITY OF REPORT: The report is available at the following Web site: *http://el.erdc.usace.army.mil/elpubs.* The report is also available on Interlibrary Loan Service from the U.S. Army Engineer Research and Development Center (ERDC) Research Library, telephone (601) 634-2355, or the following Web site *http://itl.erdc.usace.army.mil/library/*.

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Preface

This chapter in the Guidelines for Developing Regional Guidebooks was authorized by Headquarters, U.S. Army Corps of Engineers (HQUSACE), as part of the Characterization and Restoration of Wetlands Research Program (CRWRP), Work Unit 32985, "Technical Development of HGM." Mr. Dave Mathis was the CRWRP Coordinator at the Directorate of Research and Development, HQUSACE; Ms. Colleen Charles, HQUSACE, served as the CRWRP Technical Monitor's Representative; and Dr. Russell F. Theriot, Environmental Laboratory (EL), U.S. Army Engineer Research and Development Center (ERDC), was the CRWRP Program Manager.

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At the time of publication of this report, Dr. James R. Houston was Director of ERDC. COL Gary E. Johnston was Commander and Executive Director.

8 Developing the Assessment Protocol

Introduction

This chapter provides guidance to the authors of Regional Guidebooks on how to develop a protocol for the collection and interpretation of data that are necessary to assess the functional capacity of a wetland, using the HGM assessment approach (Smith et al. 1995; Clairain 2002; Smith 2001; Smith and Wakeley 2001; Wakeley and Smith 2001). This chapter will probably be the most frequently used section of the Regional Guidebook. Therefore, it is important that the descriptions of the assessment protocols are detailed and user-friendly to promote the consistent application of the approach. Authors of the Regional Guidebooks are encouraged to review other HGM Regional Guidebooks for examples of the level of specificity that is required for the assessment protocol. Examples providing various perspectives include: Ainslie et al. (1999, riverine); Hauer et al. (2002, prairie potholes); Noble et al. (2002, flats); Klimas et al. (2004, 2005 and 2006, multiple subclasses); Noble et al. (2007, headwater); and Shafer et al. (2007, coastal).

This chapter discusses each of the following tasks required to develop a protocol for wetland assessment in a Regional Guidebook:

a. Define assessment objectives.

b. Characterize the project area.

c. Screen for red flags.

d. Define the Wetland Assessment Area.

e. Determine the wetland subclass.

f. Collect the data.

g. Analyze the data.

h. Apply assessment results.

The following sections discuss each of these tasks in greater detail.

Define Assessment Objectives

The first task to be addressed in the assessment process is to unambiguously identify the purpose of the assessment. This can be as simple as stating, “The purpose of this assessment is to determine how the proposed project will impact wetland functions.” Other potential objectives could be as follows:

a. Compare several wetlands as part of an alternatives analysis.

b. Identify specific actions that can be taken to minimize project impacts.

c. Document baseline conditions at a wetland site.

d. Determine mitigation requirements.

e. Determine mitigation success.

f. Determine the effects of a wetland management technique.

The most common assessment scenario is a comparison of the functional capacity of pre-project and post-project conditions in the wetland assessment area (WAA). Data for the pre-project assessment are collected under existing conditions at the project site, while data for the post-project assessment are normally based on the conditions expected to exist following proposed project impacts. A conservative and well-documented approach is required in defining post-project conditions.

Frequently, multiple reasons are identified for conducting an assessment. The Regional Guidebook should assist the user in carefully defining the purpose(s) of the assessment to facilitate communication and understanding among the people involved in the assessment, and to make the goals of the study clear to other interested parties. In addition, defining the purpose helps to clarify the approach that should be taken.

Characterize the Project Area

Characterizing the project area involves describing the physical and biological conditions in the WAA, as well as proposed impacts that have the potential to influence how wetlands in the project area perform functions. An overview of general ecological information is typically presented for the entire reference domain in Chapter 3 of each Regional Guidebook, but a site-specific description should be assembled for each WAA within the project area. The Regional Guidebook should provide guidance to the user on how to characterize the WAA(s), including any maps and figures that are helpful in determining project area boundaries, jurisdictional wetlands, the boundaries of the WAA(s) (discussed later in this chapter), roads, ditches, buildings, streams, soil types, plant communities, threatened or endangered species habitat, and other important features. Some helpful sources of information are aerial photographs, topographic and National Wetland Inventory (NWI) maps, and county soil surveys (*http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm*). Most of the spatial data listed above can be most efficiently assembled and managed using a Geographic Information System (GIS).

In addition to characterizing the WAA, project impacts that ultimately affect wetland functions need to be identified for the proposed project. For example, impacts that directly influence the physical features of a wetland may include vegetation removal or placement of fill material. Any changes in wetland hydrology need to be determined (e.g., changes that result from flooding that occurs in conjunction with a proposed project). Changes in hydrology can be assessed by developing maps that show the frequency and duration of flooding for the pre-project and post-project conditions. These maps can be used to determine if changes in hydrology would result in a change in wetland subclass, for example, that would result in losses or gains in functions. If more than one alternative for a project is being considered, these impacts can be compared in terms of the land area that would be affected.

Screen for Red Flags

Red flags are features within or in the vicinity of the project area to which special recognition or protection has been assigned. Many red flag features, such as those based on national criteria or programs, are similar from region to region. Other red flag features are based on regional or local criteria. The Regional Guidebook should provide the user with a list of potential red flag issues that should be evaluated prior to the assessment of wetland functions. Table 1 lists potential red flag features assembled for one particular region, but a Guidebook should include any specific local or state regulations or special areas that may be appropriate. Screening for red flag features represents a proactive attempt to determine if the wetlands or other natural resources in and around the project area require special consideration or attention that may preempt or postpone the need for assessing wetland functions. An assessment of wetland functions may not be necessary if the project is likely to be stopped due to the potential impact to a threatened or endangered species or habitat, for example. An assessment of wetland functions may be unnecessary in this case since the project may be denied or modified strictly on the basis of the impacts to threatened or endangered species or habitat.

Define the Wetland Assessment Area (WAA)

The WAA is an area of wetland within a project area that belongs to a single regional wetland subclass and is relatively homogeneous with respect to the site-specific criteria used to assess wetland functions (i.e., hydrologic regime, vegetation structure, topography, soils, successional stage, etc.). Figures 1–4 illustrate a variety of possible alternative WAA designations and arrangements. In many project areas, there will only be one WAA representing a single wetland subclass (Figure 1). However, as the size and heterogeneity of the project area increase, it may be necessary to define and assess multiple WAAs within the project area.

Table 1
Red Flag Features and Respective Program/Agency Authority

Red Flag Features	Authority[1]
Native Lands and areas protected under American Indian Religious Freedom Act	A
Hazardous waste sites identified under CERCLA or RCRA	I
Areas protected by a Coastal Zone Management Plan	E
Areas providing Critical Habitat for Species of Special Concern	B, C, F
Areas covered under the Farmland Protection Act	K
Floodplains, floodways, or floodprone areas	J
Areas with structures/artifacts of historic or archeological significance	G
Areas protected under the Land and Water Conservation Fund Act	K
Areas protected by the Marine Protection Research and Sanctuaries Act	B, D
National wildlife refuges and special management areas	C
Areas identified in the North American Waterfowl Management Plan	C, F
Areas identified as significant under the RAMSAR Treaty	H
Areas supporting rare or unique plant communities	C, H
Areas designated as Sole Source Groundwater Aquifers	I, L
Areas protected by the Safe Drinking Water Act	I, L
City, County, State, and National Parks	D, F, H, L
Areas supporting threatened or endangered species	B, C, F, H, I
Areas with unique geological features	H
Areas protected by the Wild and Scenic Rivers Act	D
Areas protected by the Wilderness Act	D

[1]Program Authority / Agency
A = Bureau of Indian Affairs
B = National Marine Fisheries Service
C = U.S. Fish and Wildlife Service
D = National Park Service
E = State Coastal Zone Office
F = State Departments of Natural Resources, Fish and Game, etc.
G = State Historic Preservation Office
H = State Natural Heritage Offices
I = U.S. Environmental Protection Agency
J = Federal Emergency Management Agency
K = Natural Resources Conservation Service
L = Local Government Agencies

The Regional Guidebook should assist the user in evaluating the possible situations that could result in designation of more than one WAA within the project area. At least three situations necessitate defining and assessing multiple WAAs (Smith et al. 1995). The first situation exists when widely separated wetland patches of the same regional subclass occur in the project area (Figure 2). The second situation exists when more than one regional wetland subclass occurs within a project area (Figure 3). The third situation exists when a physically contiguous wetland area of the same regional subclass exhibits spatial heterogeneity with respect to hydrology, vegetation, soils, disturbance history, or other factors that translate into a significantly different value for one or more of the site-specific variable measures. These differences may be the result of natural variability (e.g., zonation on large river floodplains) or cultural alteration (e.g., logging, surface mining, hydrologic alterations, Figure 4). Users of the Guidebook should be instructed to designate each of these areas as a separate WAA, with a separate assessment on each area.

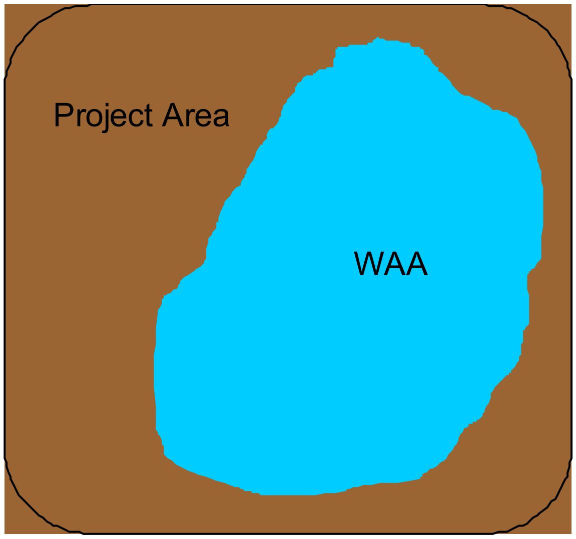

Figure 1. A single WAA within a project area

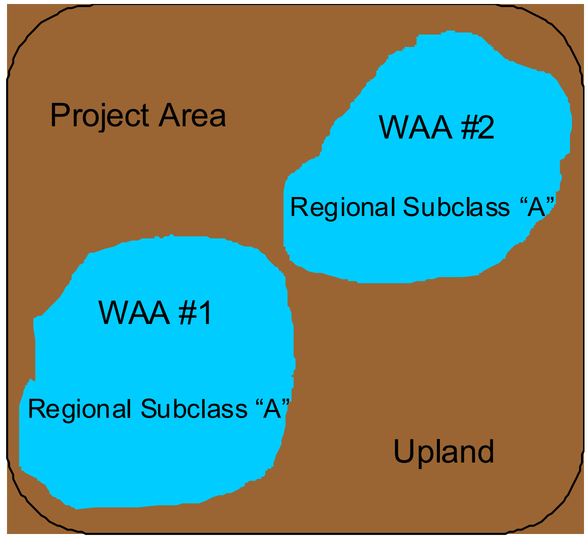

Figure 2. Spatially separated WAAs from the same regional subclass within a project.

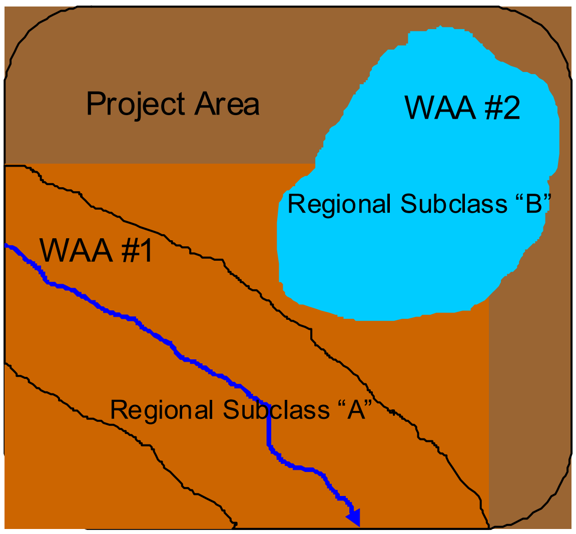

Figure 3. More than one regional subclass within a project area.

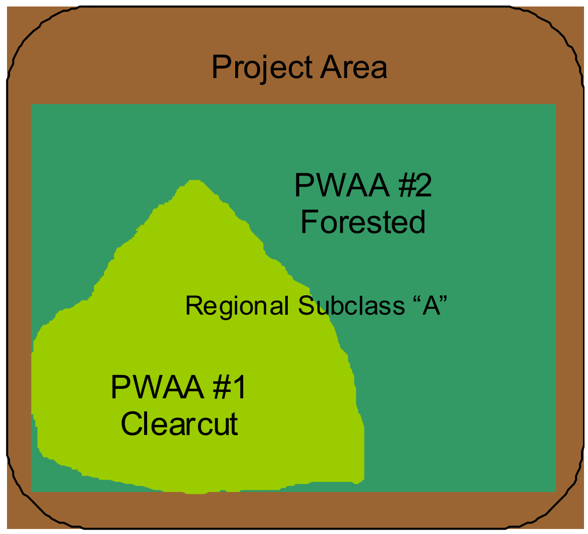

Figure 4. PWAAs defined on the basis of differences in site-specific characteristics.

There are elements of subjectivity and practicality in determining what constitutes a significant difference in portions of the WAA. Field experience with the regional wetland subclass under consideration should provide a sense of the range of variability that typically occurs, and the Guidebook should suggest specific criteria for defining multiple WAAs. For example, in Headwater Slope wetlands, recent logging in a portion of a wetland area is a commonly encountered criterion for designating two WAAs (Figure 5).

However, the presence of relatively minor differences resulting from natural variability, such as canopy openings due to natural tree fall, should not be used as a basis for dividing a contiguous wetland into multiple WAAs. Distinct zonation caused by different hydrologic regimes or disturbances caused by rare and destructive natural events (e.g., hurricanes) may be appropriate criteria for defining separate WAAs. In general, Guidebook users should be encouraged to establish multiple WAAs only where there are clear differences among sites, because data summarization and analysis become increasingly complicated as the project is fragmented into subunits.

Determine the Wetland Subclass

HGM assessment requires accurate identification of wetland subclasses to determine if an applicable Guidebook is available. Chapter 3 of each potentially applicable Regional Guidebook provides criteria for recognizing subclasses, preferably in the form of a dichotomous key. Current aerial photographs, topographic maps, soils maps, NWI maps, local knowledge, or other available information can be used to help determine which subclasses exist within the project area. In many cases it will not be possible to determine the wetland subclass from remotely sensed data or maps, and an onsite investigation will be necessary.

Collect the Data

Guidebook users should be provided with very specific and complete directions for collecting and recording data. Collection of field data will require methodology that is specific for the subclass of wetland being evaluated. A checklist is helpful to prepare for the field assessment (Figure 6). A very important consideration is to make sure that the sampling design does not create bias in data collection. The Guidebook should assist the user in determining the minimum number of samples needed for assessment. For example, recommendations can be based on the degree of variability observed during reference data collection, or on some direct measure of variability such as species area curves.

Determining the minimum number of samples needed to characterize a model variable should be based on the size and heterogeneity of the WAA. For example, Klimas et al. (2004) worked with forested wetlands in the Delta Region of Arkansas. They recommended three or four 0.04-ha plots, each containing transects and subplots, for a relatively homogenous WAA that is small, about 1 ha. Figure 7 shows a typical field sampling plot layout that was used for sampling low-gradient riverine wetlands in western Tennessee (Wilder and Roberts 2002). In this figure, a 0.04-ha plot is shown that contains two 0.004-ha subplots, four 0.0004-ha (or 1-m^2) subplots, and two 15-m transects.

Figure 5. Recent logging is a common reason for creating separate WAAs.

Methods for measuring each variable should be described in sufficient detail in the Regional Guidebook that users can make the required measurements consistently and with precision. Information needed to estimate the variables used in models to assess wetland functions will be collected at various spatial scales. For example, landscape-scale variables describe conditions in the wetland's catchment or watershed, and are evaluated using aerial photographs, maps, and field reconnaissance of the area surrounding the WAA. Examples of landscape-scale variables include change in catchment size (V_{CATCH}), upland land use (V_{UPUSE}), and habitat connections ($V_{CONNECT}$, Noble et al. 2007). Other variables can be evaluated with a walking reconnaissance of the WAA itself, for example hydrologic alterations ($V_{HYDROALT}$, Noble et al. 2007). Finally, detailed, site-specific data collected within sample plot(s), transects, or subplots at representative locations within the WAA are needed to estimate some variables (e.g., canopy tree diameter (V_{CTD}) and canopy tree density (V_{CTDEN}, Noble et al. 2007)).

The following example shows how field procedures should be presented within a Regional Guidebook. This example is for a single variable in the Tidal Fringe wetlands subclass of the Gulf Coast Region (Shafer et al. 2007):

FIELD GEAR REQUIRED	COMMENTS
DISTANCE TAPE (preferably metric, at least 50 ft or 20 m) AND ANCHOR PIN	Minimum of one, but two will speed work if enough people are available to independently record different information. A survey pin is handy to mark the plot center and anchor the tape for woody debris transects and to determine plot boundaries.
FOLDING RULE	A folding rule, small tape, or dbh caliper suitable for measuring the diameter of logs is needed.
PLANT IDENTIFICATION MANUALS	At least one person on the assessment team must be able to readily and reliably identify woody species, but field guides are recommended as part of the assessment tool kit. If species of concern, threatened, or endangered species are potentially present, the assessment team should include a botanist who can recognize them.
PLOT LAYOUT DIAGRAM	A copy is attached to this checklist.
DATA FORMS	See data form requirements table, below.
BASAL AREA PRISM OR DBH TAPE OR SUITABLE SUBSTITUTE	A 10-factor English unit wedge prism (available from forestry equipment supply companies) is the recommended tool for quickly determining tree basal area. Other tools may be substituted if they provide comparable data. Guidelines for the use of the wedge prism are attached to this checklist. If using a dbh tape or caliper, note that you will need the supplemental field data form for recording diameter measurements (Data Form C1).
SOIL SURVEY	Optional, but may be helpful in evaluating soil-related variables.
HGM GUIDEBOOK (this document)	At minimum, Chapter 6 should be available in the field to consult regarding field methods. All assessment team members should be familiar with the entire document prior to fieldwork.
SHOVEL OR HEAVY-DUTY TROWEL	If heavy or hard soils are anticipated, a shovel will be necessary. Assessment team must be able to dig at least 10 in. deep. A water bottle is recommended if conditions are dry, to help distinguish soil colors (organic-stained soils must be distinguished from mineral soil).
MISCELLANEOUS SUGGESTED GEAR	Clipboards and pencils, and extra data forms are highly recommended. Flagging may be helpful for establishing plot centers and boundaries, at least until the assessment team is comfortable with the field procedures. A camera and GPS unit will improve documentation of the assessment and are highly recommended. Record position and take a representative photo at each plot location. Field copies of aerial photos and topo maps may be important if multiple Wetland Assessment Areas must be established and recognized in the field.

Figure 6. Example of equipment list.

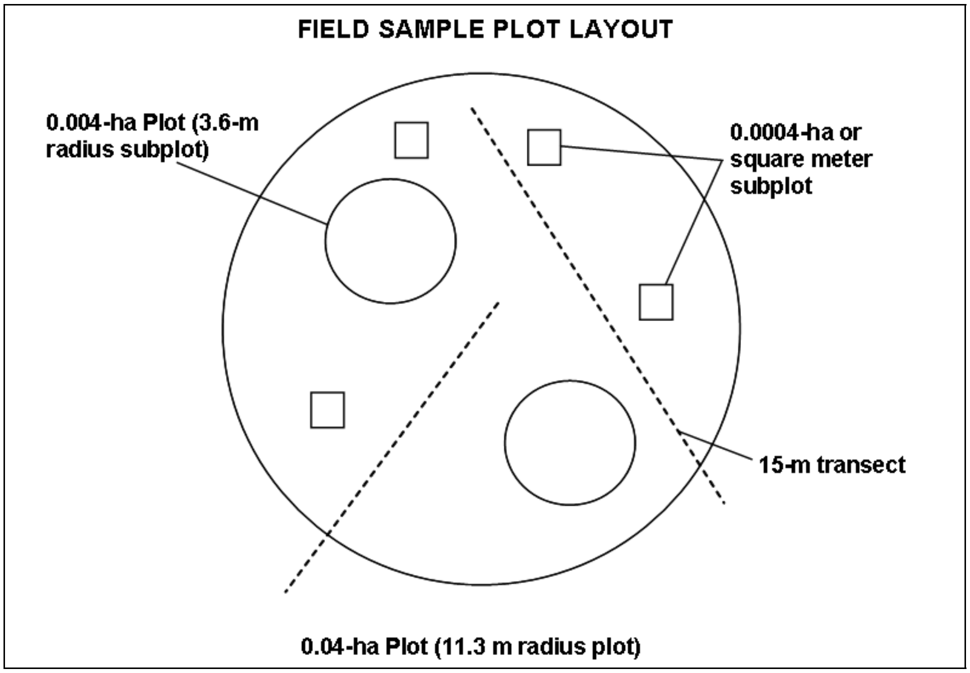

Figure 7. Sample plot layout for Riverine wetlands in Western Tennessee.

Total Percent Vegetative Cover of Native Emergent Wetland Species (V_{COVER})

This variable should be measured during the growing season using the following procedure:

(1) Select one or more representative areas within the site for sampling. Beginning at the edge of a shoreline or tidal creek, establish one or more transects perpendicular to the shoreline or along the hydrologic gradient (e.g., increasing elevation). If there are multiple vegetation community types within the WAA, the transect should intersect each vegetation community to ensure a representative sample.

(2) Using a standard 1-m^2 frame, estimate total percentage cover of native nonwoody marsh (OBL or FACW) species using the Braun-Blanquet cover class categories (Table 2, Mueller-Dombois and Ellenberg 1974). Both live and standing dead emergent plant material should be included. Tidal creeks and other areas where water depths are too deep to support the growth of emergent vegetation should be excluded. The number of transects and plots will depend on the size and heterogeneity of the site; a minimum of 10 plots per transect are recommended for all except the smallest sites.

Table 2
Braun-Blanquet Cover Class Categories

% Cover	Cover Class	Cover Class Midpoint
>75	5	87.5
50-75	4	62.5
25-50	3	37.5
5-25	2	15
<5	1	2.5

(3) Calculate the total percentage cover of each plot by summing the cover class midpoints (Table 2) for each species, then divide by the number of plots sampled to obtain the mean percentage cover of the study area.

(4) Using Table 3, determine the variable subindex that corresponds to the mean percentage cover estimate.

Table 3
Relationship Between Mean % Emergent Marsh Vegetation Cover (*VCOVER*) and Functional Capacity

% Cover	Variable Subindex
>70	1.0
61-70	0.8
51-60	0.6
41-50	0.4
31-40	0.2
11-30	0.1
<11	0.0

Sample data sheets should be included in this chapter of the Regional Guidebook. Data sheets should include measurement units. They should be organized by the type of measurement (e.g., plot size/transect/landscape, etc.). They should also provide prompts where needed, for example the minimum diameter at breast height of trees, depth of soil sample observations, etc. Also, a column is usually included for entering values that will be used in data summarization, for example averages. A sample data sheet from the HGM assessment of Flats Wetlands in the Florida Everglades is shown in Figure 8 (Noble et al. 2002). This data sheet is organized by the scale at which the data are collected. It is important to organize the data so that they can be easily entered into spreadsheets for calculating the functional capacity index (FCI) and functional capacity units (FCU) for each WAA. Figure 9 shows a spreadsheet that can be used to calculate basal area (m^2/ha) from individual tree diameter measurements (cm) for a plot (Klimas et al. 2004).

Analyze the Data

The first step in the analysis of field data is to transform the measure of each assessment variable into a variable subindex with a range of 0.0 to 1.0. For example, when the measured variable is within the range of conditions exhibited by reference standard wetlands, a variable subindex of 1.0 is assigned. If the condition of the variable deviates from that of the reference standard wetlands, the subindex is reduced according to the defined relationship between the model variable and the functional capacity. In some cases, the variable subindex drops to zero.

A Regional Guidebook will include graphical representations (subindex curves) of the relationships between assessment variables and subindex values, which are constructed as described in Chapter 4 (Smith and Wakeley 2001). Subindex values can be determined by visually comparing the values obtained in the field assessment with the subindex curves, and FCI values are determined by inserting the subindex values into the assessment models (Chapter 4, Smith and Wakeley 2001). The assessment models were verified, field tested, and validated previously, as explained in Chapter 7 (Wakeley and Smith 2001).

Organic Everglades Field Data Sheet

Assessment Team:____
Project Name:____
Location:____
Date:____**Subclass: Organic**

Sample variables 1-4 using aerial photography, topographic maps, National Wetland Inventory maps, soil survey maps, etc.

1. V_{TRACT} Area of wetland that is contiguous with WAA .... ha

2. V_{CORE} Percent of wetland tract that is >300 m from unsuitable habitat .... %

3. $V_{CONNECT}$ Percent of wetland tract perimeter that is "connected" to suitable habitat .... %

4. V_{MICRO} Percent of wetland area that has altered microtopographic features .... %

Sample variables 5 and 6 from a representative number of locations in the WAA using a 0.04-ha circular plot (11.3-m (37-ft) radius)

5. V_{WOODY} Percent cover of woody vegetation ≥ 1 m (3.3 ft) in height (average of 0.04-ha values on next line) .... %
   Average of 0.04-ha plots sampled: _____% _____% _____%

6. $V_{INVASIVE}$ Percent cover of invasive vegetation from all strata (average of 0.04-ha values on next line).. %
   Average of 0.04-ha plots sampled: _____% _____% _____%

Sample variables 8, 10, and 12 in three (3) 1-m^2 subplots placed in representative locations of each quadrant of the 0.04-ha plot

8. V_{MAC} Percent cover of emergent macrophytic vegetation (average of 0.04-ha values on next line).. %
   Average of 0.04-ha plots sampled: 1_____% 2_____% 3_____%
   4_____% 5_____% 6_____%
   7_____% 8_____% 9_____%

10. V_{SURTEX} Soil texture of surface horizon or layer of the WAA as a percent (average of 0.04-ha values on next line)... %
   Average of 0.04-ha plots sampled: 1_____% 2_____% 3_____%
   4_____% 5_____% 6_____%
   7_____% 8_____% 9_____%

12. V_{COMP} Concurrence with dominants (average of 0.04-ha values on next line)…………… %
   Average of 0.04-ha plots sampled: 1_____% 2_____% 3_____%:
   4_____% 5_____% 6_____%:
   7_____% 8_____% 9_____%:

Figure 8. Example of a field data sheet.

Record the species (optional) and dbh (cm) of all trees (i.e., woody stems ≥ 10 cm or 4 in dbh) in the 0.04-ha plot in Columns 1 and 2 in the table below. Complete the calculations (or use a spreadsheet) to derive basal area per tree, and sum to get total plot basal area (m^2/ha).							
1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Species Code (optional)	dbh (cm)	Square the Value in Column 2 (dbh x dbh)	Multiply the Value in Column 3 by 0.00196 to get m^2/ha per tree	Species Code (optional)	dbh (cm)	Square the Value in Column 2 (dbh x dbh)	Multiply the Value in Column 3 by 0.00196 to get m^2/ha per tree
SUM ALL COLUMN 4 VALUES TO GET TOTAL PLOT BASAL AREA = ________ (m^2 / ha) **Record Total Basal Area on Data Form 4 in the V_{TBA} row as a plot value**							

Figure 9. Example of a table that can be used to calculate dbh.

The third step in data analysis is to calculate the FCUs for each assessed function. This is accomplished by multiplying the FCI by the area of the WAA (Smith et al. 1995). For example, if the FCI for the Detain Floodwater function of a riverine wetland is 1.0 and the area of the WAA is 10 ha, then the FCU for this function is 10. The manual calculation of Subindex and FCI values can be easily automated using simple spreadsheets. Figure 10 is an example of such a spreadsheet, where field data are transferred directly from the data sheets to the spreadsheet input form, and FCI values are calculated and multiplied by the area (hectares) of the WAA to generate FCUs (Klimas et al. 2005). For WAAs with multiple sample plots, the FCU values are averaged to obtain an overall FCU for the WAA. This final step can also be automated using spreadsheets.

Apply Assessment Results

Once the assessment and analysis phases are complete, the results can be used to compare the level(s) of function in the same WAA at different points in time or in different WAAs at the same point in time. The information can be used to address the specific objectives identified at the beginning of the study, such as:

a. Identifying baseline conditions.

b. Determining project impacts.

c. Comparing project alternatives.

d. Determining mitigation requirements.

e. Evaluating mitigation success.

FCI and FCU Calculations for the Pine Flats Regional Subclass in the Arkansas Coastal Plain (8/2003 Version)			
Project:			
WAA#		**Area of the WAA (ha):**	

In the green shaded cells below delete any existing numeric values and enter the WAA summary values from Data Form 3. Leave no cells blank. Print and attach this sheet to the Project Information and Summary of Assessment Form applicable to the project.

Variable	Metric Value	Units	Subindex
V_{AHOR}		cm	
V_{BUFFER}	N/A	%	N/A
V_{COMP}		%	
V_{FIRE}		ha	
V_{FREQ}	N/A	years	N/A
V_{GCOMP}	N/A	# species	N/A
V_{GVC}		%	
V_{LITTER}		%	
V_{LOG}		m^3 / ha	
V_{OHOR}		cm	
V_{OUT}	N/A	discharge frequency	N/A
V_{PATCH}	N/A	ha	N/A
V_{POND} (Holocene Flats)		%	
V_{POND} (Late Pleistocene)		%	
V_{POND} (Early & Mid-Pleistocene)		%	
V_{SNAG}		stems / ha	
V_{SOIL}		%	
V_{SSD}		stems / ha	
V_{STRATA}		# layers	
V_{TBA}		m^2 / ha	
V_{TCOMP}		%	
V_{TDEN}		stems / ha	
V_{WD}		m^3 / ha	

Function	Functional Capacity Index (FCI)	Functional Capacity Units (FCU)
Detain Floodwater	N/A	N/A
Detain Precipitation		
Biogeochemical Cycling		
Export Organic Carbon	N/A	N/A
Maintain Plant Communities		
Provide Wildlife Habitat		

Figure 10. Example of a spreadsheet for calculating variable subindices and FCIs.

A Regional Guidebook should clearly state that to evaluate project-related impacts, at least two assessments will generally be needed. The first assesses the number of functional capacity units (FCUs) provided by the site in its pre-project or baseline condition. The second assesses the number of FCUs provided by the site in a post-project state, based on proposed project plans and the associated changes to each of the model variables. The difference between pre-project and post-project conditions, expressed in numbers of FCUs, represents the potential loss of functional capacity due to project impacts. Conversely, in a mitigation scenario, the difference between the current condition and future condition of a site, with mitigation actions implemented and successfully completed, represents the potential gain in functional capacity as a result of restoration activities. However, since the mitigation project is unlikely to become fully functional immediately upon completion, a time lag must be incorporated in the analysis to account for the time necessary for the mitigation site to mature and demonstrate improved functional capacity.

Spreadsheets that can be used to help evaluate project impacts and estimate mitigation requirements are available on the internet at *http://el.erdc.usace.army.mil/wetlands/datanal.html*. A Regional Guidebook should include a specific discussion of how to estimate changes in variable values resulting from impacts or mitigation actions relative to the particular regional wetland subclass(es) covered by the document.

Conclusions

This chapter of the Hydrogeomorphic Approach to Assessing Wetland Functions: Guidelines for Developing Regional Guidebooks presents information to assist in the development of an assessment protocol for a Regional Guidebook using the following steps:

(1) Define assessment objectives – The Guidebook should help the user to develop a clearly defined purpose for the project.

(2) Characterize the project area – A site-specific description for each WAA within the project area should include any factors that influence how the wetlands function, such as: climate, geology, geomorphic setting, hydrology, vegetation, soils, land use, and any natural or anthropogenic disturbances, etc.

(3) Screen for red flags – The Guidebook should provide a list of potential issues with priority at the national, regional, or local level that could potentially delay or stop the wetland assessment.

(4) Define the WAA – This is an area of wetland within the project that is homogeneous and belongs to a single wetland subclass. The Guidebook should present criteria for the regional subclasses of wetlands to assist the user in making decisions on how to determine boundaries for one or more WAAs within the project area. Larger, more diverse project areas may require multiple WAAs.

(5) Determine the wetland subclass – The subclass identification is based on hydrogeomorphic characteristics. The Regional Guidebook should provide or recommend maps, aerial photos, and other information to assist the user in delineating regional subclasses of wetlands within the project area.

(6) Collect the data – Data are collected at the landscape, WAA, and plot levels (including transects, subplots, and points). Specific instructions should be included in the Guidebook for collecting and recording data, including recommendations on how to determine the minimum number of samples needed.

(7) Analyze the data – Guidance should be provided in the Regional Guidebook to help the user construct spreadsheets to calculate FCI and FCU for each WAA.

(8) Apply assessment results – The Guidebook should assist the user in evaluating gains or losses in functional capacity by comparing pre-project and post-project FCUs.

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14. ABSTRACT

This chapter of the Guidebook describes how to develop an Assessment Protocol, which is a chapter in all HGM Regional Guidebooks. It provides specific information necessary to develop an Assessment Protocol for a new regional guidebook using examples from existing regional guidebooks. The chapter describes how to collect data including red flag features, office and field equipment needs, plot layout, data collection procedures, and field data sheets used to collect the data used to compute model outputs.

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