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Hydrogeomorphic Wetland Classification System: An Overview and Modification to Better Meet the Needs of the Natural Resources Conservation Service

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Hydrogeomorphic Wetland Classification System: An Overview and Modification to Better Meet the Needs of the Natural Resources Conservation Service

Purpose

The hydrogeomorphic (HGM) wetland classification system was first introduced by Brinson in 1993. To many wetland scientists, HGM is synonymous with a wetland functional assessment approach. However, the original work by Brinson was limited to the development of a wetland classification system. It was Smith et al. (1995), after publishing *An Approach for Assessing Wetland Functions Using HGM Classification, Reference Wetlands, and Functional Indices*, who expanded the HGM concepts to include wetland functional assessments, based on Brinson's HGM classification system.

This technical note provides a brief review of Brinson's original concepts and provides additional structure to the HGM wetland classification system. The information presented will provide guidance to U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) staffs when:

- deciding on an appropriate title for an HGM interim wetland functional assessment model
- deciding if it is appropriate to use an existing HGM-based functional assessment for a specific project
- there is a need to classify a wetland using the HGM classification system

This technical note does not attempt to provide detailed information on HGM classification, as other resources cited in the reference section meet this need. Users are encouraged to access the links in the reference if more detailed information is desired.

Policy mandates for wetland functional assessments

Congress, in drafting of the Wetland Conservation (WC) Provisions of the 1985 Food Security Act (FSA), linked USDA program eligibility with the conservation of wetlands. In the original Act, an exemption to the WC provisions was provided if the proposed impacts to the wetland were determined to be minimal. In 1990, Congress added the Good Faith exemption if the person restores the converted wetland. In 1996, the FSA was amended to allow for an additional exemption if the USDA participant mitigates for wetland functions, values, and acres lost associated with the conversion. Additionally, the 1996 amendments modified the Good Faith exemption to allow for mitigation, rather than just restoration of the converted wetland. If no exemptions apply, a participant who is determined to be out of compliance due to conversion of a wetland is able to regain eligibility if the wetland functions, values, and acres are adequately mitigated. Thus, there are four unique instances where a wetland functional assessment may be required:

- consideration of a request for Minimal Effect Exemption (or prior to a determination of noncompliance)
- consideration of a request for a Mitigation Exemption
- determination that adequate mitigation has been obtained associated with a Good Faith determination by the Farm Services Agency
- determination that adequate mitigation is obtained in a participant's efforts to regain eligibility when no exemption was provided

By regulation (Federal Register 1996), the NRCS is mandated to grant or deny these exemptions based on the results of a wetland functional assessment. The policy (NFSAM) mandates the use of models using the HGM approach, if available. Additionally, functional assessments are required by the NRCS in the administration of the NRCS Wetland Protection Policy (Federal Register 1997b).

In 1997, the U.S. Army Corps of Engineers (USACE); U.S. Department of Transportation, Federal Highway Administration; USDA, NRCS; U.S. Department of Interior, Fish and Wildlife Service (USFWS), and the U.S. Environmental Protection Agency (EPA) agreed to use HGM as a basis for wetland functional assessments

(Federal Register 1997b). The National Action Plan to Implement the HGM Approach to Assessing Wetland Functions outlined a process by which the USACE would develop regional HGM guidebooks for selected HGM classes across the United States.

At the time of the drafting of this technical note, the USACE lists 16 regional guidebooks available for use in the United States. They can be accessed at *http://www.usace.army.mil/cw/cecwo/reg/techbio.htm*.

NRCS policy mandates that in the absence of an applicable regional guidebook, each NRCS state conservationist will develop and approve interim HGM functional assessment models or will use alternative state approved assessment methods. This technical note will assist those that choose to develop interim HGM-based models.

Premise behind HGM classification

Past efforts to develop wetland classification systems (Shaw and Fredine 1956; Cowardin et al. 1979) were undertaken by the USFWS as a prerequisite to conducting national wetland inventories. Both systems targeted wetland vegetation and more specifically, waterfowl habitat. The data obtained from the USFWS inventories were used to assess and monitor national and regional wetland trends.

Similarly, the HGM classification developed by Brinson (1993) and later modified by Smith et al. (1995) was developed as a prerequisite for a larger goal. Rather than for wetland inventories, HGM classification was developed to "provide a tool for measuring changes in the functions of wetland ecosystems due to impacts by proposed projects, and restoration, creation, and/or enhancement" (Brinson et al. 1997).

The HGM classification system places an emphasis on geomorphic and hydrologic attributes, rather than using a system that is limited to biotic characteristics. Brinson recognized that water inputs and outputs drive wetland systems, and he placed an emphasis on the fact that water is the foundation of all wetlands and habitat is a result of the abundance of water. Brinson, by design, choose to ignore values in his classification system.

Comparison of biotic-based systems to HGM

Based on the Cowardin system (Cowardin et al. 1979), a seasonally ponded herbaceous wetland in a flood plain in Mississippi has the same classification as a seasonally ponded herbaceous playa lake in the Texas Panhandle or an herbaceous wetland associated with spring flow in the foothills of Wyoming's eastern slope of the Rocky Mountains. All of these wetlands support similar habitat per the Cowardin system, but each functions in a vastly different manner. Similarly, challenges and potentials associated with wetland restoration, wetland delineation, and assessments of wetland function would be vastly different between these wetlands.

Using Circular 39 (Shaw and Fredine 1956) or the Cowardin system (Cowardin et al. 1979), the user can envision what the wetland looks like. Using HGM, the user can envision how the wetland works.

Foundation and principles of the HGM classification

Brinson's HGM classification (Brinson 1993) has wetland classes and subclasses predicated on three components:

- geomorphic setting—topographic location within the surrounding landscape
- water source and its transport—precipitation, surface/near surface flow, and ground water discharge
- hydrodynamics—direction and strength (hydrologic head) of flow

HGM classes

Originally, the HGM classification system included four wetland classes: DEPRESSIONAL, EXTENSIVE PEATLAND, RIVERINE, and FRINGE WETLANDS. The classification system was later expanded to include seven major HGM classes (Smith et al. 1995).

Since 1993, users of the HGM classification system have interpreted the appropriate HGM class appreciably different—particularly for wetlands in bottomland landscapes. For NRCS purposes, the appropriate HGM class should be reflective of the geologic location or setting of the wetland, which might have little impact on how the wetland functions. By taking this approach, rather than targeting function, the HGM class provides valuable insight to the geomorphologic processes that formed the wetland. As an example, RIVERINE wetlands are associated with natural channels and their morphology. RIVERINE wetlands occur in bottomlands and/or riparian areas, regardless of current connectivity to the channel.

HGM classes are limited to the following approved classes and are described in more detail in table 1. HGM class should be denoted by capitalization.

- RIVERINE
- DEPRESSIONAL
- SLOPE
- MINERAL SOIL FLATS
- ORGANIC SOIL FLATS
- ESTUARINE FRINGE
- LACUSTRINE FRINGE

HGM subclasses

In addition to the seven major classes, HGM encourages the development of subclasses. While the HGM class provides a general overview of the where the wetland occurs in the landscape, the subclass can provide details of the HGM characteristics of the wetland and provides insight to major hydrologic inputs and outputs. At a minimum, the subclass should be reflective of the primary hydrologic influence. It is important to note that in keeping with HGM principles, subclasses must be distinguished on the basis of morphological characteristics, water source, and/or hydrodynamics.

Unlike the Cowardin system (Cowardin et al. 1979) or the newly proposed Federal Geographic Data Committee Wetland Mapping Standard (USFWS 2007), subclasses under HGM are not limited to a rigid, predeveloped set of established terms. Smith et al. (1995) explains that "There is considerable flexibility in defining wetland subclasses with a region. The hierarchical nature of HGM classification makes it possible to work at different scales of resolution depending on the region, HGM class, or projects under consideration."

Building on the example presented in the previous section, the appropriate HGM class for a depressional wetland that occurs on a low terrace or flat within a riparian area would be RIVERINE. The use of the term depression would be appropriate in the HGM subclass. Again, flexibility is encouraged at the subclass level. Depending on the intended use of the classification effort, HGM subclasses can be singe phase (depression) or multiphase (depression/flow-through/ground water influenced). By using multiphase nomenclature, the subclass can indicate more detail regarding how the wetland functions. For this reason, multiphase subclasses are recommended. A valuable reference regarding the array of terms that can be used in a subclass is the Field Book for Describing and Sampling Soils (USDA NRCS 2002).

A few examples of terms that can be used in regional subclasses (single phase or multiphase) are:

- landscape—alluvial plain, basin, lowland
- landforms—arroyo, barrier flat, bog, Carolina Bay, fen, flood plain, meander scar, open depression, oxbow lake, slough, terrace
- microfeatures—closed depression, interdune, mound, gilgai, hummocks, mimi mounds, pothole, swale, vernal pool
- anthropogenic features—borrow pit, pond, quarry, rice paddy
- tidal, nontidal, upland, bottomland
- ponded, flooded, saturated, open
- ground water influenced
- leveed, incised
- flow-through, recharge, discharge, connected

Regional subclass

Similar to the varied use of the appropriate HGM class, there has been varied use of the phrase regional subclass. According to Smith et al. (1995), a regional subclass is "distinguished on the basis of geomorphic setting, water source, and hydrodynamics." A regional subclass is defined as "wetlands within a region that are similar based on HGM classification factors. There may be more than one regional wetland subclass identified within each HGM wetland class depending on the diversity of wetlands in a region, and assessment objectives" (Federal Register 1997). Others use regional subclasses to describe a geographical limit of a particular model. For NRCS purposes, a regional subclass should define the geographical extent of any particular model.

Table 1 Definitions of hydrogeomorphic wetland classes (modified from Brinson et al. 1995)

HGM class	Definition
RIVERINE	RIVERINE wetlands occur in flood plains and riparian corridors in association with stream channels. Dominant water sources are often overbank flow from the channel or subsurface hydraulic connections between the stream channel and wetlands. However, sources may be interflow and return flow from adjacent uplands, occasional overland flow from adjacent uplands, tributary inflow, and precipitation. At their headwater, RIVERINE wetlands often are replaced by SLOPE or DEPRESSIONAL wetlands where the channel morphology may disappear. They may intergrade with poorly drained flats or uplands. Perennial flow in the channel is not a requirement.
DEPRESSIONAL	DEPRESSIONAL wetlands occur in topographic depressions. Dominant water sources are precipitation, ground water discharge, and both interflow and overland flow from adjacent uplands. The direction of flow is normally from the surrounding uplands toward the center of the depression. Elevation contours are closed, thus allowing the accumulation of surface water. DEPRESSIONAL wetlands may have any combination of inlets and outlets or lack them completely. Dominant hydrodynamics are vertical fluctuations, primarily seasonal. DEPRESSIONAL wetlands may lose water through intermittent or perennial drainage from an outlet, by evapotranspiration and, if they are not receiving ground water discharge, may slowly contribute to ground water. Peat deposits may develop in DEPRESSIONAL wetlands. Prairie potholes are a common example of DEPRESSIONAL wetlands.
SLOPE	SLOPE wetlands normally are found where there is a discharge of ground water to the land surface. They normally occur on sloping land; elevation gradients may range from steep hillsides to slight slopes. SLOPE wetlands are usually incapable of depressional storage because they lack the necessary closed contours. Principal water sources are usually ground water return flow and interflow from surrounding uplands, as well as precipitation. Hydrodynamics are dominated by downslope unidirectional water flow. SLOPE wetlands can occur in nearly flat landscapes if ground water discharge is a dominant source to the wetland surface. SLOPE wetlands lose water primarily by saturation subsurface and surface flows and by evapotranspiration. SLOPE wetlands may develop channels, but the channels serve only to convey water away from the SLOPE wetland. Fens are a common example of SLOPE wetlands.
MINERAL SOIL FLATS	MINERAL SOILS FLATS are most common on interfluves, extensive relic lake bottoms, or large historic flood plain terraces where the main source of water is precipitation. They receive no ground water discharge, which distinguishes them from DEPRESSIONAL and SLOPE wetlands. Dominant hydrodynamics are vertical fluctuations. MINERAL SOIL FLATS lose water by evapotranspiration, saturation overland flow, and seepage to underlying ground water. They are distinguished from flat upland areas by their poor vertical drainage, often due to spodic horizons and hardpans, and low lateral drainage, usually due to low hydraulic gradients. MINERAL SOIL FLATS that accumulate peat can eventually become the class ORGANIC SOIL FLATS. Pine flatwoods with hydric soils are a common example of MINERAL SOIL FLAT wetlands.
ORGANIC SOIL FLATS	ORGANIC SOIL FLATS, or extensive peatlands, differ from MINERAL SOIL FLATS, in part because their elevation and topography are controlled by vertical accretion of organic matter. They occur commonly on flat interfluves, but may also be located where depressions have become filled with peat to form a relatively large flat surface. Water source is dominated by precipitation, while water loss is by saturation overland flow and seepage to underlying ground water. Raised bogs share many of these characteristics, but may be considered a separate class because of their convex upward form and distinct edaphic conditions for plants. Portions of the Everglades and northern Minnesota peatlands are common examples of ORGANIC SOIL FLAT wetlands.

Table 1 Definitions of hydrogeomorphic wetland classes *other than riverine* (Brinson et al. 1995)—Continued

HGM class	Definition
ESTUARINE FRINGE	ESTUARINE FRINGE wetlands occur along coasts and estuaries and are under the influence of sea level. They intergrade landward with RIVERINE wetlands where tidal currents diminish and riverflow becomes the dominant water source. Additional water sources may be ground water discharge and precipitation. The interface between the ESTUARINE FRINGE and RIVERINE classes is where bidirectional flows from tides dominate over unidirectional ones controlled by flood plain slope of RIVERINE wetlands. Because ESTUARINE FRINGE wetlands frequently flood and water table elevations are controlled mainly by sea surface elevation, ESTUARINE FRINGE wetlands seldom dry for significant periods. ESTUARINE FRINGE wetlands lose water by tidal exchange, by saturated overland flow to tidal creek channels, and by evapotranspiration. Organic matter normally accumulates in higher elevation marsh areas where flooding is less frequent and the wetlands are isolated from shoreline wave erosion by intervening areas of low marsh. *Spartina alterniflora* salt marshes are common examples of ESTUARINE FRINGE wetlands.
LACUSTRINE FRINGE	LACUSTRINE FRINGE wetlands are adjacent to lakes where the water elevation of the lake maintains the water table in the wetland. In some cases, these wetlands consist of a floating mat attached to land. Additional sources of water are precipitation and ground water discharge, the latter dominating where LACUSTRINE FRINGE wetlands intergrade with uplands or SLOPE wetlands. Surface water flow is bidirectional, usually controlled by water-level fluctuations such as seiches in the adjoining lake. LACUSTRINE FRINGE wetlands are indistinguishable from DEPRESSIONAL wetlands where the size of the lake becomes so small relative to fringe wetlands that the lake is incapable of stabilizing water tables. LACUSTRINE FRINGE wetlands lose water by flow returning to the lake after flooding, by saturation surface flow, and by evapotranspiration. Organic matter normally accumulates in areas sufficiently protected from shoreline wave erosion. Unimpounded marshes bordering the Great Lakes are a common example of LACUSTRINE FRINGE wetlands.

It is always preferable for any wetland assessment model to include the class, subclass, and regional subclass in the title of the model. As an example, in the *Regional Guidebook for Assessing the Functions of Low Gradient, Riverine Wetlands in Western Kentucky*, “Low Gradient” would be the HGM subclass, “RIVERINE” would be the HGM class, and “Western Kentucky” would be the regional subclass.

Modifiers

Some perceived that Brinson’s approach limited HGM classification to geomorphic and hydraulic characteristics in the pure sense of the terms. According to the Geomorphic Description System provided by the NRCS (2002), geomorphic descriptions are limited to landscape, landform, microfeature, and anthropogenic features. Most wetland scientists with a background in soils would not consider vegetation, soil texture, soil pH as geomorphic descriptions—others might disagree.

Regardless, Brinson (2003) recognized that wetland properties outside the scope of geomorphic setting and hydrology can dictate how a wetland functions. Flood plain wetlands supporting woody vegetation function at a vastly different level as an abatement mechanism of floodwater energy than will an herbaceous flood plain wetland. Soil pH and texture can influence biochemical processes associated with the sequestration of elements and compounds and will dictate plant species used in the HGM model.

Brinson (2003) recommended that “biotic components should be drawn into the classification system.” Many regional guidebooks follow Brinson’s advice and deviated from the pure HGM classification by including a non-HGM term, such as forested (e.g., Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley; Forested Wetlands in the West Gulf Coastal Plain Region of Arkansas; and Wetland and Riparian Forests in the Ouachita Mountains and Crowley’s Ridge Regions of Arkansas). Many will find that Brinson’s advice of expanding the HGM classification system might be desirable. In this regard, the NRCS recommends that the precedence set by Cowardin et al. (1979) be followed, and the use of modifiers be added to the HGM classification system.

Vegetative type would be a good example of a HGM modifier (e.g., forested, herbaceous), as might soil reaction (e.g., acid, calcareous). Similar to HGM subclasses, modifiers might be multiphase (e.g., forested/clay/calcareous). In rare cases, vegetative characteristics might be even further expanded to define a unique wetland type or structure. Cypress/tupelo might be an example of a taking the forested modifier to another level. It is recommended to always denote a modifier of a HGM class and subclass by using italics.

Caution must be exercised when adding modifiers to the HGM classification. Some might wish to use modifiers to target other aspects of the use of wetland functional assessments based on regulatory programs (isolated, adjacent) or wetland value (declining species, waterfowl, or location significance). Users of the modified HGM classification should refrain from using any term in the classification that is not related to the physical characteristics that dictate how a wetland functions.

A few examples of modifiers are:

- *forested*, *herbaceous*, *scrub/shrub*
- *acid*, *calcareous*, *salty*
- *clayey*, *loamy*, *sandy*
- *bald cypress*, *pitcher-plant*

Summary

The HGM classification system was developed by Brinson (1993) to be used for wetland functional assessments. The foundations behind HGM are that hydrology and geomorphic principles define wetlands; whereas, other wetland characteristics, such as vegetation, are the result of the HGM conditions. HGM classification provides an insight to why a particular wetland occurs on the landscape, whereas past wetland classification systems described habitat types and served poorly as a tool associated with functional assessments.

Brinson (1993) recognized that other physical properties of wetlands (e.g., vegetation, soil texture, soil pH) can have a pronounced impact on the level of all functions. By coupling HGM classification with non-HGM-based modifiers, such as *forested* and/or *calcareous*, users of NRCS-developed interim models will be able to obtain greater insight into why the wetland(s) occurs on the site being assessed, what hydrology and geomorphic limitations and potentials are unique to the site, and what plant community occurs (or will) occur on the site.

Examples of the modified HGM classification are:

- DEPRESSIONAL: Playa, Playa Floor; *Clayey/Calcareous*
- RIVERINE: Depression, Backswamp, Frequently flooded; *forested*
- SLOPE: Mountain System, Stratigraphic, Seasonal; *herbaceous*

By policy, the NRCS should utilize regional guidebooks as a tool to determine minimal-effect or mitigation. In the absence of regional guidebooks, NRCS state conservationists are directed to develop interim models or use existing alternative assessment methods. To aid in consistency across the United States, the modified HGM classification system provided in this document should be utilized by NRCS field wetland specialists in naming interim models and when defining a model's reference domain.

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