Using Hydrogeomorphic (HGM) Wetland Functional Assessments for Civil Works Planning

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Outline

- What is a HGM wetland functional assessment?
- How can HGM be applied to planning studies?
- Future directions of HGM

History

- HGM wetland functional assessments developed primarily for regulatory purposes in the mid-late 1990's.
- 1997 – USACE National Action Plan to Implement HGM

Wetland Functions versus Values

- Functions are processes or activities that take place in wetland ecosystems.
- Wetland values are beneficial goods and services resulting from wetland functions
- “Value” is the relative importance of something to an individual or group (e.g., society)
- The HGM Approach assesses functions, but does not determine value

Examples of Wetland Functions

- **Hydrologic Functions**
  - Temporary storage of surface and groundwater
  - Dissipate energy of waves or currents
- **Biogeochemical Functions**
  - Sediment and toxicant retention
  - Nutrient removal and transformation
  - Organic matter export
- **Habitat Functions**
  - Support for plant and animal communities

Wetland Functions and Values

Hydrologic Functions

Biogeochemical Functions

Habitat Functions

Flood Damage Reduction
Base Flow / Aquifer Recharge
Water Quality Improvement
Nutrient / Carbon Sink
Recreational Opportunities
Biodiversity
Hunting / Fishing / Gathering
Aesthetic Appeal
Wood Products
Open / Green Space
Educational Activities

What is Functional Capacity?

- The degree or magnitude to which a wetland performs a function
- Depends on characteristics of the wetland and the surrounding landscape
- Similar wetlands exhibit a range of functional capacities due to inherent characteristics, natural disturbance, and anthropogenic alteration

What is the HGM Approach?

- A method for assessing the functional capacity of a wetland
- Three pillars of the HGM Approach:
  - ►Hydrogeomorphic Classification
  - ►Reference Wetlands
  - ►Assessment Models
- End result is a “rapid” assessment technique for the user

Why Classify Wetlands?

Goal is to narrow the focus to a group of wetlands that function similarly, and thus . . .

- Reduce the variability that must be addressed in assessment models
- Specify only relevant functions
- Simplify construction of assessment models
- Reduce time needed to perform an assessment

Hydrogeomorphic Classification

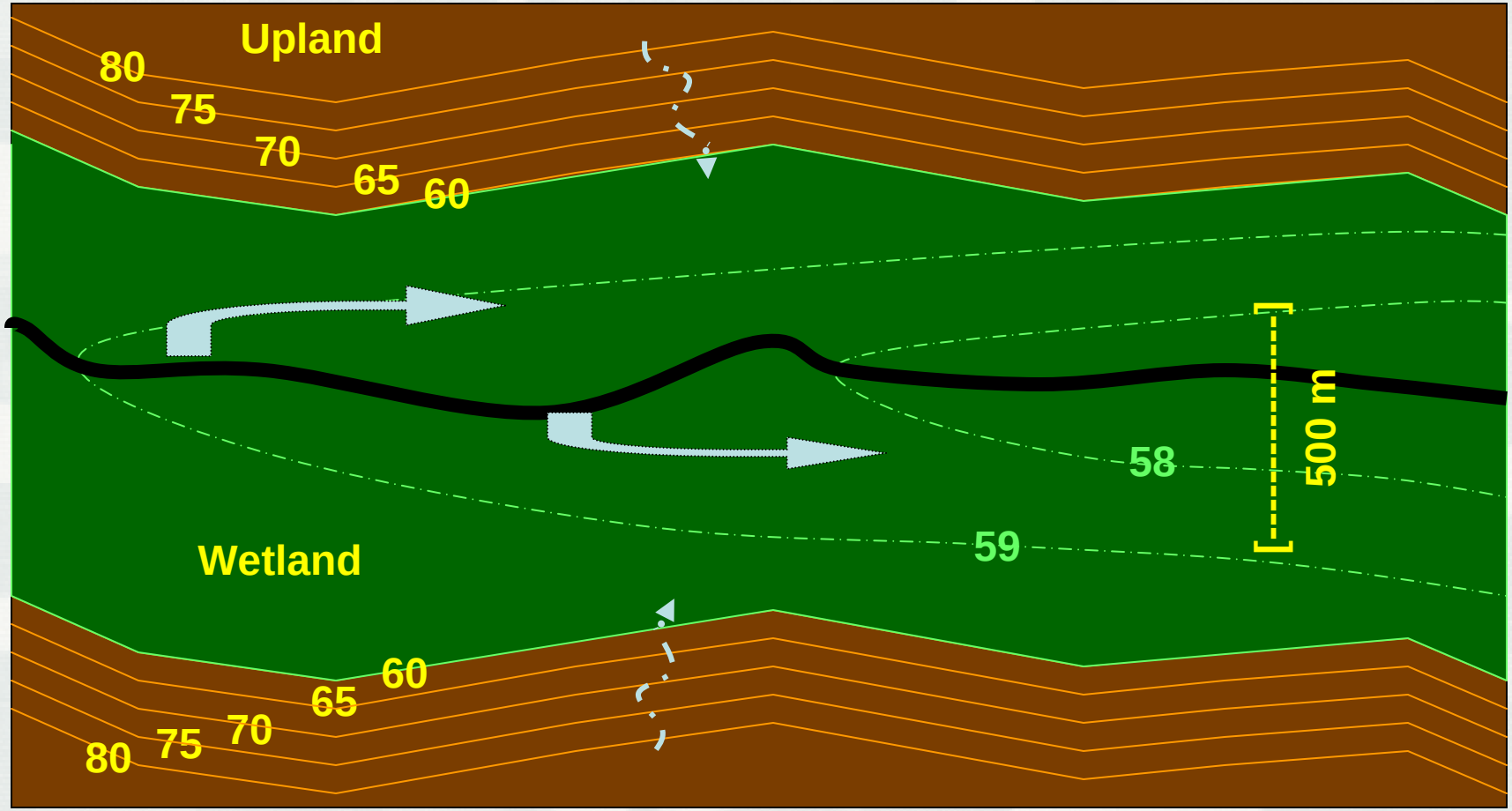
- Developed by Brinson (1993) to aid in development of models for assessing functions
- Wetlands classified based on fundamental characteristics of
  - Landscape (geomorphic) setting
  - Hydrologic source
  - Hydrodynamics

Hydrogeomorphic Classification

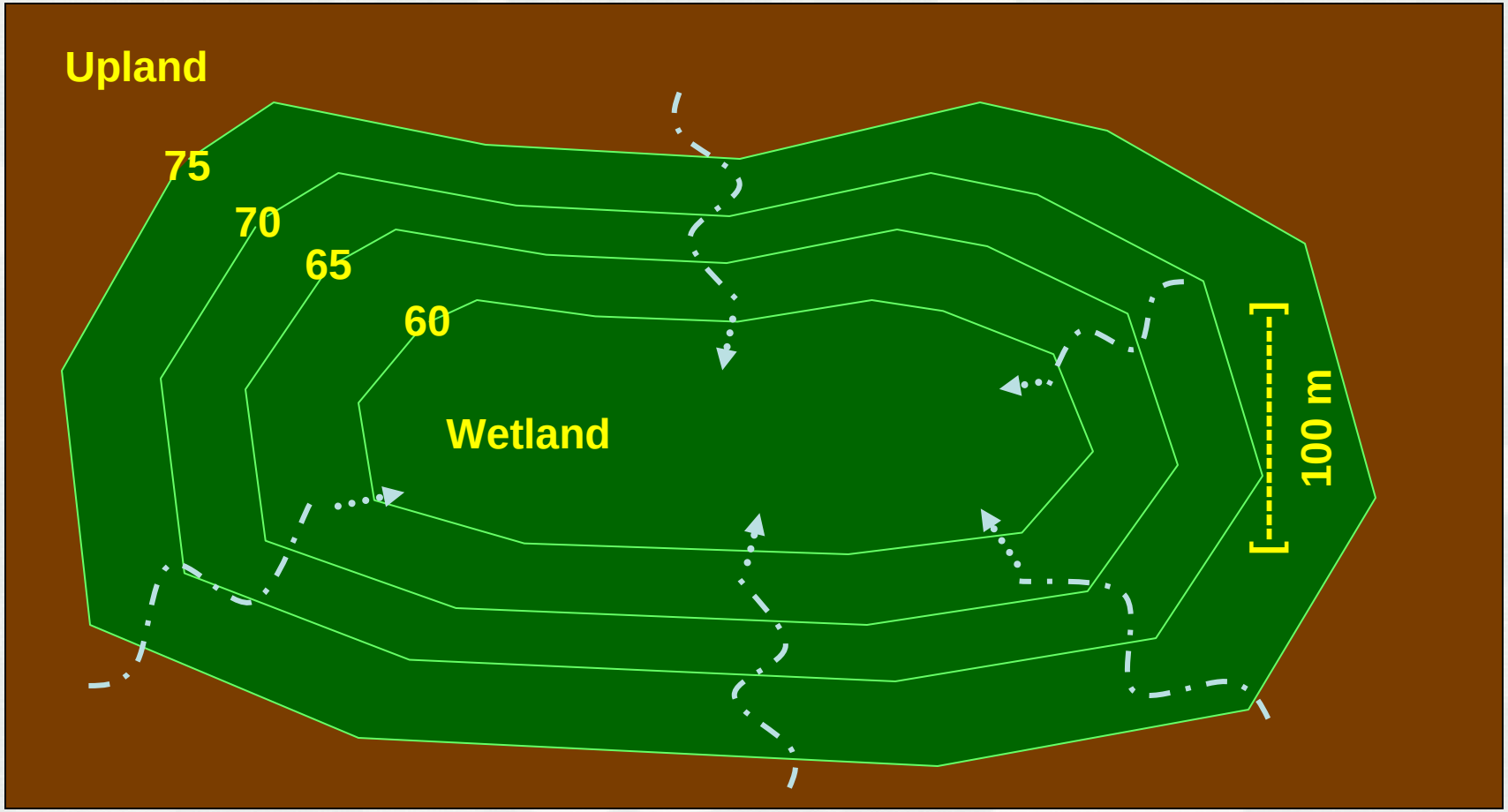
Classification is based on:

- Geomorphic Setting
  - Depression
  - Lacustrine Fringe
  - Tidal Fringe
  - Slope
  - Organic Flats
  - Mineral Flats
  - Riverine
- Primary Water Source
  - Precipitation
  - Groundwater
  - Surface Water
- Hydrodynamics
  - Vertical Fluctuation
  - Unidirectional Flow
  - Bidirectional Flow

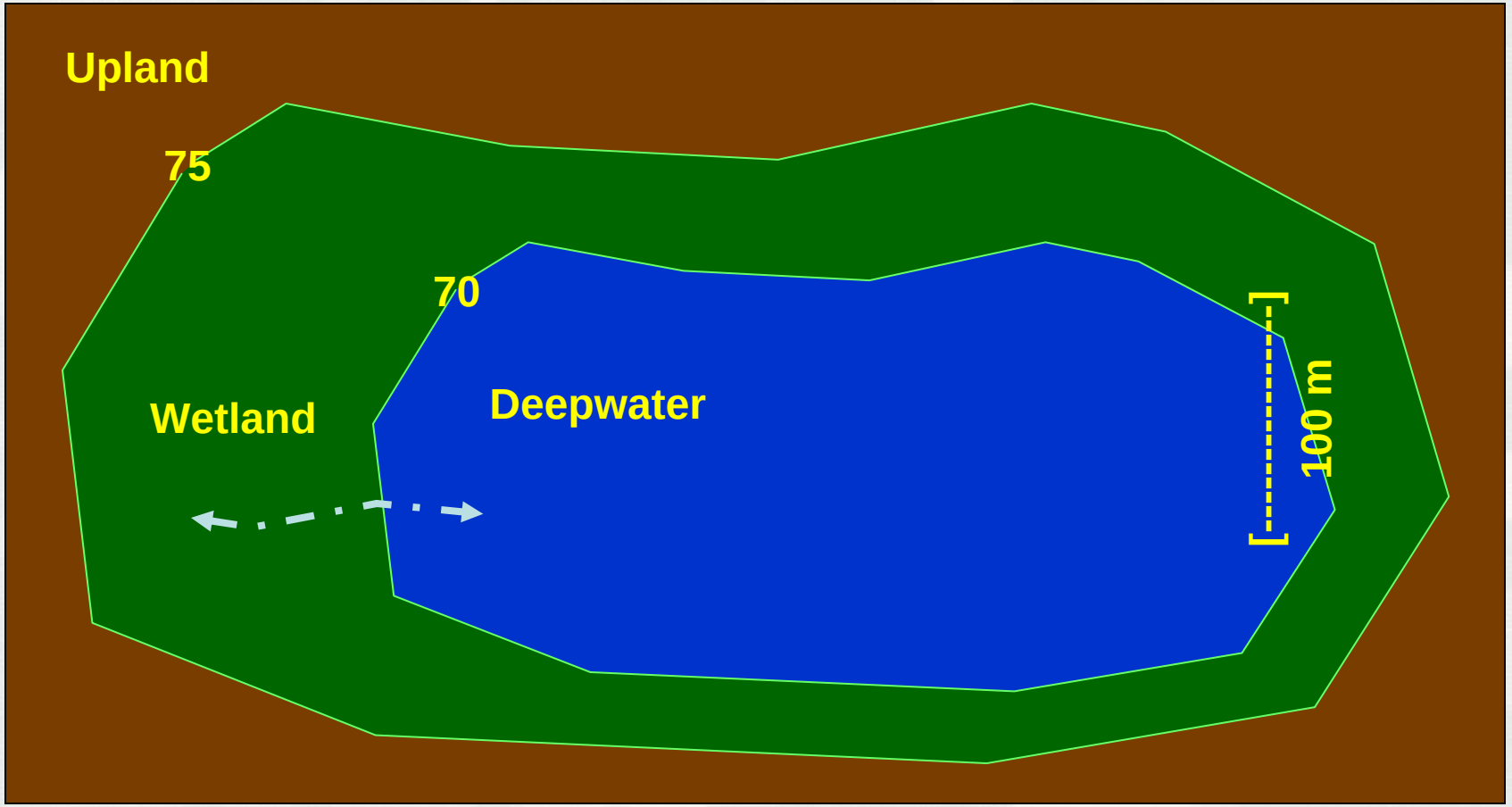
Riverine Geomorphic Setting



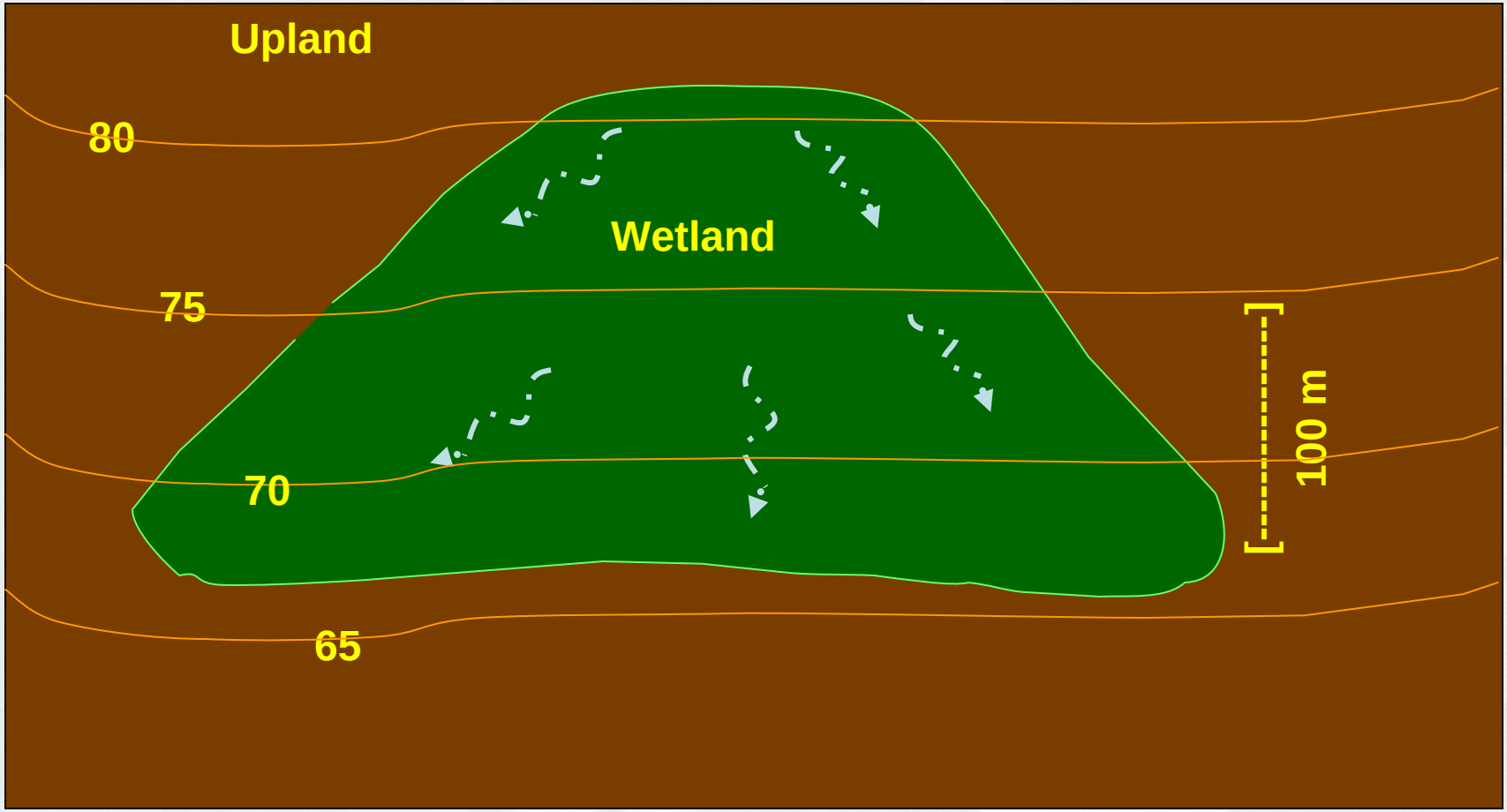
Depression Geomorphic Setting



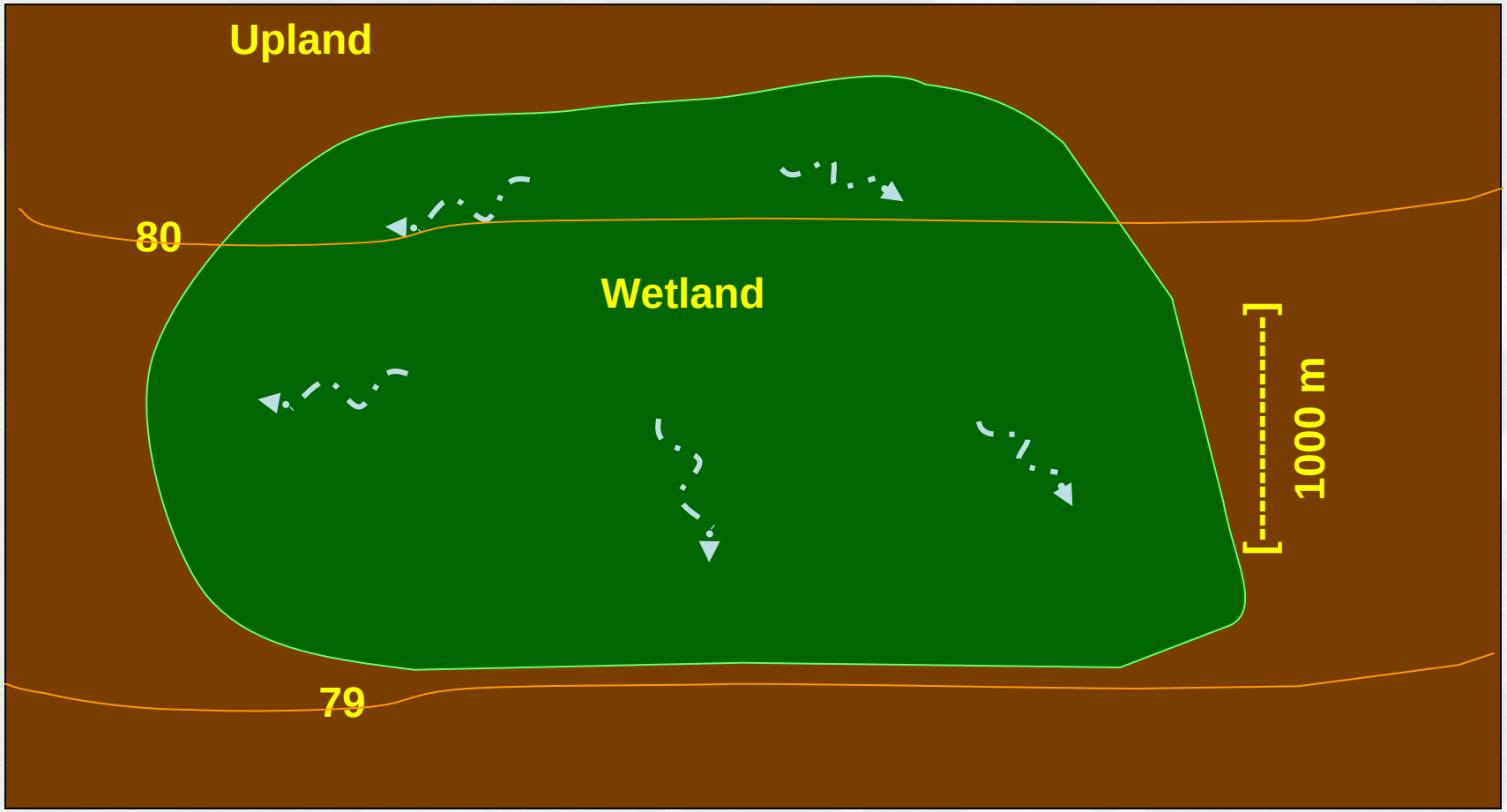
Fringe Geomorphic Setting



Slope Geomorphic Setting



Flat Geomorphic Setting



Regional Subclasses

- Applying the HGM classification to a specific geographic area leads to regional wetland subclasses
- Regional subclasses may be further refined based on fundamental characteristics - for example when adding:
  - Water Source
  - Hydrodynamics
- A single regional subclass, “Atlantic Coastal Plain depression” becomes multiple regional subclasses
  - Atlantic Coastal Plain groundwater flow-through depression
  - Atlantic Coastal Plain precipitation-influenced depression
- Additional regional peculiarities may also be used to refine subclasses. Two examples might be the ranges of significant species or human disturbance history (agriculture, logging, impoundments, etc

Regional Subclasses

- Regional subclasses are the target for development of HGM assessment models
- “There is considerable flexibility in defining wetland subclasses within 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.” (Smith et al.)
- A great deal of variation can be addressed by refining subclasses before any reference wetland data is collected.
- However, the benefits of creating additional subclasses must be great enough to justify the additional work required.

What are Reference Wetlands?

- A group of wetlands that encompasses the range of variability exhibited by a regional wetland subclass
- **Reference Standard** wetlands are the most fully functional wetlands within the regional subclass
- Variability results from:
  - Natural processes and disturbance
  - Anthropogenic alteration

Developing Assessment Models

HGM models are designed to estimate functional capacity of a target wetland relative to reference standard wetlands

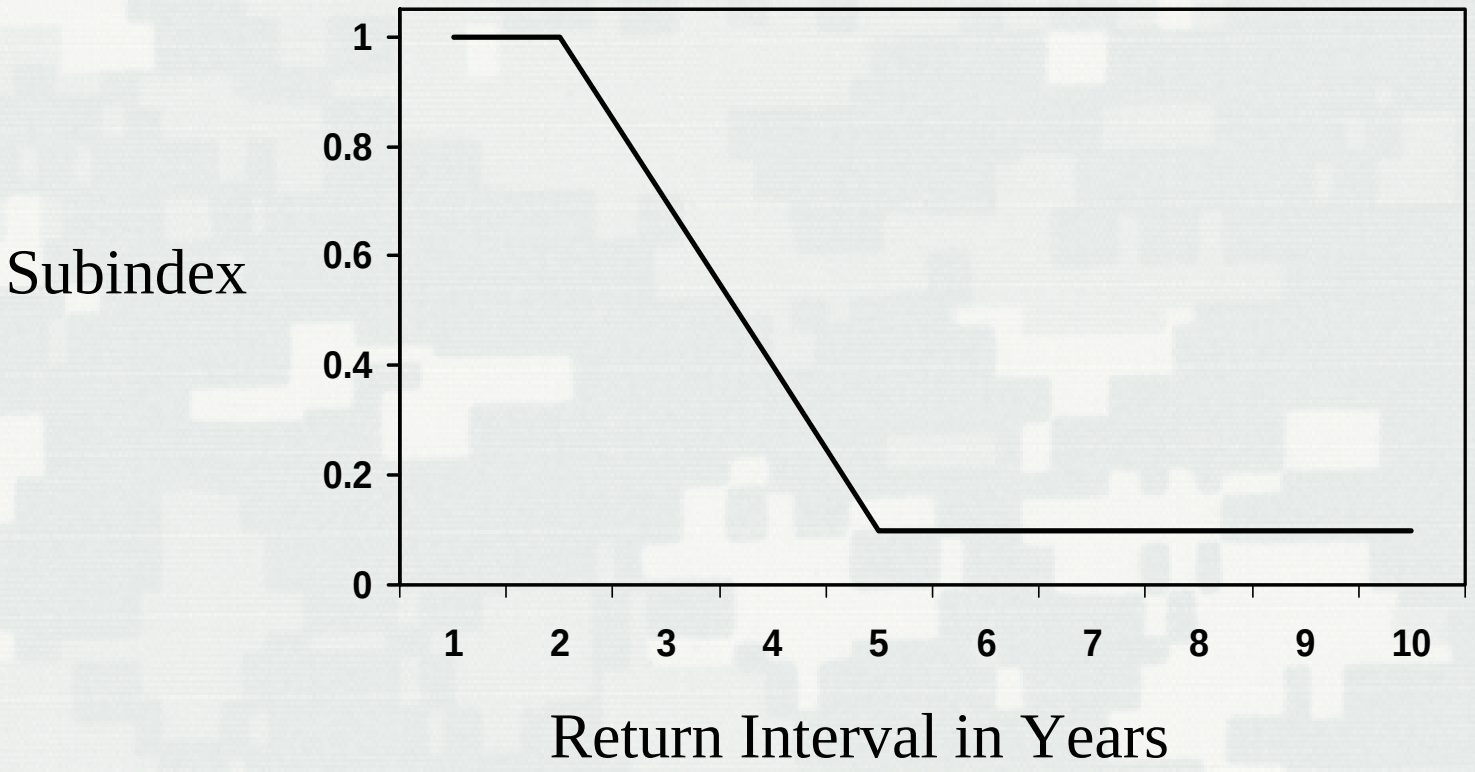
$$FCI = \frac{\text{Functional Capacity of the Target Wetland}}{\text{Functional Capacity of Reference Standard Wetlands}}$$

Developing Assessment Models

- Functional Capacity depends on characteristics of the wetland and the surrounding landscape
- Therefore, HGM models use variables that are measures of site and landscape characteristics
  - Frequency or depth of flooding
  - Soil organic matter content (color)
  - Tree density
  - Amount of coarse woody debris
  - Size of watershed

Model Variables

V_{FREQ} -- Flood Frequency



Assessment Models

- Consist of model variables aggregated in an equation to produce a Functional Capacity Index (FCI)
- For example, the function “Temporary Storage of Surface Water” for a riverine wetland:

$$FCI = \{(V_{FREQ} \times V_{WIDTH})^{1/2} \times (V_{ROUGH} + V_{SLOPE})/2\}^{1/2}$$

Steps in Developing a HGM Model

1. Assemble A-Team
2. A-Team Workshop 1 (1 week)
   a) classify wetland types in area
   b) determine functions to be assessed for each class
   c) determine initial variables used to assess each function
   d) determine relationships among variables
   e) determine reference sites
3. Sample reference wetlands (~ 3 months)
4. Analyze data, scale variables, adjust models as necessary (~ 3 months)
5. A-Team Workshop 2 (1 week)
   a) review adjusted models
6. Write and publish HGM Guidebook (~ 6 months)

Applications of HGM Models for Planning

- Estimate impacts of a proposed project
  - ► Evaluate project alternatives
  - ► Determine mitigation requirements
- Estimate benefits from ecosystem restoration (EBA)
  - ► Evaluate project alternatives
- Monitor restoration efforts

Example 1: Estimate impacts of proposed project

- Yazoo Backwater Pump FRM study
- What are the functional impacts to wetlands from different alternatives?
- HGM Model: Yazoo Basin Riverine Backwater Model

Plan	Acres Impacted by a Change in Duration	Baseline FCU	Post-Project FCU	Change in FCU
Plan 2 (B1)	0	0	0	0
Plan 2A (B1)	0	0	0	0
Plan 2B (B1)	92104	365395	314526	-50869
Plan 2C (B1)	0	0	0	0
Plan 3 (B1)	118486	580515	536525	-43990
Plan 4 (B1)	101629	493627	465496	-28132
Plan 5 (B1)	66945	299869	285680	-14188
Plan 6 (B1)	48066	209762	200461	-9300
Plan 7 (B1)	28408	122389	118440	-3949

Example 2: EBA

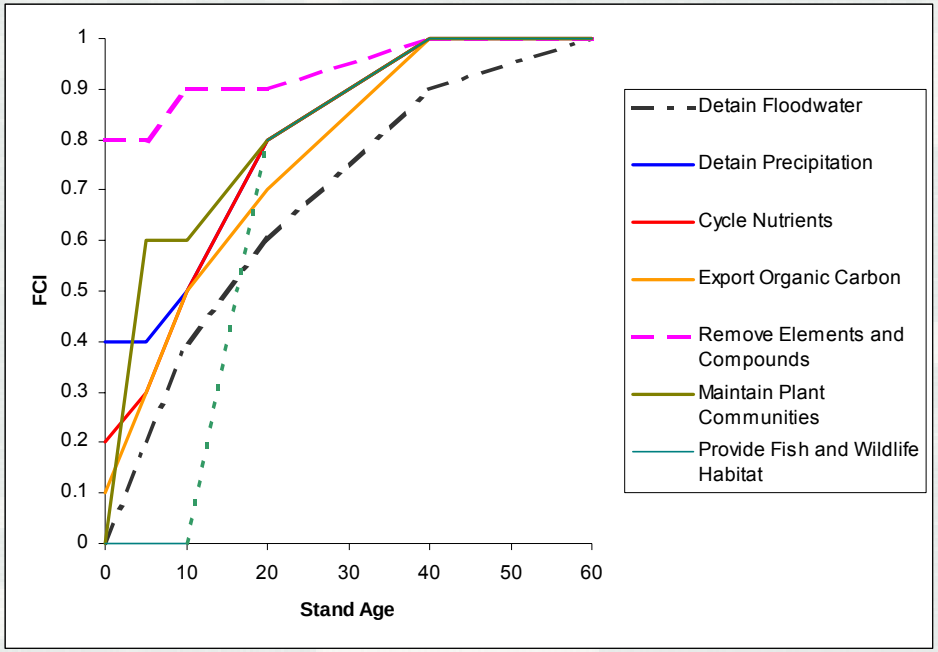
- Mississippi Coastal Improvements Program
- What are functional benefits from wetland restoration?
- HGM Models: MS/AL Gulf Coast Tidal Fringe & Atlantic/Gulf Coastal Plains Wet Pine Flats models

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit[1]
Bayou Cumbest	373	No-action plan	0
Bayou Cumbest	373	plan 1	647
Bayou Cumbest	373	plan 2	637
Bayou Cumbest	373	plan 3	622
Bayou Cumbest	373	plan 4	582
Bayou Cumbest	373	plan 5	572
Bayou Cumbest	373	plan 6	557

Example 3: Monitor Restoration Efforts

- Vicksburg District mitigation sites
- Are mitigation sites functionally recovering?
- HGM Model: Yazoo Basin Riverine Backwater and Flats Model

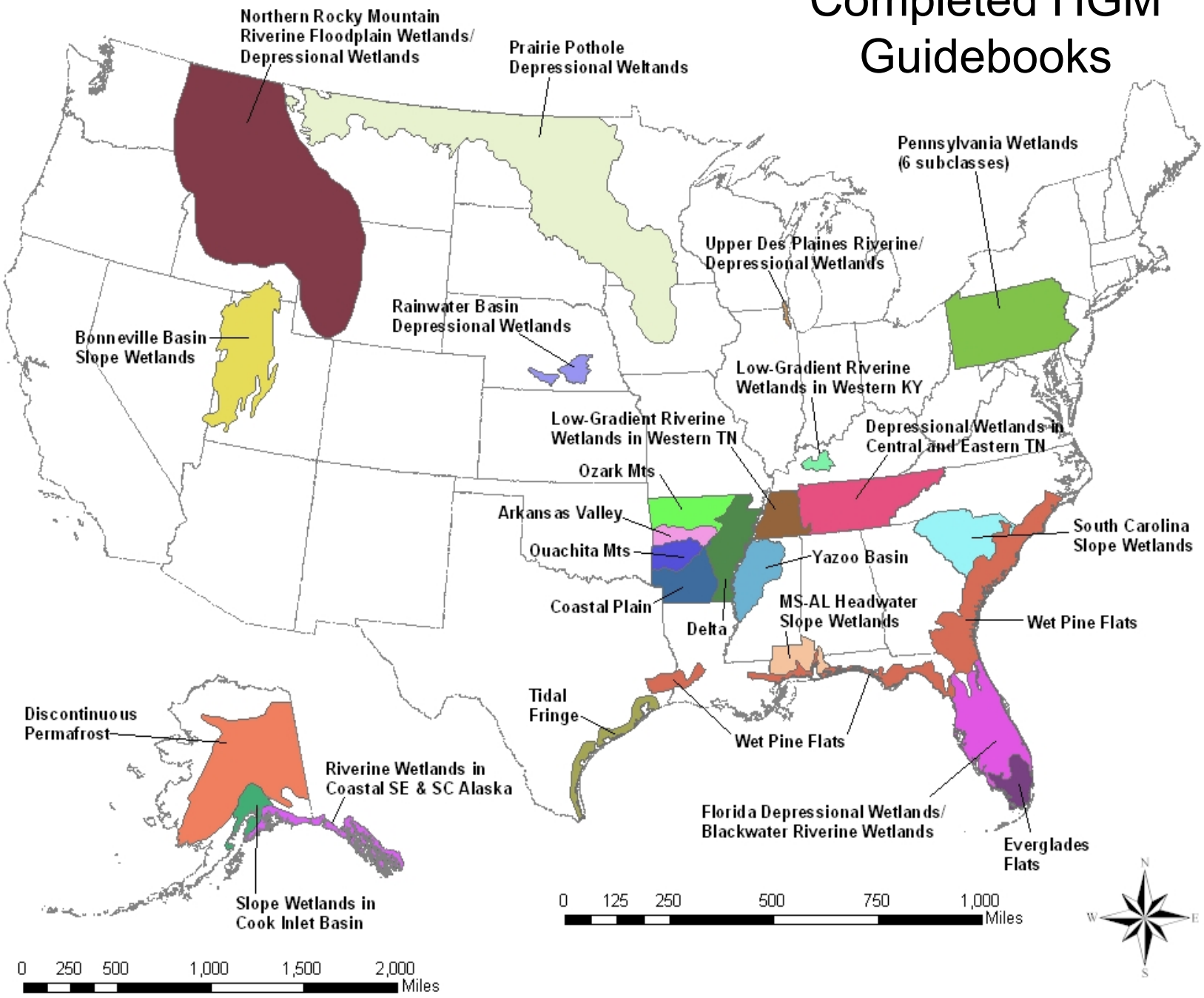
	FCI	
	2007 Actual	*2007 Predicted*
FUNCTION		
Detain Floodwater	0.4	0.4
Detain Precipitation	0.5	0.4
Cycle Nutrients	0.5	0.6
Export Organic Carbon	0.3	0.4
Remove Elements and Compounds	0.7	0.7
Maintain Plant Communities	0.5	0.5
Provide Fish and Wildlife Habitat	0.4	0.4



HGM Status and Future Directions

- HGM has changed with experience
  - Quicker to develop, quicker to apply (fewer variables, fewer functions)
  - Data collection is stream-lined and simpler
  - Development of Subclasses throughout a larger geographic area
    - State
    - Ecoregion
- Expanding HGM approach to other ecosystems besides wetlands

Completed HGM Guidebooks



Current HGM Development Efforts

- SE Riverine
- MN and WI Organic Flats, Riverine
- California Vernal Pools
- Lower MS Valley (several subclasses)
- Southern Rocky Mountains (several subclasses)
- WV High Gradient Riverine (stream assessment)

Questions?

ERDC HGM Guidebooks:

http://el.erdc.usace.army.mil/wetlands/guidebooks.html

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