

# USACE Science Support for Compensatory Mitigation

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US Army Corps of Engineers  
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# Wetlands Regulatory Assistance Program (WRAP)

- ▶ Provide scientific and technical support to USACE Regulatory Program
- ▶ Input received from USACE HQ and District offices
- ▶ Project focus and direct District requested support
- ▶ Interagency participation through technical committees, regional working groups, assessment and project delivery teams



# WRAP Compensatory Mitigation Contributions

- Identifying and delineating wetlands
  - ▶ National Wetland Plant List
  - ▶ Regional Supplements
- Assessing wetland functions
  - ▶ Hydrogeomorphic Approach
- Mitigation banking
  - ▶ Regulatory In-lieu fee and Bank Information Tracking System (RIBITS)
- Review mitigation plans
  - ▶ District requests



# WRAP Projects

## National Wetland Plant List (Bob Lichvar)

[http://wetland\\_plants.usace.army.mil](http://wetland_plants.usace.army.mil)





# National Wetland Plant List

## Scientific Development

- 65 Regional Panel and National Panel members
- 30 professional external botanists from museums and universities
- Web-based system for scientific community and public input
- 12 rounds of voting, including Federal Register Notice
  - ▶ Comments received via Federal Register Notice, submitted to website, written comments received in letter form
- External peer review
- Interagency briefings and acceptance
- Active public use website launched June 1, 2012



# National Wetland Plant List

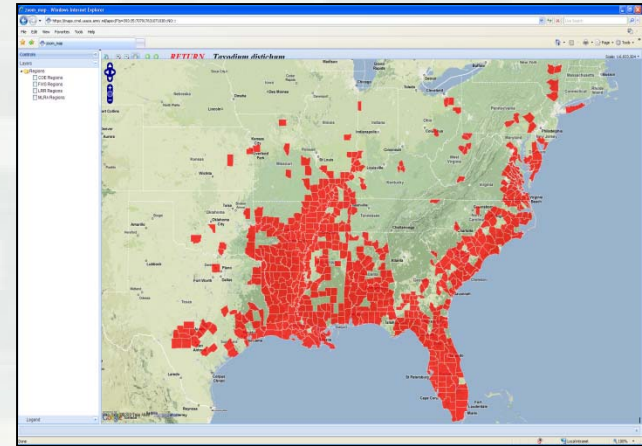
## Results

- Follows ecological boundaries identified in Regional Supplements
- Contains 8200 plants and their wetland indicator status territories
- Indicator status represents the probability of occurrence in a wetland or upland area
  - ▶ OBL (almost always occurs), FACW, FAC (usually occurs), FACU, UPL (rarely occurs)
- + and – dropped from indicator status ratings
- Estimated 12% overall change from 1988-2012
  - ▶ 4% wetter, 4% drier and 4% were former FAC- which went almost 50% wetter and 50% drier
- Maintenance and annual reviews and updates will be conducted by interagency panels using the same web-based system



# National Wetland Plant List

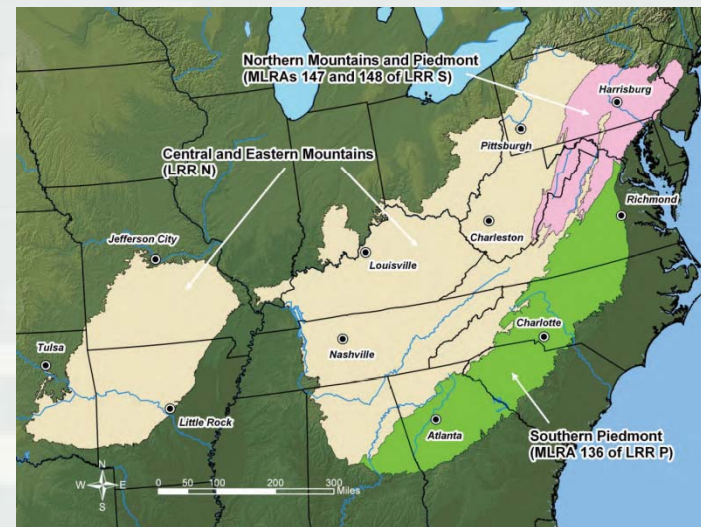
- Query capabilities
  - ▶ Nomenclature
    - Family, genus, scientific/common name
  - ▶ Attribute
    - Plant group, habitat, morphology
  - ▶ Geographic distribution
    - County level
- Over 90,000 pictures



# WRAP Projects

## Regional Supplements to the Corps of Engineers Wetland Delineation Manual (Jacob Berkowitz)

[http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/reg\\_supp.aspx](http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/reg_supp.aspx)





# Regional Supplements

## Scientific Development

- National Academy of Sciences recommendation to increase regional sensitivity of wetland delineation methods
- Regional Working Groups composed of Federal, State and local wetland experts
- Reviewed by interagency National Advisory Team for Wetland Delineation
- Independent Peer Review
- Field testing
- Public comment notice
- One year implementation period
- Version 2.0



# Regional Supplements

## Scientific Input

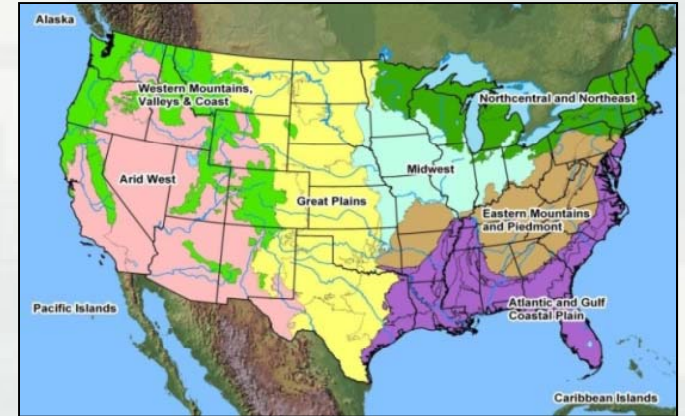
- National Advisory Team for Wetland Delineation
  - ▶ Jacob Berkowitz
    - Bob Lichvar
    - Chris Noble
- National Technical Committee for Wetland Vegetation
  - ▶ Bob Lichvar
- National Technical Committee for Hydric Soils
  - ▶ Chris Noble



# Regional Supplements

## Results

- 10 ecological regions based on USDA Land Resource Regions and Major Land Resource Areas
- All 10 Version 2.0 published and in use
- Same formatting and organizational structure maintains consistency
- Contain indicators of hydrophytic vegetation, hydric soils and wetland hydrology
- Chapter dedicated to difficult wetland situations within region
  - ▶ Wetlands on soils derived from coal
  - ▶ Black parent materials
- Updated to reflect current state of wetland science



# WRAP Projects

## Hydrogeomorphic Approach to Assessing Wetland Functions; HGM (Chris Noble)

<http://el.erdc.usace.army.mil/wetlands/hgmhp.html>



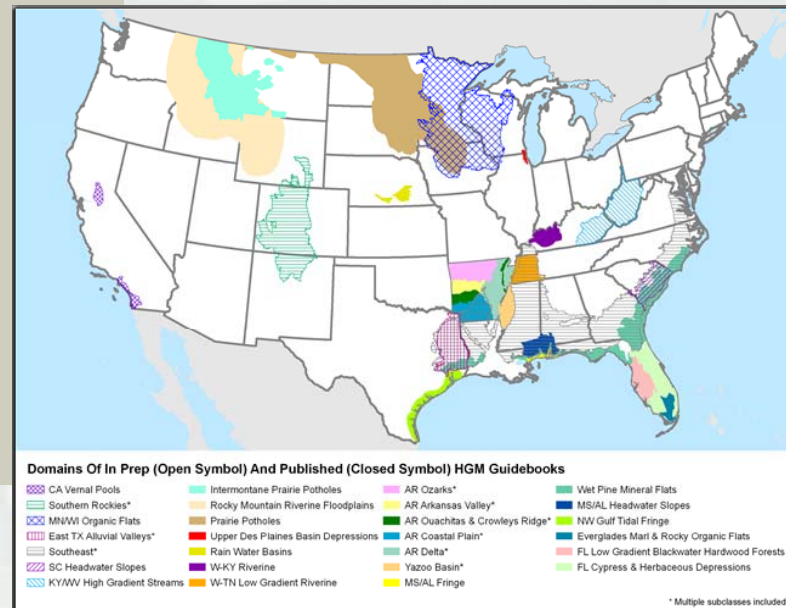
Guidebooks Wetland Classifications Procedural Documents Related Literature Data

[US Army Corps of Engineers](#) | [Engineer Research & Development Center](#) | [Environmental Laboratory](#) | [Search EL](#)

Point of Contact: [Chris V. Noble](#), Project Manager

Acknowledgement: The HGM Approach is a multi-agency effort involving the U.S. Army Corps of Engineers, the Environmental Protection Agency, the Federal Highway Administration, the Natural Resources Conservation Service, and the U.S. Fish and Wildlife Service.

- [Overview of the HGM Approach](#)
- [Background](#)





# HGM Approach

## Scientific Development

- National Interagency Implementation Team developed National Action Plan to Implement the Hydrogeomorphic Approach
  - ▶ Federal register notice 1997
  - ▶ Outlined strategy to promote development of HGM Regional Guidebooks
- 2008 Compensatory Mitigation Rule
  - ▶ Replace lost aquatic resource functions and area
- Regional Assessment Team
  - ▶ Federal, State or local agencies, non-government organizations, academia
  - ▶ Identify and prioritize regional subclasses
  - ▶ Determine reference conditions
  - ▶ Select functions, variables, metrics and develop assessment models
- Independent Peer Review



# HGM Approach

## Results

- Based on three criteria that fundamentally influence wetland function
  - ▶ Geomorphic setting – position in landscape
  - ▶ Water source – precipitation, overbank floodwater
  - ▶ Hydrodynamics – direction water moves
- Seven hydrogeomorphic wetland classes
  - ▶ Depression
  - ▶ Tidal fringe
  - ▶ Lacustrine fringe
  - ▶ Slope
  - ▶ Mineral flats
  - ▶ Organic flats
  - ▶ Riverine
- Reference wetlands establish range and variability of regional wetland conditions; data for calibrating model variables and assessment models



# HGM Approach

Potential regional wetland subclasses in relation to geomorphic setting, dominant water source and hydrodynamics

Classification Criteria			Potential Regional Wetland Subclasses	
Geomorphic Setting	Dominant Water Source	Dominant Hydrodynamics	Eastern USA	Western USA/Alaska
Depression	Groundwater or interflow	Vertical	Prairie potholes, marshes, Carolina bays	California vernal pools
Fringe (tidal)	Ocean	Bidirectional, horizontal	Chesapeake Bay and Gulf of Mexico tidal marshes	San Francisco Bay marshes
Fringe (lacustrine)	Lake	Bidirectional, horizontal	Great Lakes marshes	Flathead Lake marshes
Slope	Groundwater	Unidirectional, horizontal	Headwater wetlands	Avalanche chutes
Flat (mineral soil)	Precipitation	Vertical	Wet pine flatwoods	Large playas
Flat (organic soil)	Precipitation	Vertical	Peat bogs; portions of Everglades	Peatlands over permafrost
Riverine	Overbank flow from channels	Unidirectional, horizontal	Bottomland hardwood forests	Riparian wetlands
Adapted from <a href="#">Smith et al. (1995)</a> , and <a href="#">Rheinhardt et al. 1997</a> .				



# HGM Approach

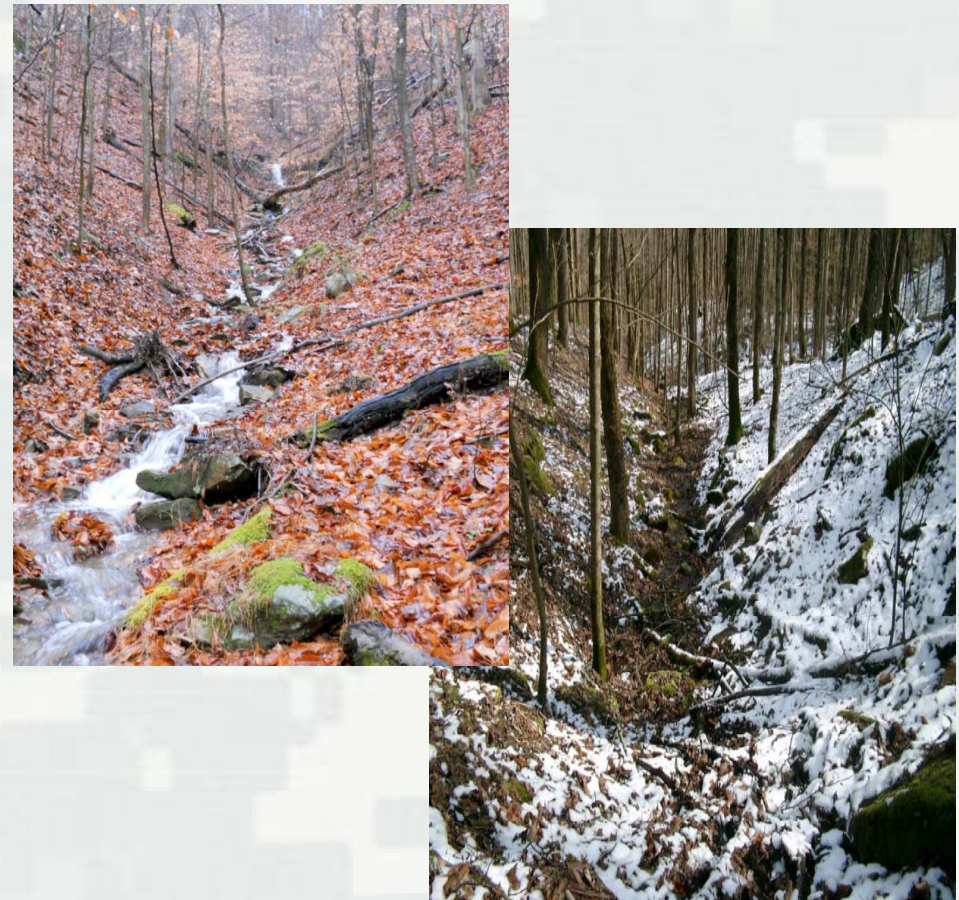
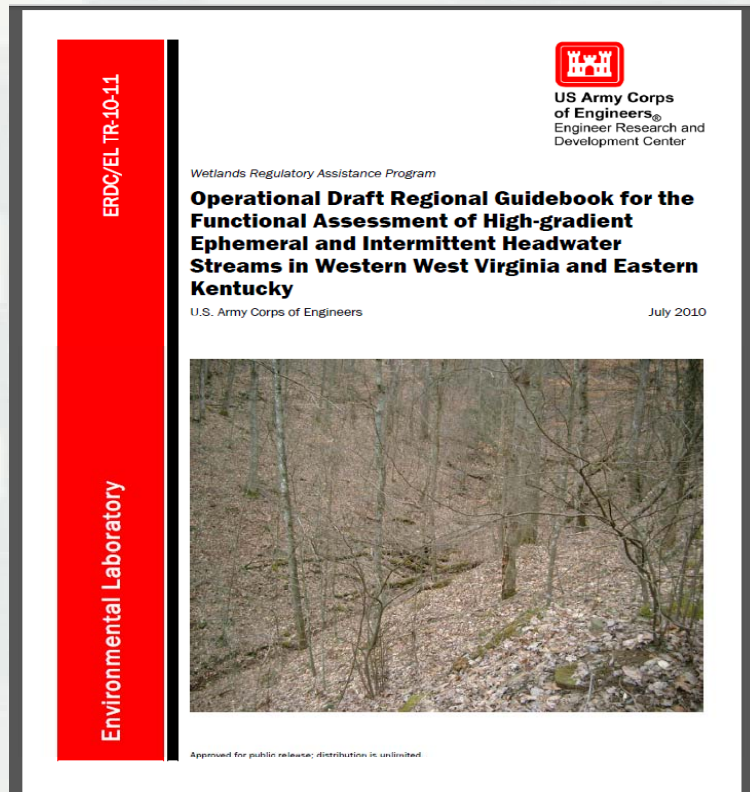
## Results

- Three primary functions
  - ▶ Habitat – amphibian abundance and richness
  - ▶ Biogeochemistry – nutrient and material cycling
  - ▶ Hydrology – water storage, sediment transport
- Assessment models are mathematical equations that represent how wetlands perform specific functions; derive a functional capacity index
- Functional capacity index (FCI) is an estimate of the capacity of a wetland to perform a function relative to other wetlands in same regional subclass; value 0 to 1
- FCI use
  - ▶ Compare functional capacity of pre- and post-project conditions
  - ▶ Compare several wetlands as part of an alternatives analysis
  - ▶ Document mitigation requirements
  - ▶ Determine mitigation success
  - ▶ Determine effects of wetland management techniques



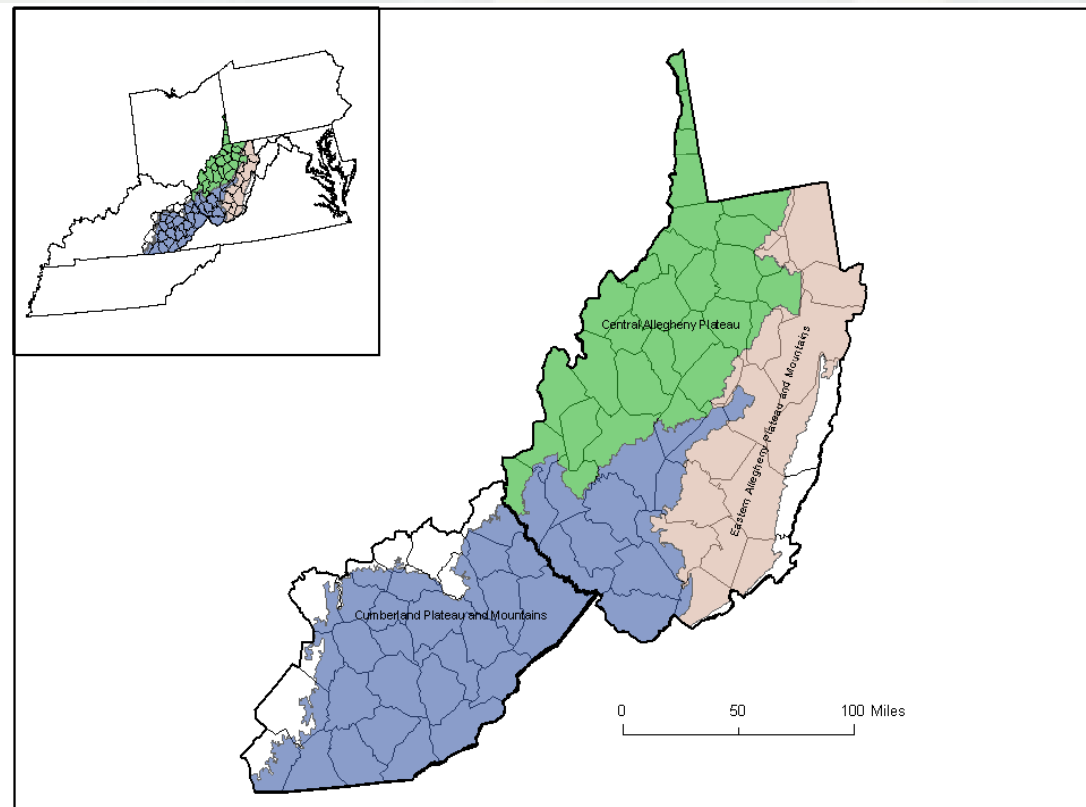


# Functional Assessment of High-gradient Ephemeral and Intermittent Headwater Streams in Western West Virginia and Eastern Kentucky



# Functional Assessment of High-gradient Ephemeral and Intermittent Headwater Streams in Western West Virginia and Eastern Kentucky

Map of reference domain



# Functional Assessment of High-gradient Ephemeral and Intermittent Headwater Streams in Western West Virginia and Eastern Kentucky

- Functions assessed
  - ▶ Hydrology
  - ▶ Biogeochemical cycling
  - ▶ Habitat
- Variables used to assess function
  - ▶ Channel Canopy Cover
  - ▶ Channel Substrate Size and Embeddedness
  - ▶ Potential Channel Bank Erosion
  - ▶ Large Woody Debris
  - ▶ Riparian/Buffer Zone Tree Diameter
  - ▶ Riparian/Buffer Zone Snag Density
  - ▶ Riparian/Buffer Zone Sapling/Shrub Density
  - ▶ Riparian/Buffer Zone Species Richness
  - ▶ Riparian/Buffer Zone Soil Detritus
  - ▶ Riparian/Buffer Zone Herbaceous Cover
  - ▶ Watershed Land-use



# Functional Assessment of High-gradient Ephemeral and Intermittent Headwater Streams in Western West Virginia and Eastern Kentucky

## ■ Channel Canopy Cover

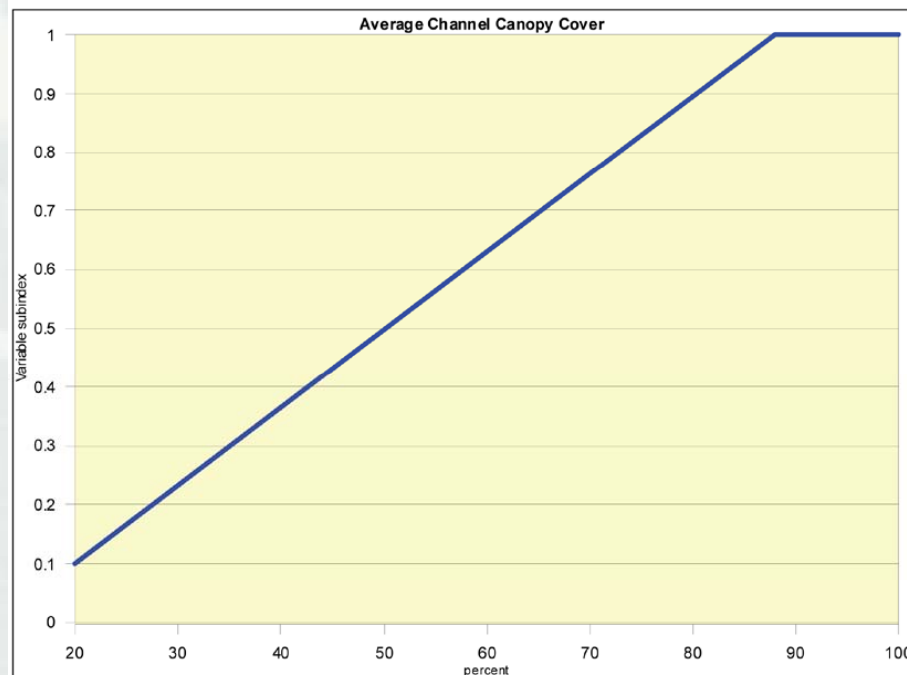
- ▶ Average percent cover of canopy over the stream channel
- ▶ Determined using a visual estimate (comparison charts)
- ▶ Affects temperature, nutrient cycling, and habitat of riparian and stream ecosystems
  - Reduced coverage can accelerate desiccation and lead to mortality in amphibians
  - Increase surface temperatures increases detrital decomposition altering habitat and affects nutrient cycling





# Functional Assessment of High-gradient Ephemeral and Intermittent Headwater Streams in Western West Virginia and Eastern Kentucky

## ■ Channel Canopy Cover



Relationship between average percent channel canopy cover and functional capacity;  
Reference standard values  $\geq 88$  percent



# Functional Assessment of High-gradient Ephemeral and Intermittent Headwater Streams in Western West Virginia and Eastern Kentucky

High-Gradient Headwater Streams in eastern Kentucky and western West Virginia  
Field Data Sheet and Calculator

Team: \_\_\_\_\_ Latitude/UTM Northing: \_\_\_\_\_  
Project Name: \_\_\_\_\_ Longitude/UTM Easting: \_\_\_\_\_  
Location: \_\_\_\_\_ Sampling Date: \_\_\_\_\_  
SAR Number: \_\_\_\_\_ Reach Length (ft): 100 Stream Type: Ephemeral/Intermittent (circle one)

Top Strata: Tree/Sapling Strata (determined from percent calculated in  $V_{CANOPY}$ )  
Site and Timing: Project/Mitigation Site (circle one) Before/After Project (Circle One)

**Sample Variables 1-4 in stream channel**

1  $V_{CANOPY}$  Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.) 49.0 % 0.48

List the percent cover measurements at each point below:

20	30	85	45	90	30	35	20	85	50
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2  $V_{EMBED}$  Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

--	--	--	--	--	--	--	--	--	--

3  $V_{SUBSTRATE}$  Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in  $V_{EMBED}$ .

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in. asphalt or

FCI Calculator SAR Data Entry

HighGradientHeadwaterStreamAssess.xls [Read Only] [Compatibility Mode] Microsoft Excel

To ensure accurate calculations, the **UPPERMOST STRATUM** of the plant community is determined based on the calculated value for  $V_{CANOPY}$  (220% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-gradient Ephemeral and Intermittent Headwater Streams in Western West Virginia and Eastern Kentucky (Environmental Laboratory U.S. Army Corps of Engineers 2010).

Project Name: \_\_\_\_\_  
Location: \_\_\_\_\_  
Sampling Date: Enter dates on Data Form Choose Site on Data Form Choose Timing of Data Form

Subclass for this SAR: Select Stream Type on Data Form

Uppermost stratum present at this SAR: Tree/Sapling Strata SAR number: \_\_\_\_\_

**Functional Results Summary:** Please Fill Out Site and Timing Information on Data Form

Function	Functional Capacity Index
Hydrology	
Biogeochemical Cycling	
Habitat	

**Variable Measure and Subindex Summary:**

Variable	Name	Average Measure	Subindex
$V_{CANOPY}$	Percent canopy over channel	32.50	0.27
$V_{EMBED}$	Average embeddedness of channel		
$V_{SUBSTRATE}$	Median stream channel substrate particle size		
$V_{EROD}$	Total percent of eroded stream channel bank		
$V_{LWD}$	Number of down woody stems per 100 feet of stream		
$V_{DBH}$	Average dbh of trees	0.00	0.00

FCI Calculator SAR Data Entry



# Functional Assessment of High-gradient Ephemeral and Intermittent Headwater Streams in Western West Virginia and Eastern Kentucky

## ■ Validation Study

- ▶ Testing rapid assessment outcome (FCI) reliability using comparisons with independent measures of function determined by interagency project delivery team
- ▶ Sensitivity analysis ensure model outputs behave as intended; identifies key variables
  - Hydrology
  - Rainfall
  - Ground water level in channel
  - Temperature (water, air, soil, cover board, leaf litter)
  - Sediment
  - Water chemistry
  - Leaf fall and decomposition
  - Macroinvertebrates and amphibians



# Validation Study

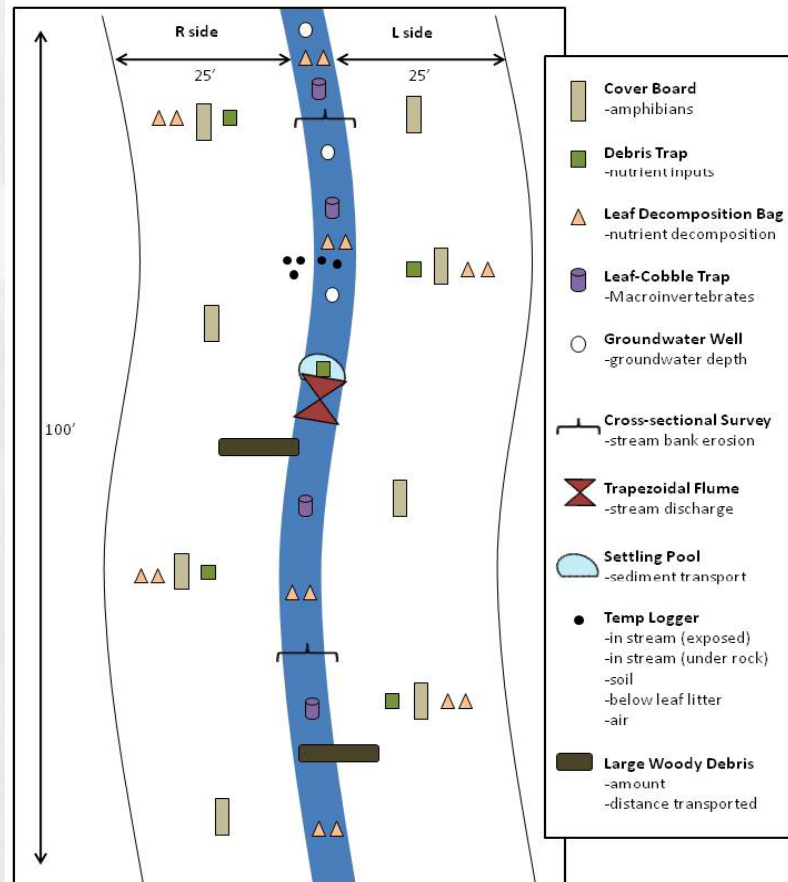


Diagram of the location and number of sampling stations at reference stream sites



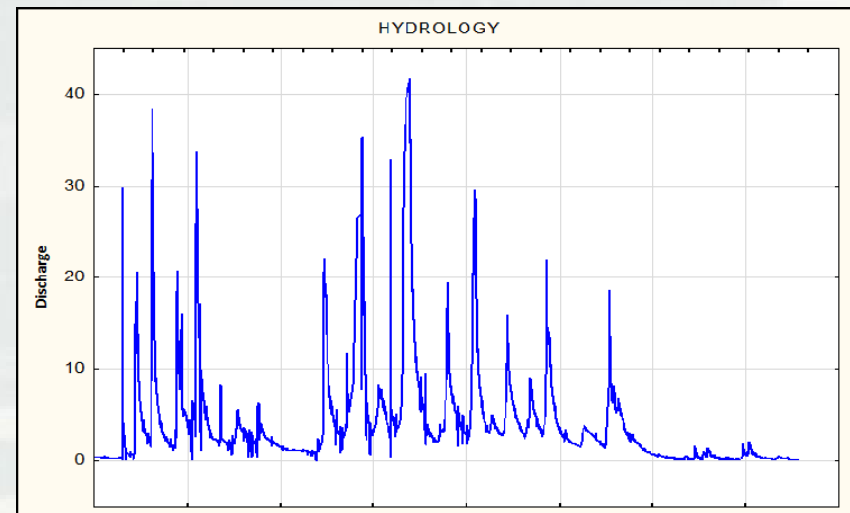
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# Validation Study

## ■ Hydrology

- ▶ Trapezoidal flume outfitted with an automated pressure transducer
- ▶ Water level recorded every 15 minutes
- ▶ Also recorded conductivity and temperature



# Validation Study

## ■ Macroinvertebrate Community Characteristics

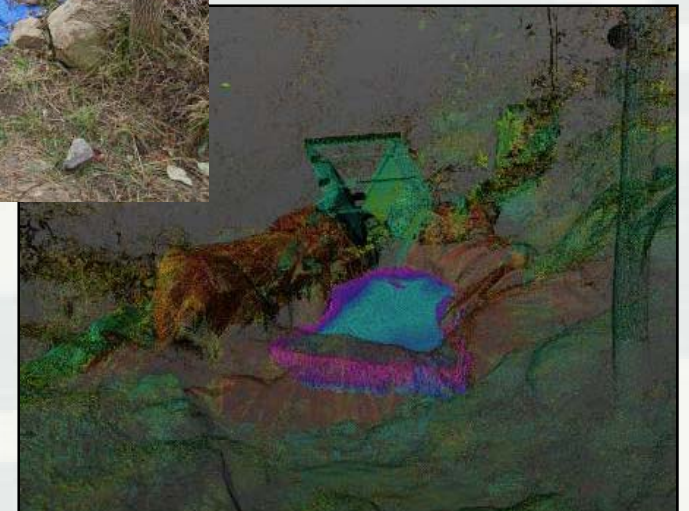
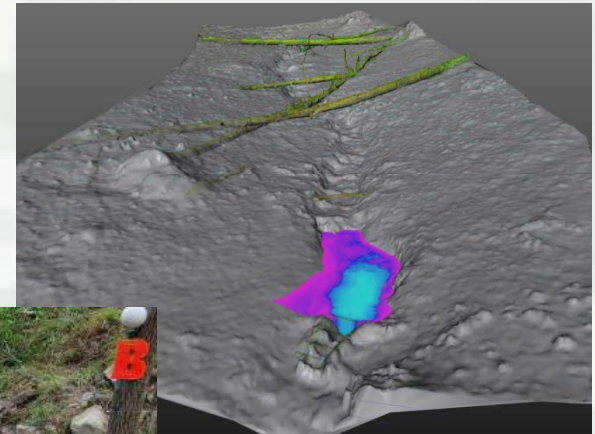
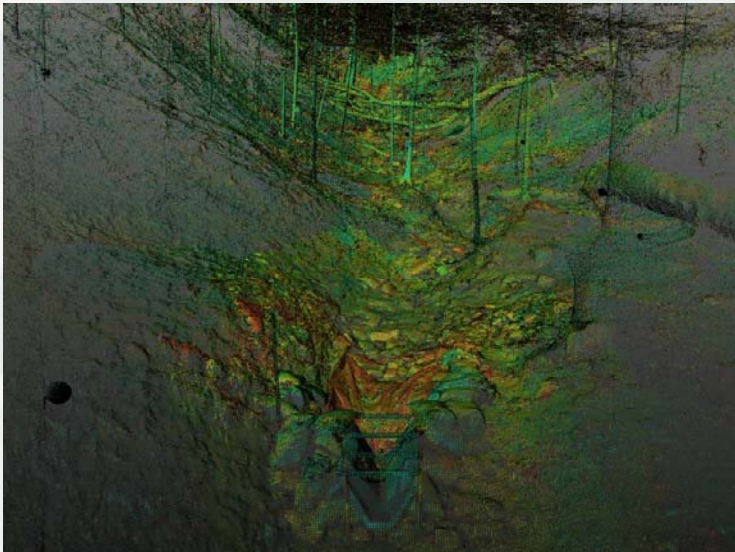
- ▶ Taxa richness and diversity
- ▶ Individual abundance
- ▶ Proportion of community composed of EPT taxa
- ▶ All habitat inventory (submerged roots, sticks/wood, leaf packs, riffles) and basket samplers
- ▶ Assistance from EPA Freshwater Biology Lab in Wheeling, WV



# Validation Study

## ■ LiDAR

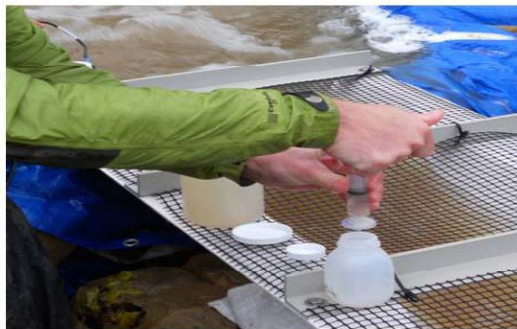
- ▶ Digital terrain models
- ▶ Contour lines
- ▶ Cross sections
- ▶ Large woody debris
- ▶ Stream reach slope
- ▶ Modeling input





# Future HGM efforts

- Draft Validation report currently in review
- Perennial Streams
- Geographical Expansion

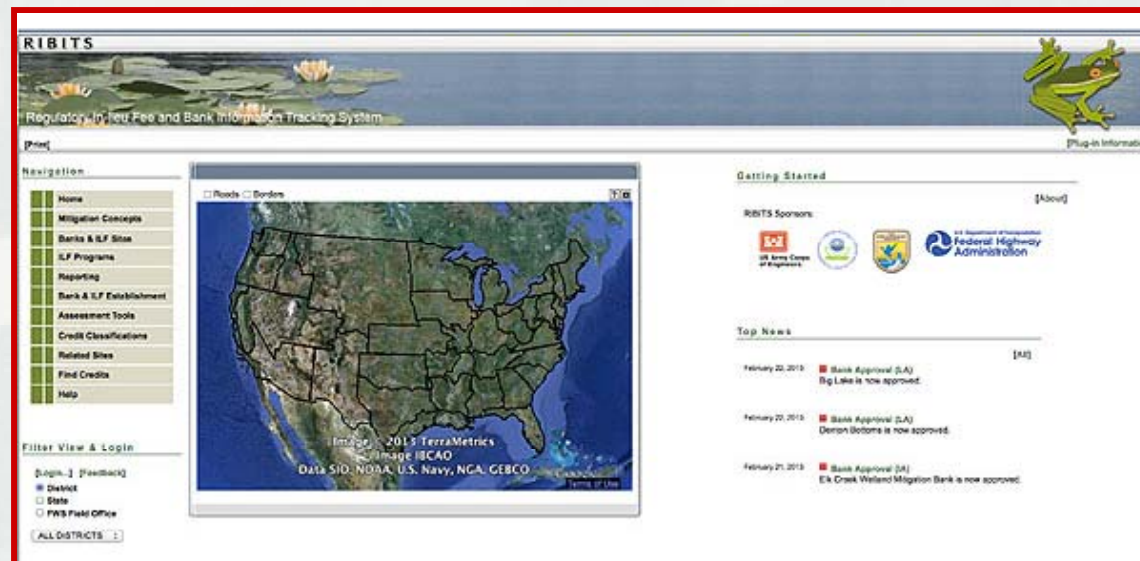


# WRAP Projects

## RIBITS

Regulatory In-lieu fee and Bank Information Tracking System

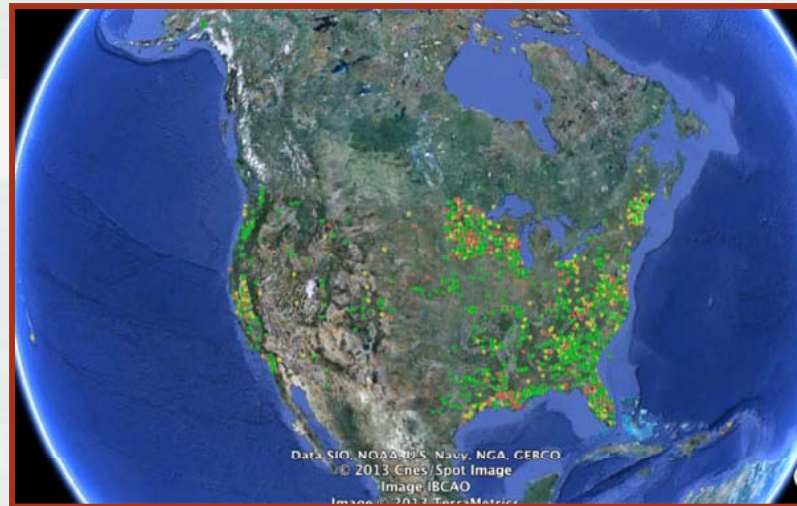
<http://ribits.usace.army.mil>





# RIBITS

- USACE Institute for Water Resources (IWR) was tasked with national implementation of the system
  - ▶ Types and numbers of mitigation and conservation bank and in-lieu fee program sites
  - ▶ Mitigation credit availability
  - ▶ National and local policy info
- Nearly 1100 operational banks in RIBITS with more than 41,000 ledger transactions & more than 14,000 bank documents



# WRAP Requests

- Delineation Technical Reviews
  - ▶ Irrigated agricultural lands
- Review Assessment Methodologies
  - ▶ Agency and District developed
- Hydrology Assessment Reviews
  - ▶ Hydrologic connectivity
  - ▶ Indicator verification
- Technical review of science to support CWA guidance
- Mitigation plan reviews
  - ▶ Large scale projects
  - ▶ Hydrologic assessments – groundwater flow model and ditch flow analysis
  - ▶ Channel patterns and stream structure placement



# Questions?

