

# Modeling and Ranking Wetland Functions, Condition, and Land Acquisition Priority

- Building the Model
- Examples of Metrics
- Applications

Presented by Elizabeth Byers, Senior Wetland Scientist  
WVDEP Water Quality Standards & Assessment Section



# Building the Model

Goal: robust, repeatable, rapid assessment  
for regulation, status & trends, restoration, and conservation





## Building the Model



Ecological  
integrity & wildlife  
habitat: 50%



Water quality:  
sediment, nutrients,  
pollutants: 25%

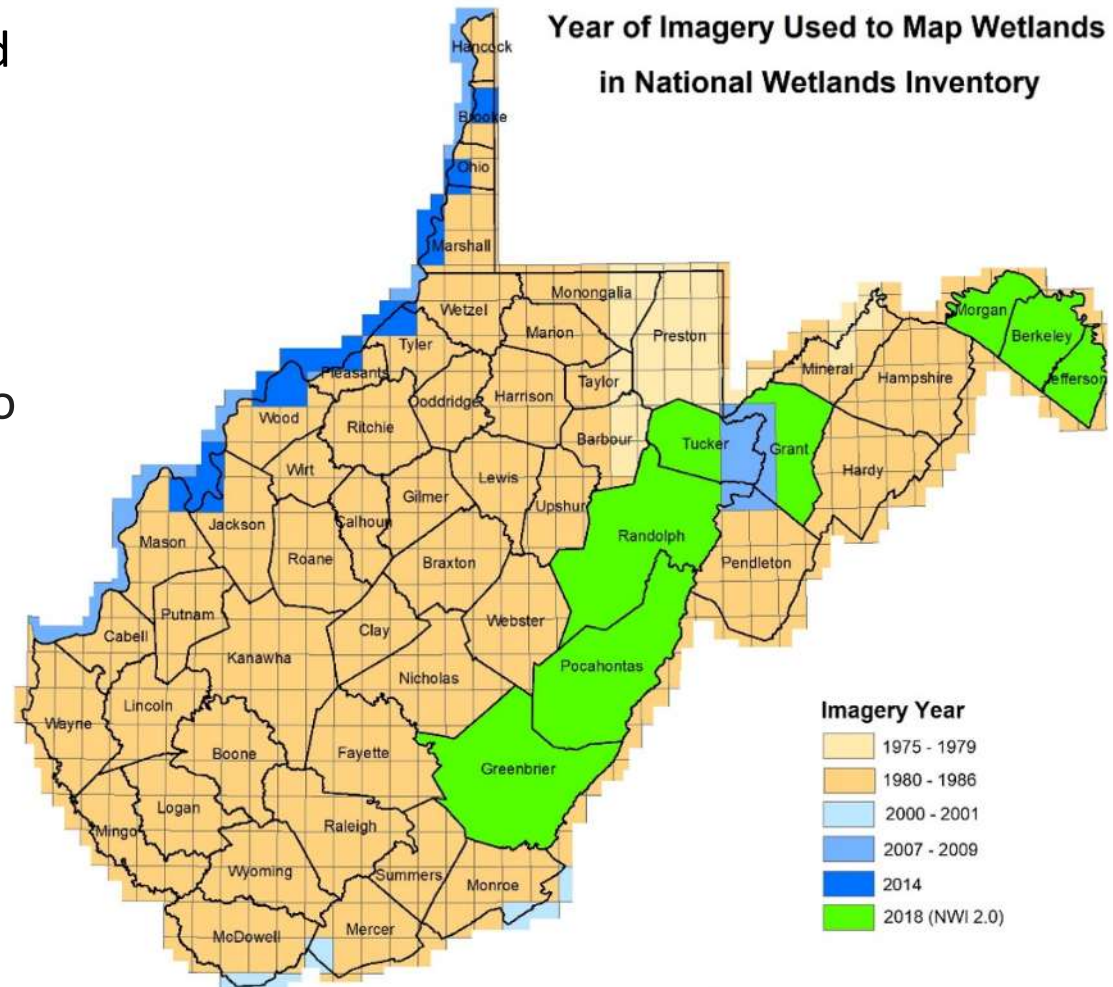


Flood  
attenuation,  
baseflow: 25%

**3 metric groupings**

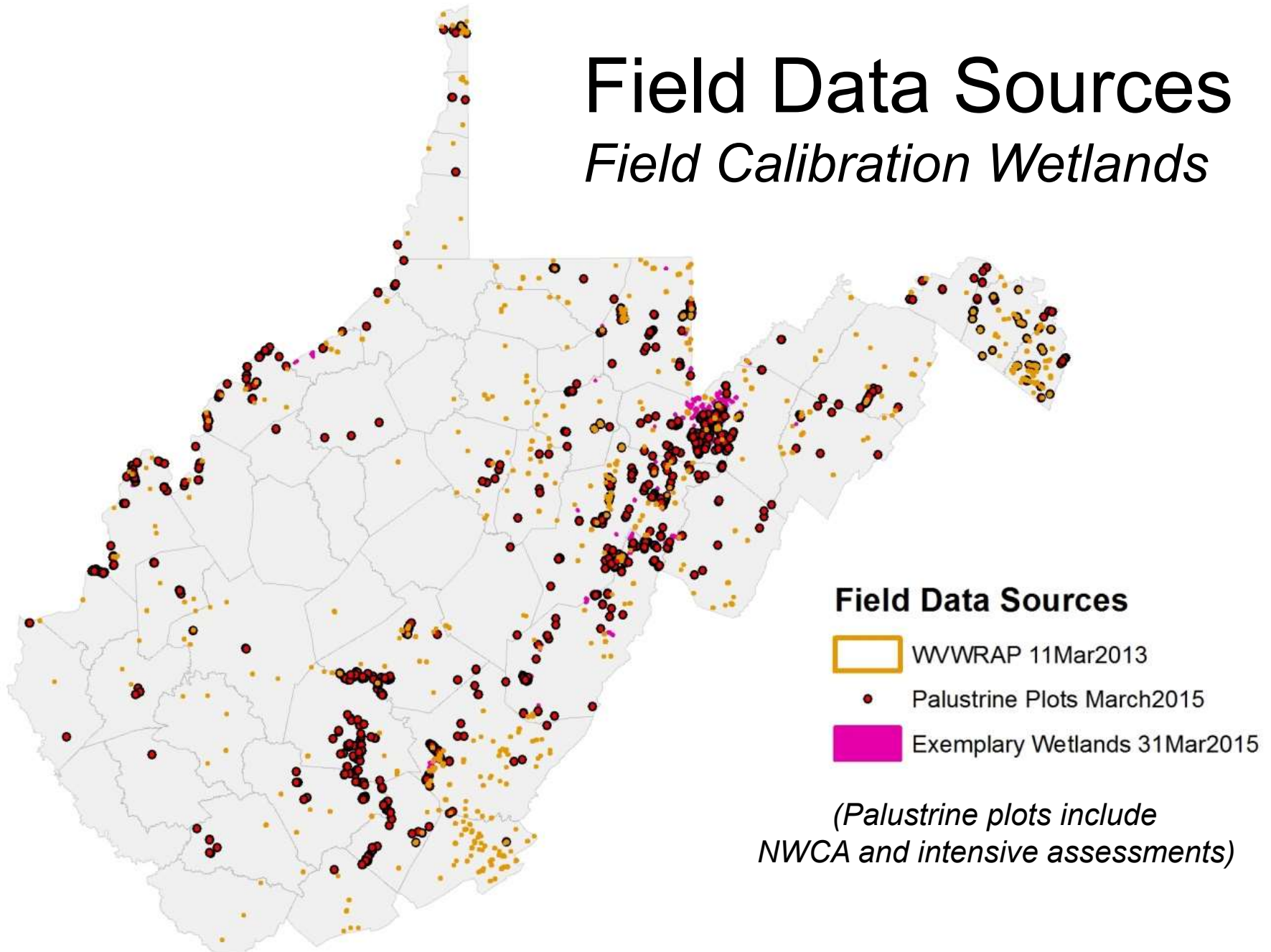
## Essential Data: Wetland Maps

- Most of West Virginia's wetland mapping is more than 40 years old.
- Created calibration set of 2000 field-sampled wetlands distributed across ecoregions to develop metrics
- With Q2 LiDAR & hi-res leaf-off aerial photos, maps now being updated



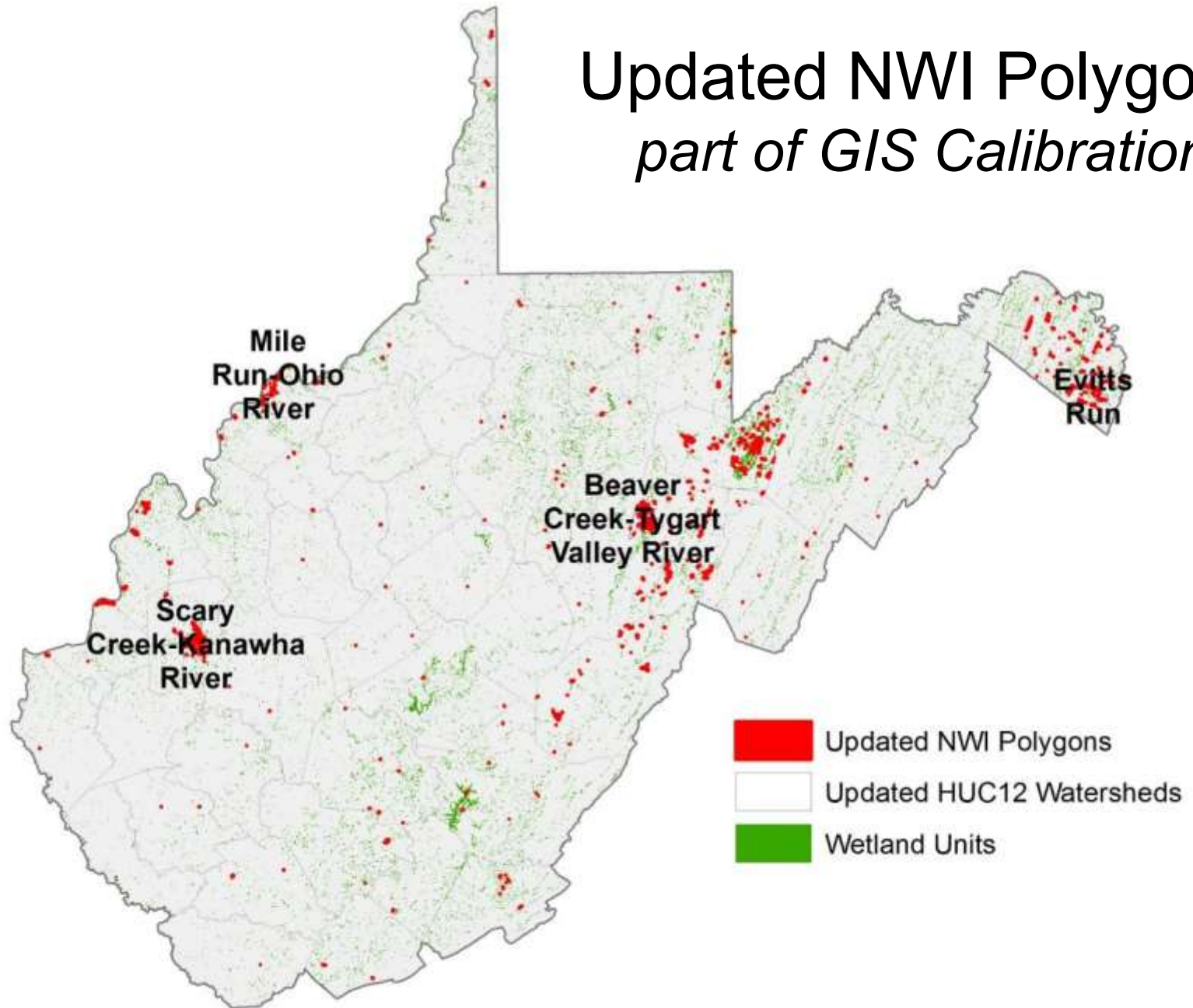
# Field Data Sources

## *Field Calibration Wetlands*



# Updated NWI Polygons

*part of GIS Calibration*



DEPARTMENT OF **ECOLOGY**  
State of Washington

Calculating Credits and Compensatory Mitigation of Eastern Wash

Final Report August 2012

**Manual for the Oregon Rapid Wetland Assessment Protocol (ORWAP)**  
version 2.0.2

Paul Adams, Ph.D.  
Adams Resource Assessment, Inc.

Janet Morton, PWS  
Kathy Verble, CPSS  
Oregon Department of State Lands

JULY 2010

California Rapid Assessment Method for Wetlands

User's Manual

Version 6.1

NatureServe Ecological Integrity Assessment: Protocols for Rapid Field Assessment of Wetlands v2.0

State of Ohio Environmental Protection Agency

Ohio Rapid Assessment Method for Wetlands

User's Manual and Scoring Form

February 1, 2001

Rapid Floristic Quality Assessment Manual

Montana Department of Transportation

Montana Wetland Assessment Method

Prepared for:  
Montana Department of Transportation  
Environmental Services

The Watershed Approach  
A Statewide Decision Support Tool for Restoring and Protecting Wetland Services

Tom Bernthal, Nick Miller, Matt Matrise, Joanne Kline, Max Axler, Chris Smith, John Wagner, Michele Kille

WAWIA GIS-RAM Matrix - FINAL for GIS-TEAM Analysis

| Watershed | Wetland   | Wetland Type   | Wetland Code   | Wetland Area (Acres) | Wetland Value (\$) | Wetland Status   |
|-----------|-----------|----------------|----------------|----------------------|--------------------|------------------|
| 1001      | Wetland 1 | Wetland Type 1 | Wetland Code 1 | 100                  | \$100,000          | Wetland Status 1 |
| 1002      | Wetland 2 | Wetland Type 2 | Wetland Code 2 | 200                  | \$200,000          | Wetland Status 2 |

**Built on the best available existing science**

Robert A. Taft, Governor  
State of Ohio

Christoph Environnt

P.O. Box 1049, Lucas Government Center, 122 S. Front Street, Columbus

Minnesota Pollution Control Agency

801 N. Last Chance Gulch, Suite 101  
Helena, Montana 59601-3360

March 2008

| Watershed | Wetland   | Wetland Type   | Wetland Code   | Wetland Area (Acres) | Wetland Value (\$) | Wetland Status   |
|-----------|-----------|----------------|----------------|----------------------|--------------------|------------------|
| 1001      | Wetland 1 | Wetland Type 1 | Wetland Code 1 | 100                  | \$100,000          | Wetland Status 1 |
| 1002      | Wetland 2 | Wetland Type 2 | Wetland Code 2 | 200                  | \$200,000          | Wetland Status 2 |

**Efficacy of Natural Wetlands to Retain Nutrient**  
 A. K. Knox, R. A. Dahlgren, K. W. Tate, and E. R. Atwill

Wetlands can improve water quality through natural processes including sedimentation, nutrient immobilization, and denitrification. However, these processes are often limited by the form of sediment, nutrient, and pollutant that enters the wetland. We examined how the form of sediment, nutrient, and pollutant that enters a wetland affects its ability to retain these substances. We found that a sediment characterized by a high organic content and a high surface area (fine-grained sediment) was most effective at retaining sediment, nutrients, and pollutants. In contrast, a sediment characterized by a high sand content and a low surface area (coarse-grained sediment) was most effective at retaining sediment, nutrients, and pollutants. These results suggest that wetlands with fine-grained sediment and high surface area will be most effective at retaining sediment, nutrients, and pollutants. This information can be used to help select wetlands for restoration or to help design wetlands for water quality improvement.

**Biogeochemical Hot Moments at the Terrestrial and Aquatic Interface**

Michael E. McClain, Elizabeth Sarah E. Gorgol, Nancy B. Grimm, Judson W. Harvey, Carol A. J. Williams H. McDowell

**ABSTRACT:** Biogeochemical processes that occur at the interface between land and water are important for the global carbon and nitrogen cycles. We studied the biogeochemistry of a large river wetland in the Amazon basin to understand the processes that control the exchange of carbon and nitrogen between the land and water. We found that the wetland is a net sink for carbon and nitrogen, and that the processes that control the exchange of these elements are highly variable in space and time. This variability is driven by changes in the amount of organic matter that enters the wetland from the land, and by changes in the microbial community that lives in the wetland. Our results suggest that the wetland is a dynamic system that can respond to changes in land use and climate.

**Realizing ecosystem services along a gradient of wetland hydroperiod**

Thomas L. McClain et al.

**ABSTRACT:** Wetlands provide numerous ecosystem services, but their ability to provide these services varies along a gradient of hydroperiod. We studied the biogeochemistry of a large river wetland in the Amazon basin to understand the processes that control the exchange of carbon and nitrogen between the land and water. We found that the wetland is a net sink for carbon and nitrogen, and that the processes that control the exchange of these elements are highly variable in space and time. This variability is driven by changes in the amount of organic matter that enters the wetland from the land, and by changes in the microbial community that lives in the wetland. Our results suggest that the wetland is a dynamic system that can respond to changes in land use and climate.

**RECOMMENDED RECONCILIATION WETLAND ASSESSMENT TECHNIQUE**



Final Report - April  
 Association of State Wetland Managers

**Wetland Assessment: Measuring the Quality of the Nation's Wetlands**  
 By Leah Steffen, ASWM

A commonly accepted principle among architects and designers is that "form ever follows function," which means that the shape or appearance of a structure should be predicted by its intended purpose—whatever it does. But when wetland scientists talk about function, conditions and values—these are different views on what these things mean and what they say about the quality of a wetland.

Condition describes the "health" of a wetland. The National Wetland Monitoring & Assessment Work Group's working definition of condition is, "the state of a resource, generally reflecting a combination of physical, chemical, and biological characteristics such as structure, water clarity, chemical composition, or the status of biological communities." (U.S. EPA, 2007)

A wetland's functions include the ecological processes it performs, a wetland performs generally related to habitat, hydrology and water quality. More specifically, these can be divided into all functions. In a watershed context, wetland functions are key factors that drive the health of the watershed.

**A unifying approach for wetland communities at the landscape scale**

Carol A. Johnston et al.

**ABSTRACT:** Assessment of wetland communities is a complex task. We present a unifying approach for wetland communities at the landscape scale. This approach involves the use of a common set of metrics to describe the structure and function of wetland communities. We found that this approach is effective at describing the structure and function of wetland communities at the landscape scale. This information can be used to help select wetlands for restoration or to help design wetlands for water quality improvement.



**A Regional Geomorphological Assessment of Wetlands in the Hydrologic Valleys of the Midwest**

Hans M. Williams, et al.

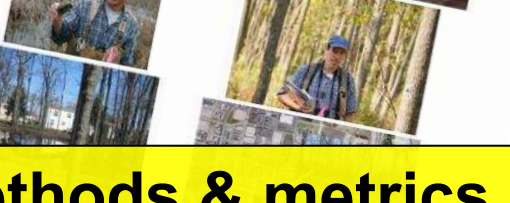
**ABSTRACT:** Assessment of wetland communities is a complex task. We present a unifying approach for wetland communities at the landscape scale. This approach involves the use of a common set of metrics to describe the structure and function of wetland communities. We found that this approach is effective at describing the structure and function of wetland communities at the landscape scale. This information can be used to help select wetlands for restoration or to help design wetlands for water quality improvement.

**The Use of Wetlands in Urban Areas**



**AN ECOLOGICAL AND FUNCTIONAL ASSESSMENT OF URBAN WETLANDS IN CENTRAL OHIO**  
 VOLUME 3: A COMPARISON OF THE AMPHIBIAN COMMUNITIES OF URBAN AND REFERENCE WETLANDS, USING LEVEL 1, 2 AND 3 ASSESSMENT TOOLS

Ohio EPA Technical Report WET-2008-1



Chris Katselis, Director  
 Environmental Protection Agency  
 P.O. Box 1049, Lotus Government Center, 10 West Town Street, Columbus, Ohio 43216-1049

**...we looked only at tested, validated methods & metrics**





# WVWRAM: 75 metrics

## Land Acquisition Score

|  | Intrinsic Potential         | Landscape Opportunity                               | Value to Society               |
|--|-----------------------------|---|--------------------------------|
| <b>Water Quality</b>                     | vegetation, soil, hydrology | 50 m buffer, contributing watershed                 | public use, planning           |
| <b>Flood Attenuation</b>                 | vegetation, soil, hydrology | 50 m buffer, contributing watershed                 | economic risk                  |
| <b>Habitat/<br/>Ecological Integrity</b> | vegetation, soil, hydrology | 50/300/1000 m buffer, perimeter, contrib. watershed | investment, public use, access |

Regulatory Function Score

Condition Score

# Water Quality

## Intrinsic potential to provide function

- Vegetation cover and persistence
- Surface depressions
- Surface water outflow
- Organic soils
- Seasonal ponding, slope, wetland/upland interface
- Headwater location

## Landscape opportunity (function score only)

- Discharges to the wetland
- Land use disturbance, 50 m buffer & contributing watershed
- Roads and railroads
- Impaired waters, algal blooms, powerboat use



# Flood Attenuation & baseflow

## Intrinsic potential to provide function

- Vegetation cover and structure
- Runoff and storage
- Surface water outflow
- Median percent slope
- Headwater location
- Connectivity to historic floodplain

## Landscape opportunity (function score only)

- Overland flow delivered to wetland



# Habitat & Ecological Integrity

## Intrinsic potential to provide function

- Vegetation (structure and floristic quality)
- Hydrology (intact regime, floodplain connectivity)
- Soils
- Structural patches

## Landscape opportunity

- Buffer and landscape integrity
- Landscape-level hydrologic connectivity
- Landscape-level ecological connectivity

## Special Conservation Concern override

- Up to 100% of score (applies to 2% of wetlands)

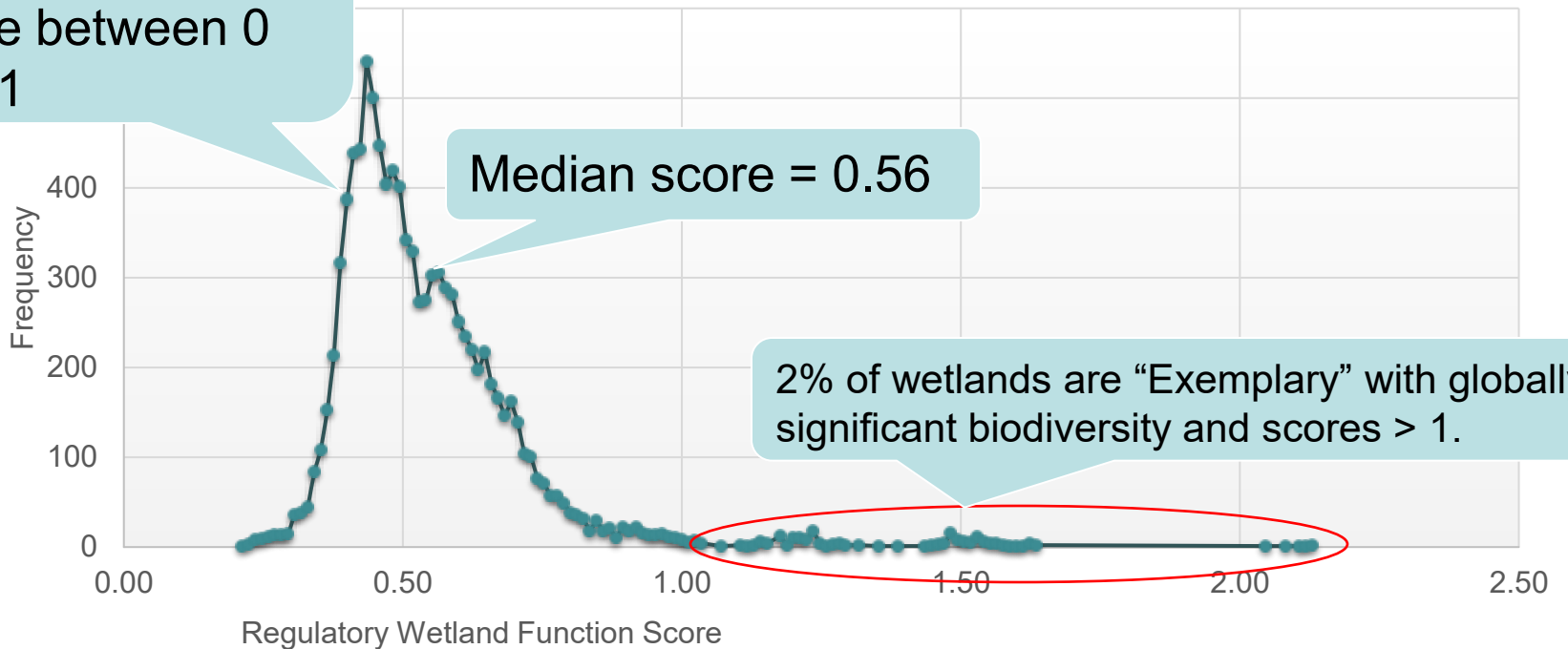




# Let's deter impacts to high-functioning wetlands!

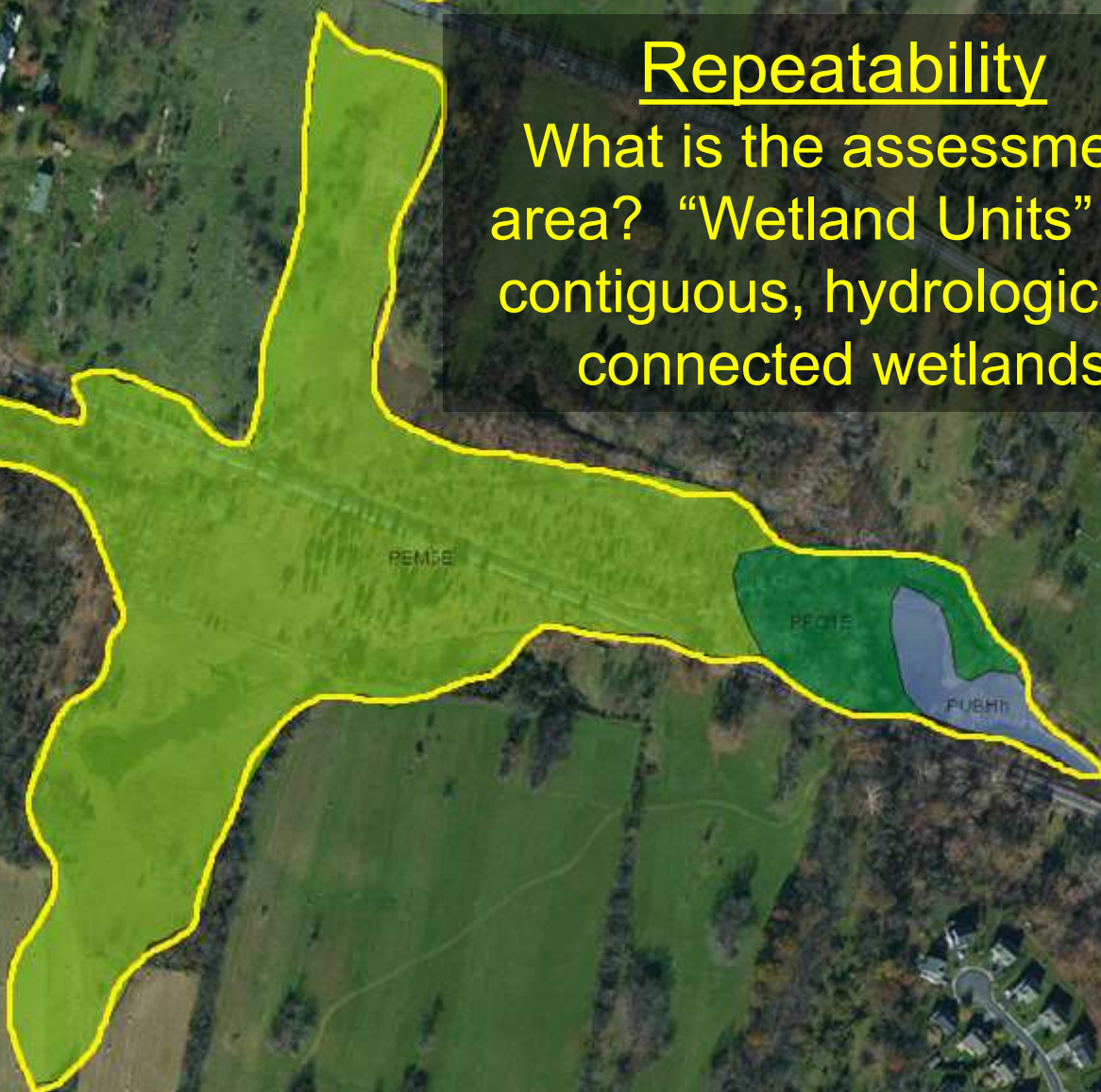
98% of wetlands have a WVWRAM score between 0 and 1

Regulatory Function Scores (GIS only) for 10,416 vegetated wetlands





Zoom History



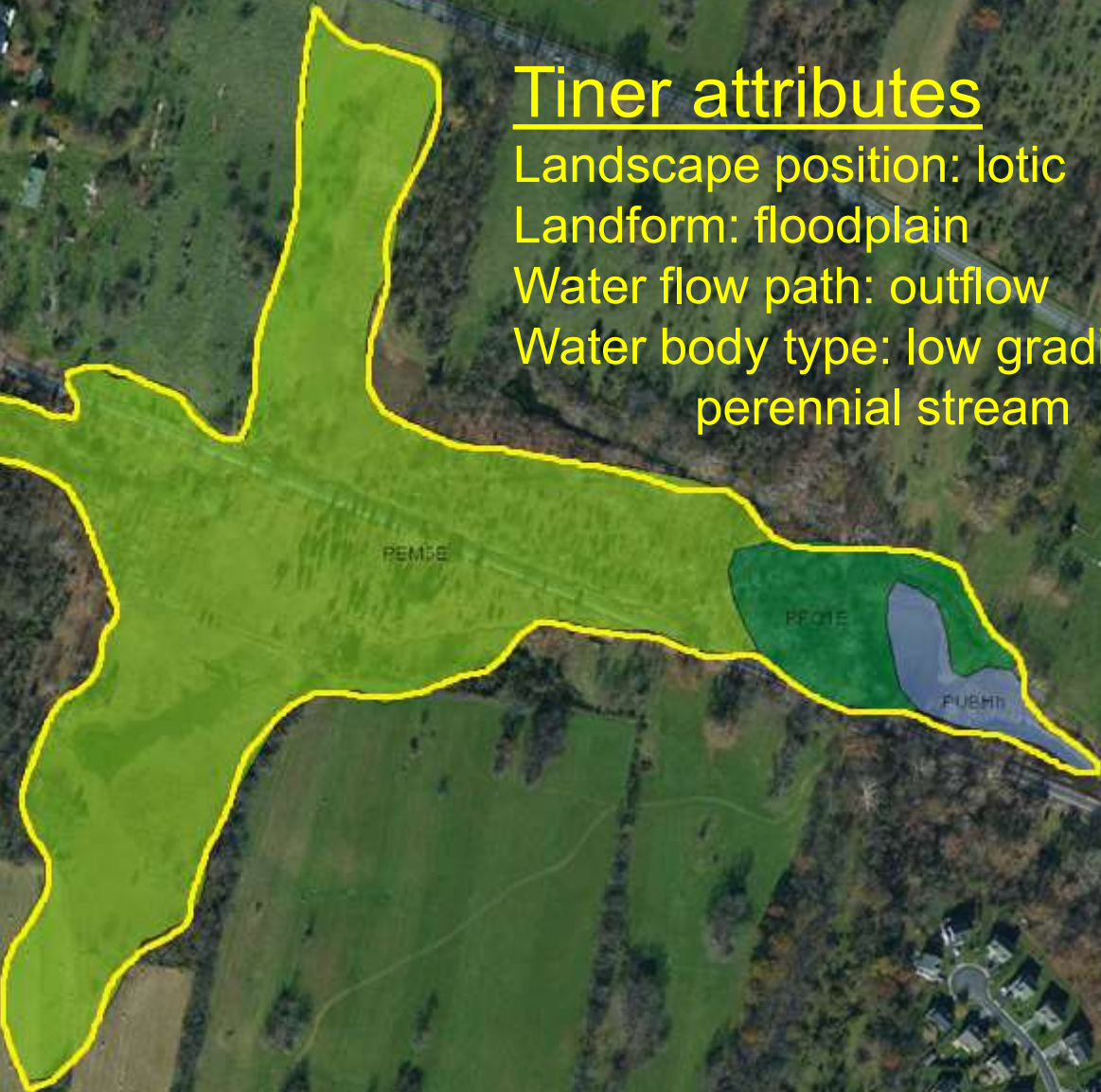
## Repeatability

What is the assessment area? “Wetland Units” are contiguous, hydrologically connected wetlands





Zoom History



## Tiner attributes

Landscape position: lotic

Landform: floodplain

Water flow path: outflow

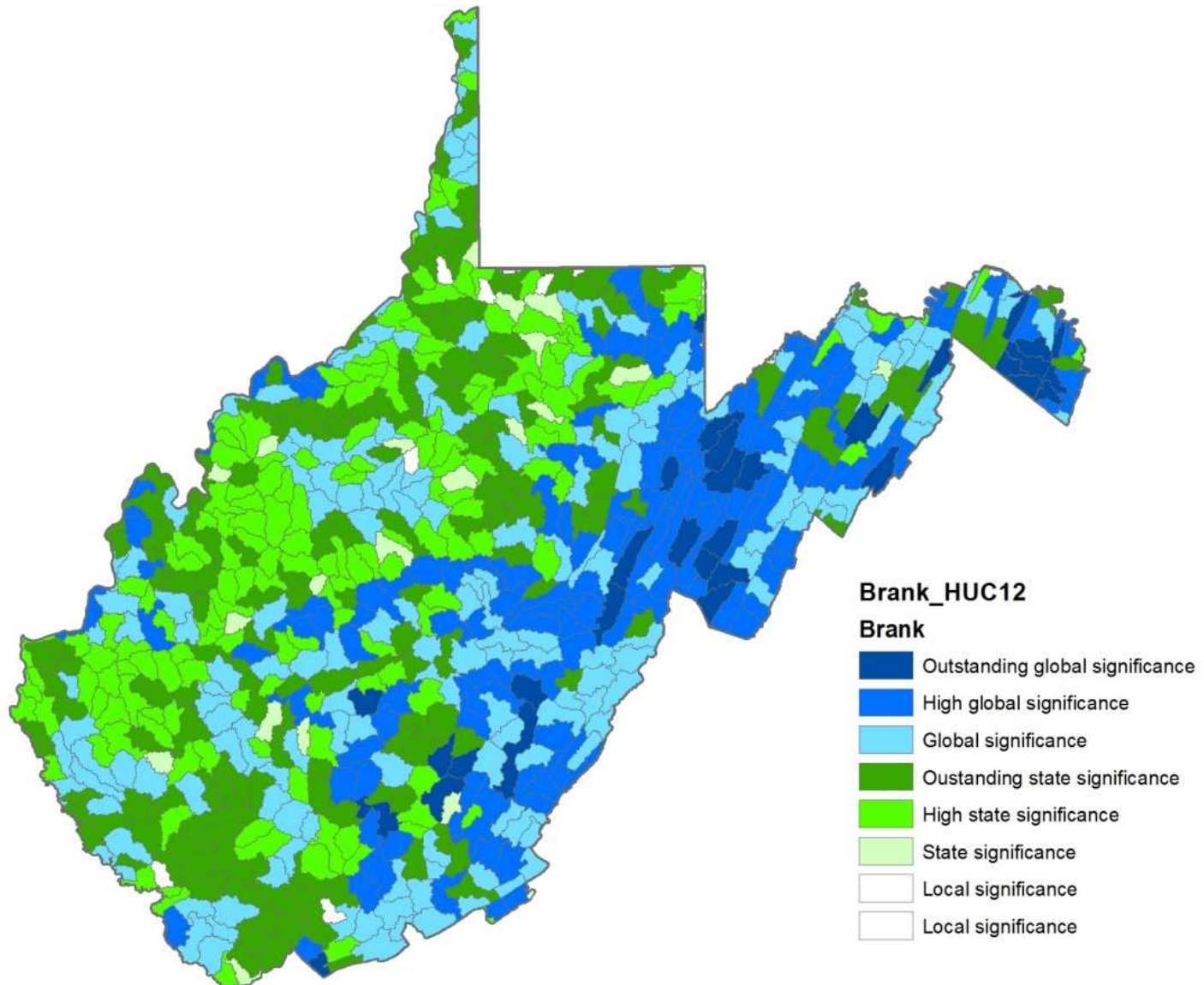
Water body type: low gradient  
perennial stream

## Source data: 62 statewide GIS datasets

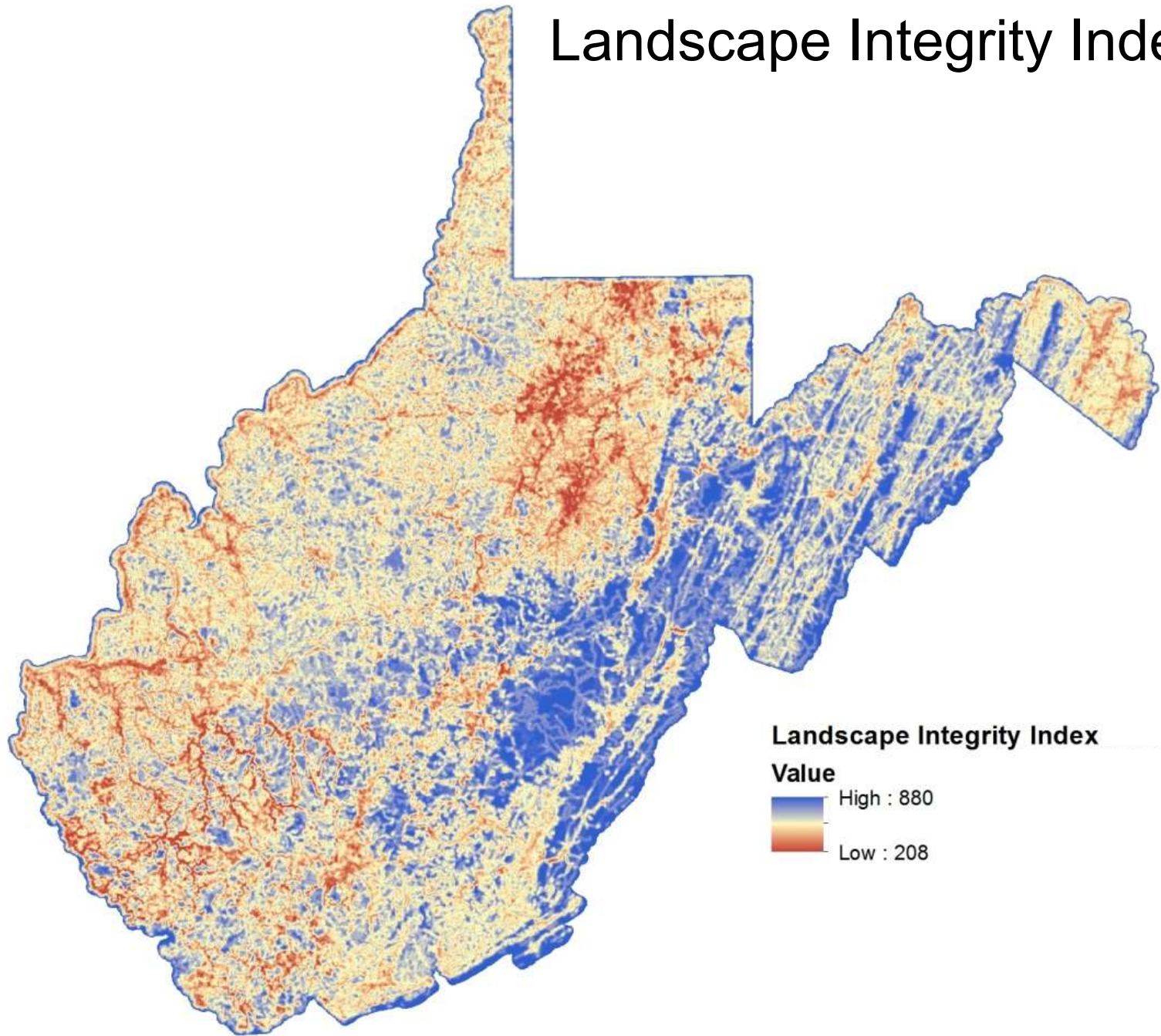
- Biodiversity
- Ecosystems
- Elevation
- Geology
- Hydrology
- Imagery
- Infrastructure
- Jurisdiction
- Landcover
- Landform
- Soils
- Stressors



# Watershed Biodiversity Ranks

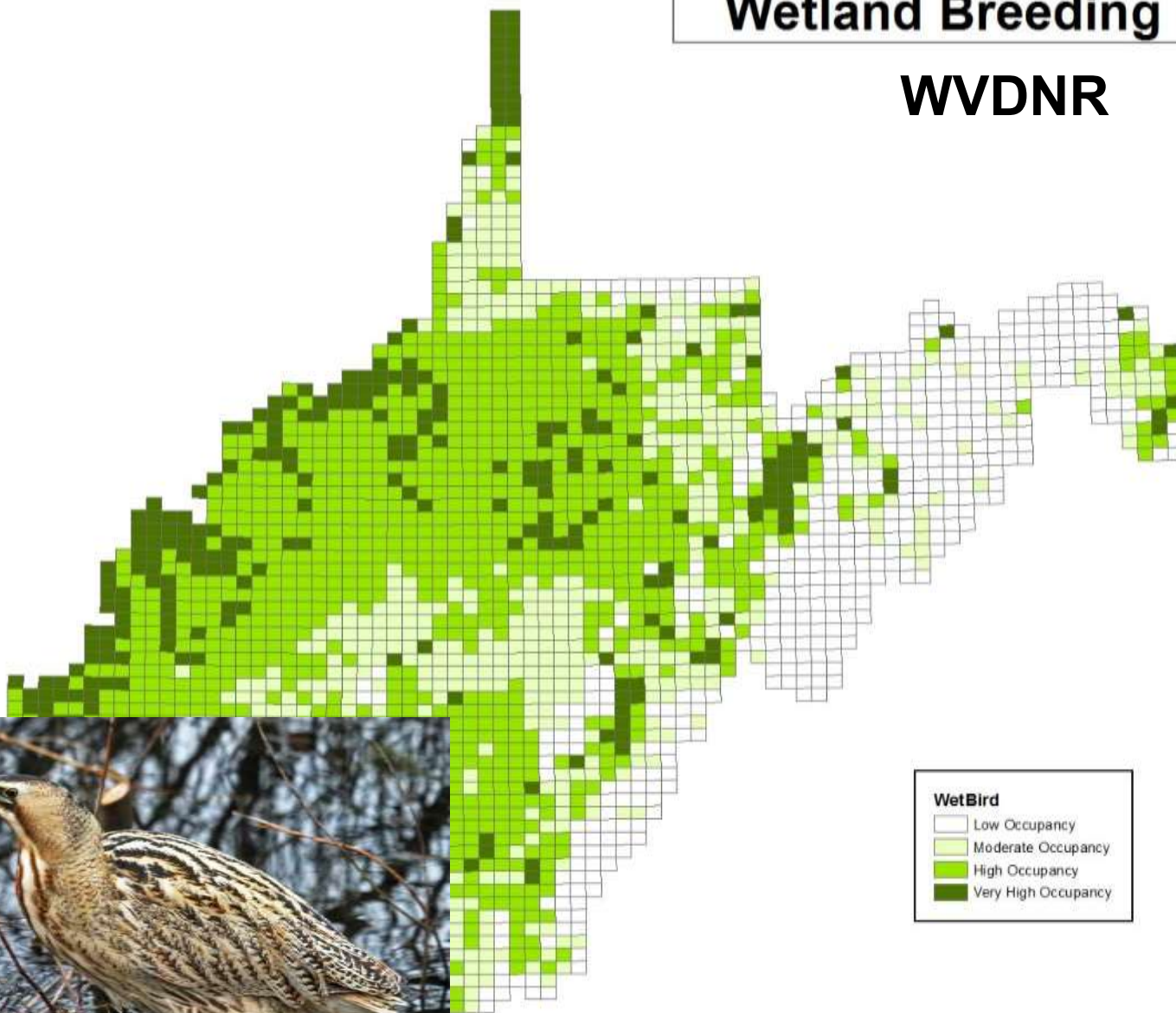


# Landscape Integrity Index



# Wetland Breeding Birds

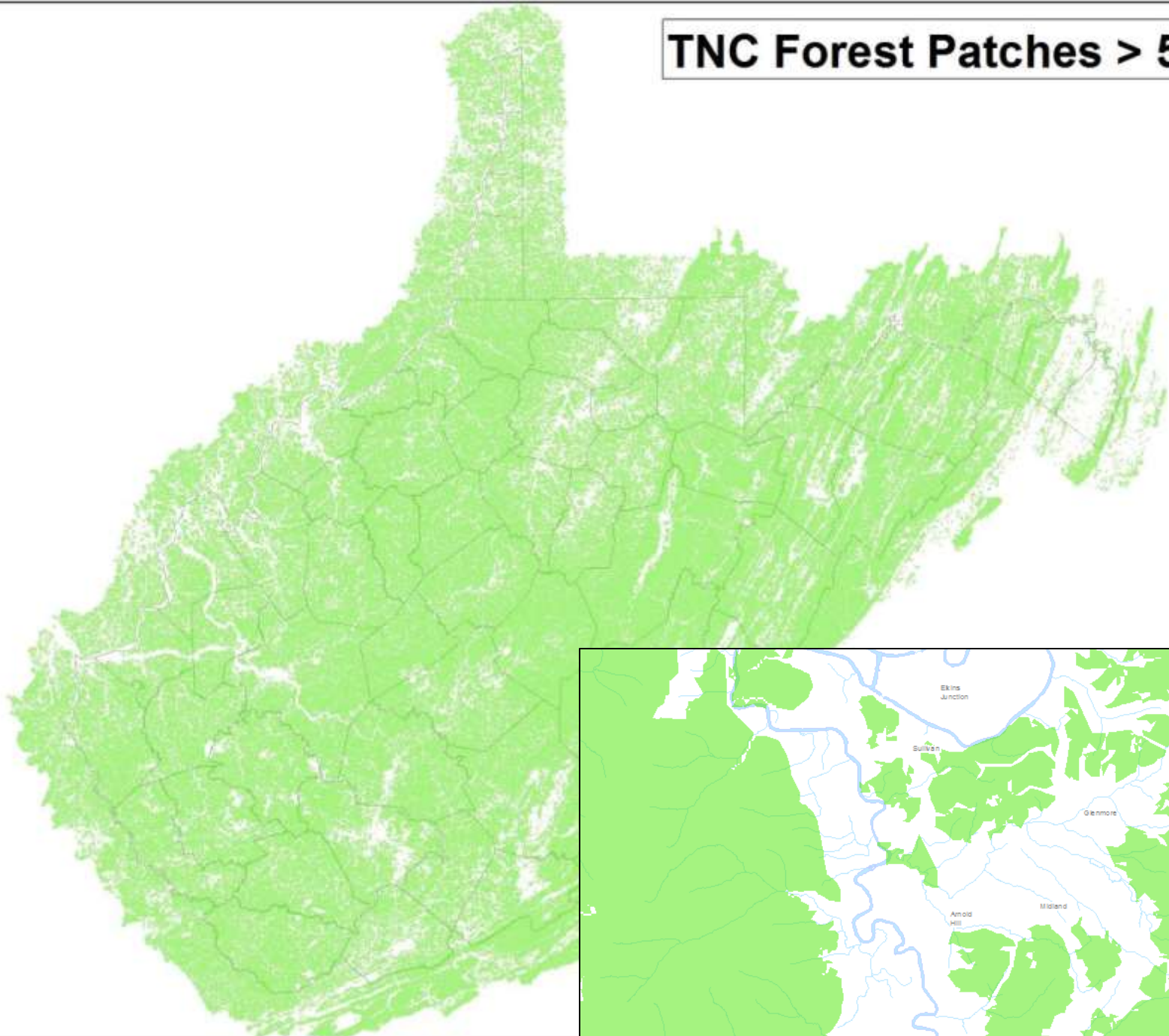
## WVDNR



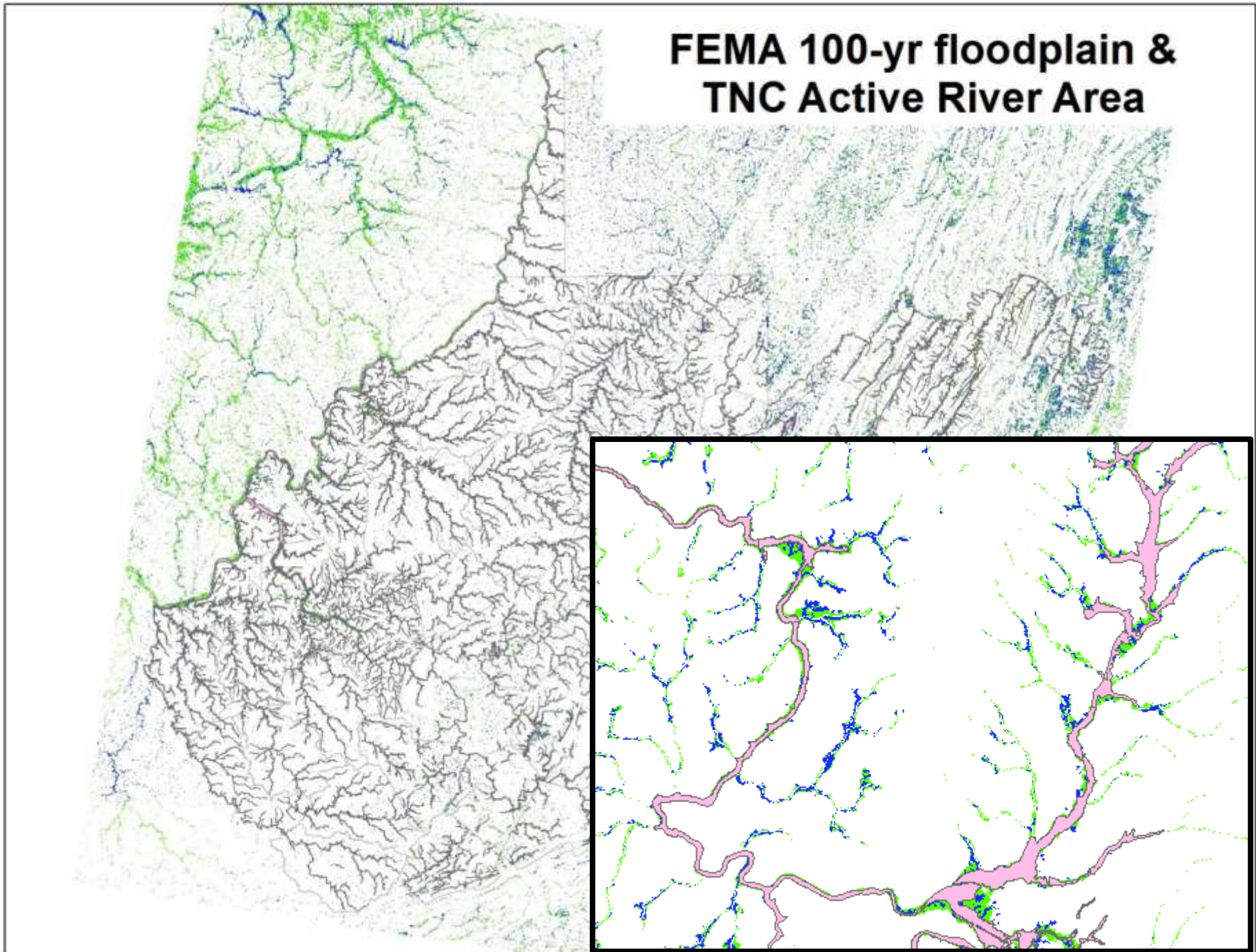
### WetBird

- Low Occupancy
- Moderate Occupancy
- High Occupancy
- Very High Occupancy

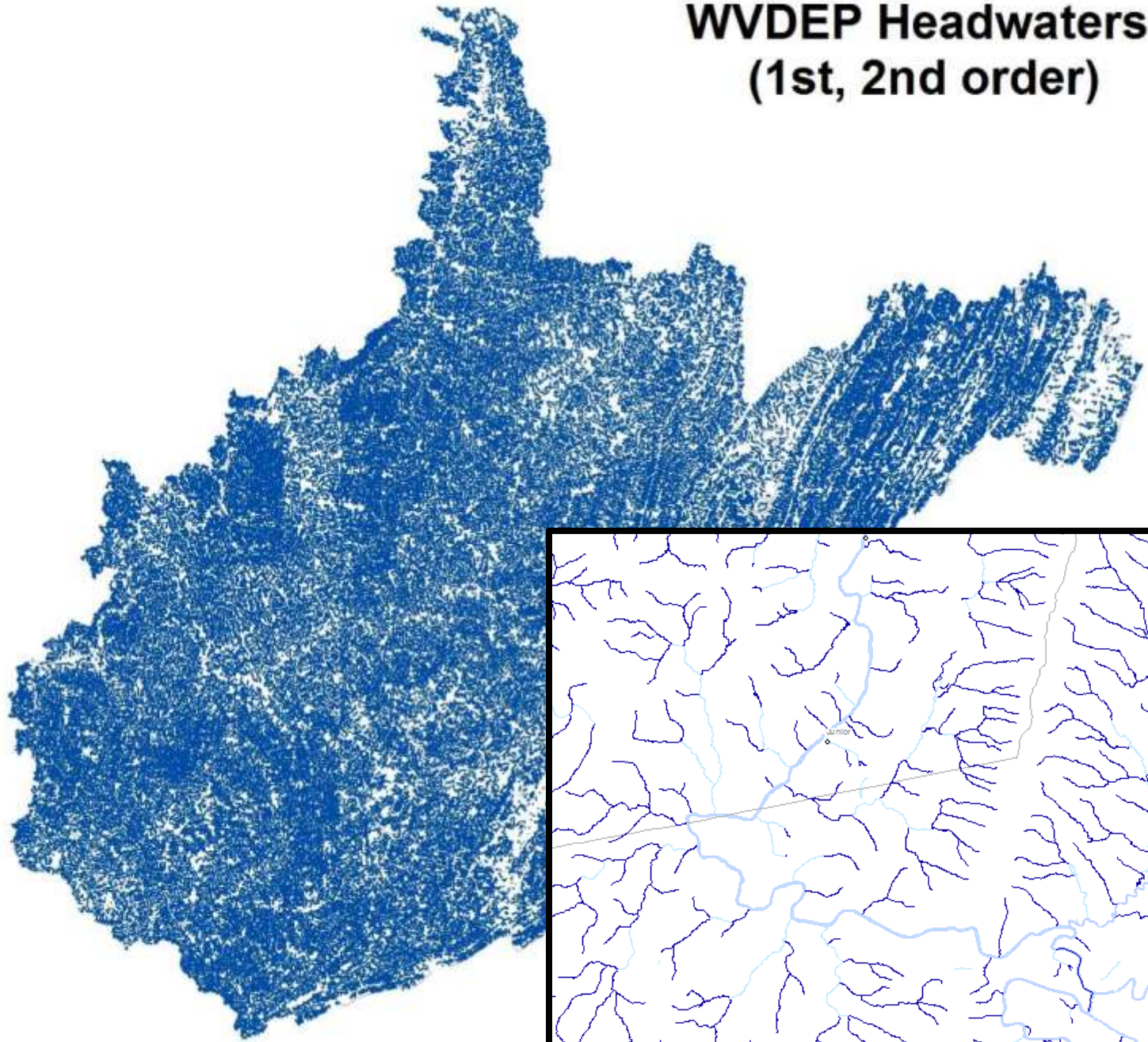
# TNC Forest Patches > 50 ac



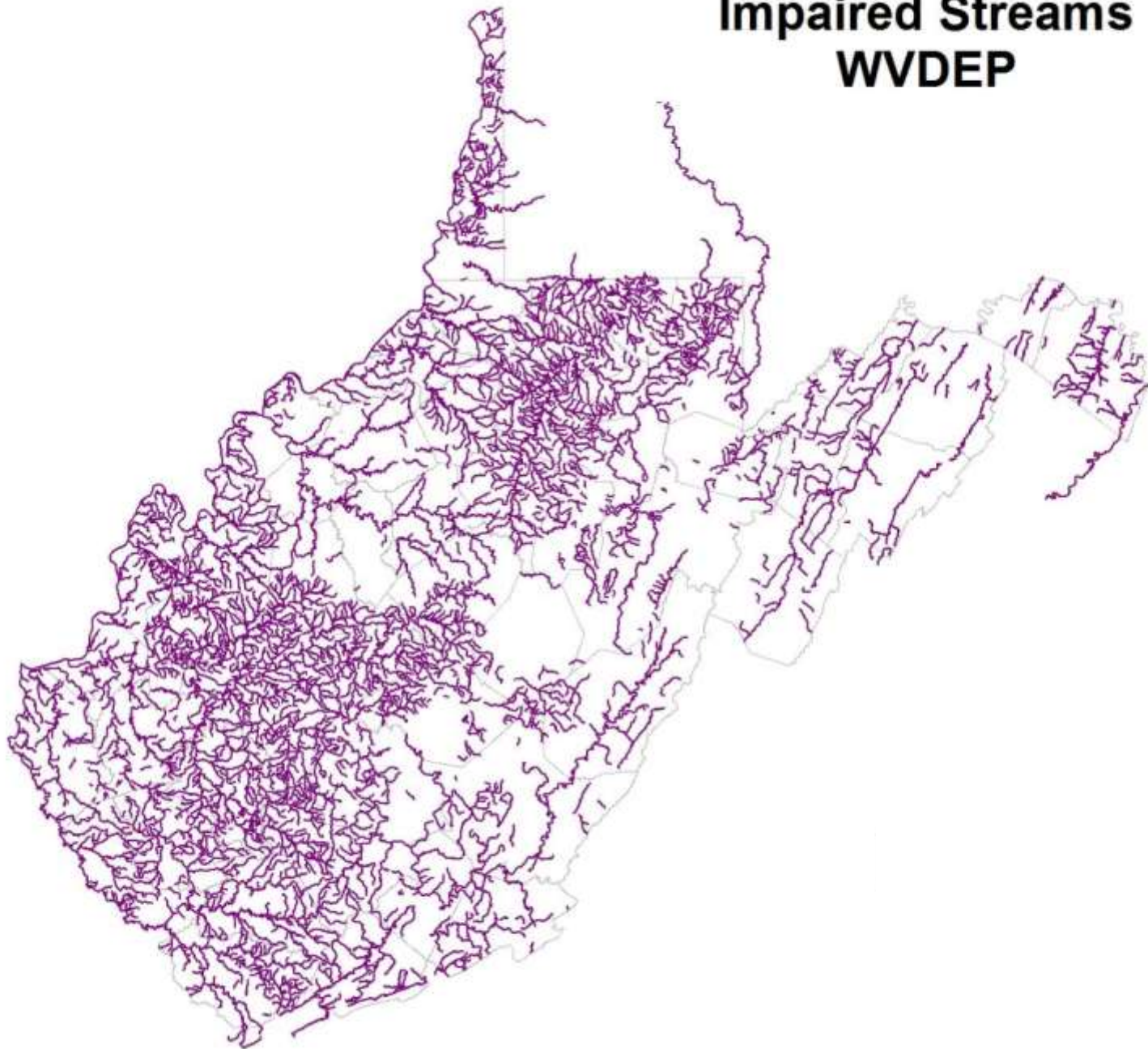
# FEMA 100-yr floodplain & TNC Active River Area



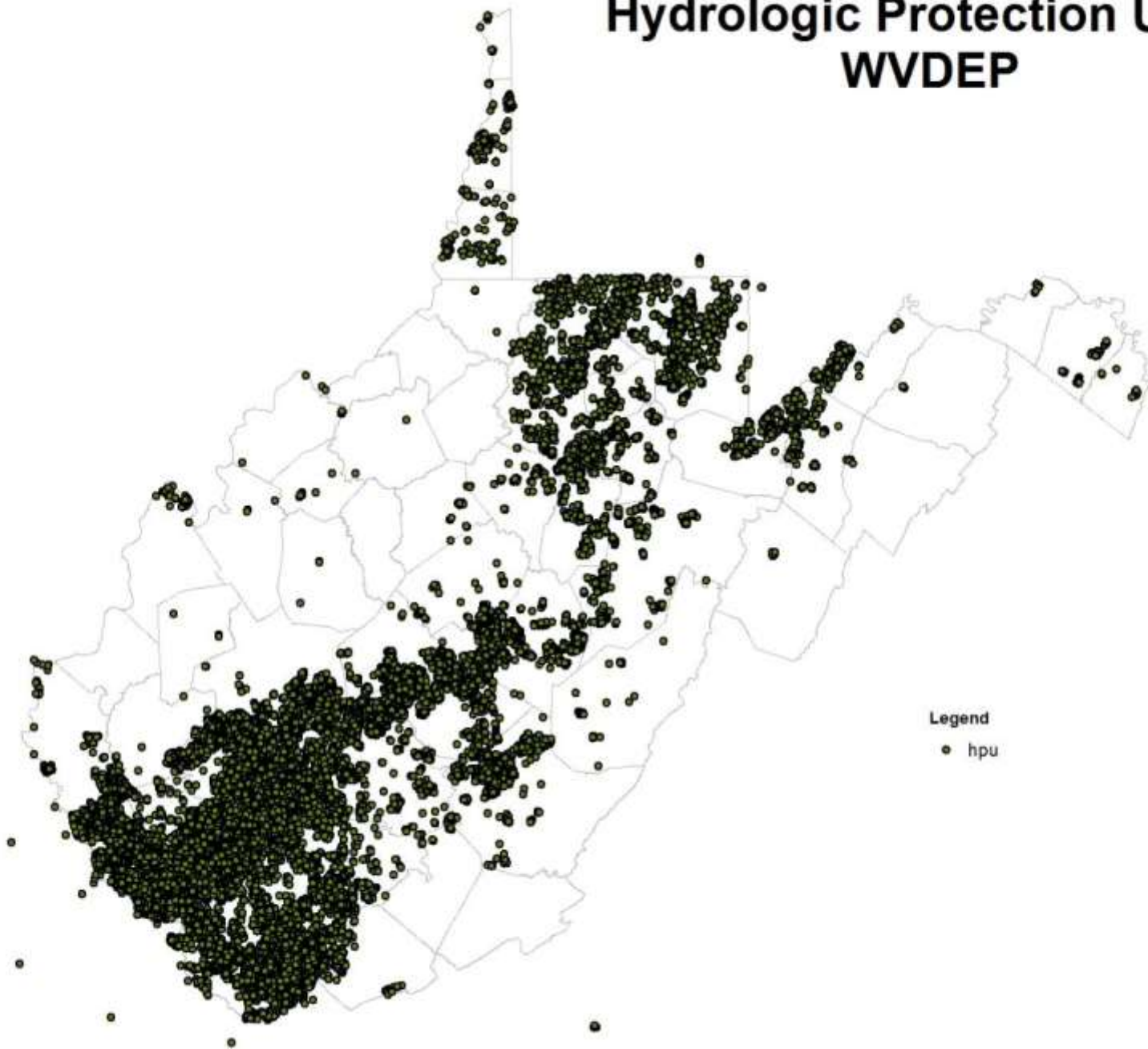
# WVDEP Headwaters (1st, 2nd order)



# Impaired Streams WVDEP



# Hydrologic Protection Units WVDEP

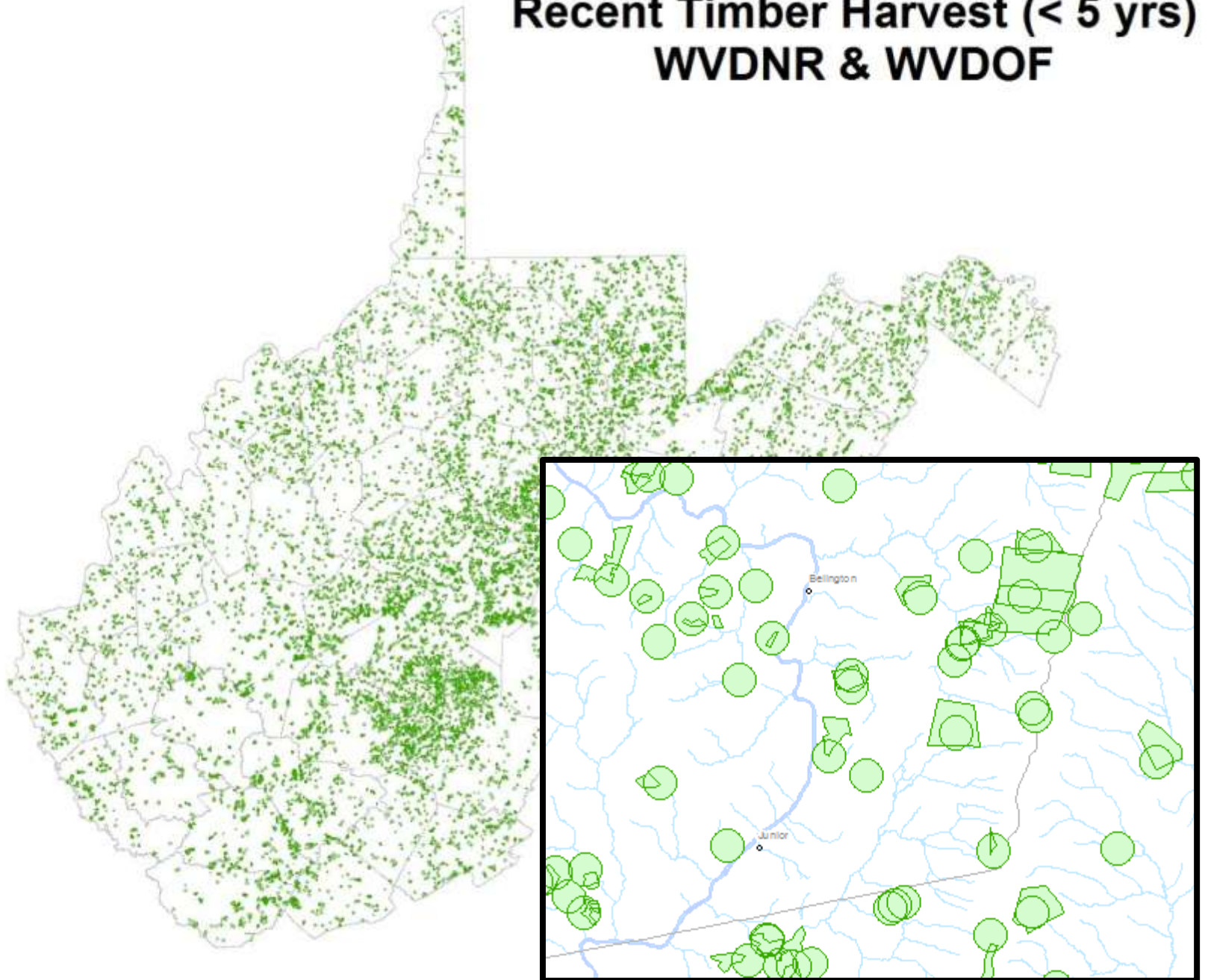


Legend

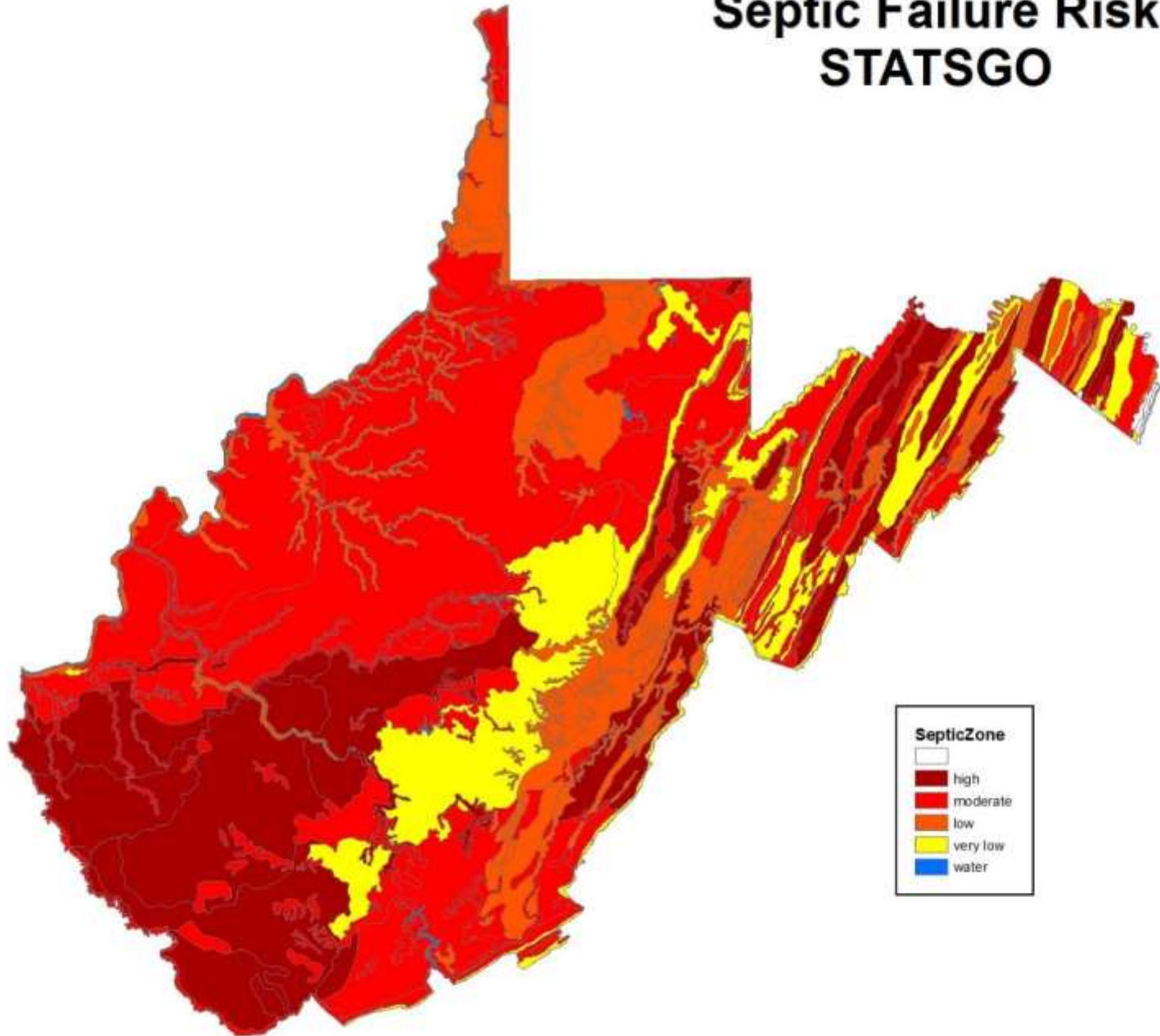
• hpu



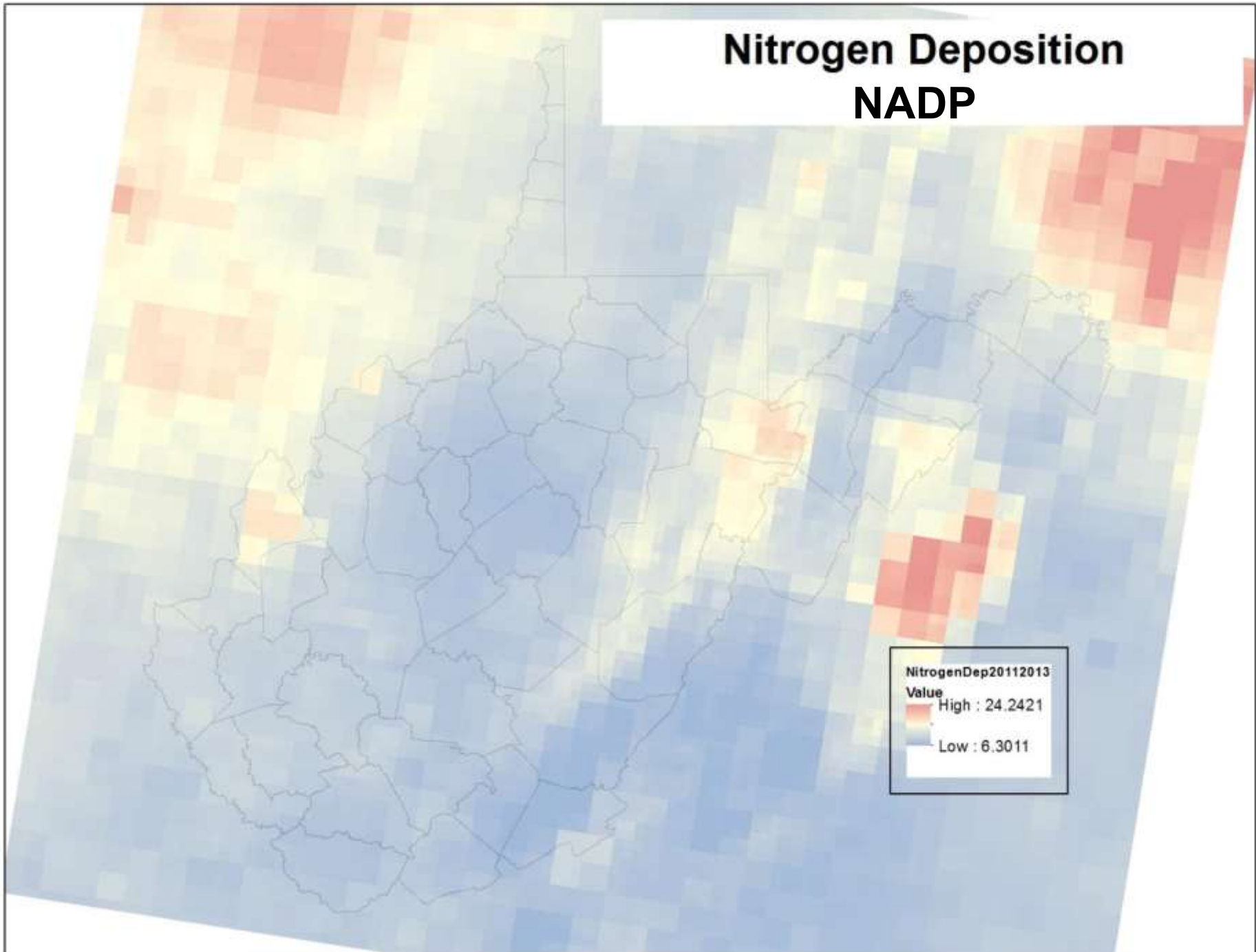
# Recent Timber Harvest (< 5 yrs) WVDNR & WVDOP



# Septic Failure Risk STATSGO



# Nitrogen Deposition NADP



NitrogenDep20112013  
Value  
High : 24.2421  
Low : 6.3011

# Metric Examples



## Site Biodiversity Rank

### Why?

- Rare species and habitats are important conservation targets

### How?

Select wetlands where:

- Rare species and habitats are documented in the Natural Heritage Database
- May have local, state, or global biodiversity significance

### Relationship to field assessment

- May be modified if old growth, mature forested swamp, large bog/fen, or summit sinkhole wetland is observed



# Floristic Quality

## Why?

- Best proxy for wetland condition; integrates many factors

## How?

Select wetlands where:

- Landscape integrity is high, especially in 50 m buffer
- Vegetation is forested (except on marl or in beaver complexes)
- Extra points for histosol or karst



### Relationship to field assessment

- Overwritten

# Connection to the River Continuum



## Why?

- Flood interception, habitat value

### Relationship to field assessment

- Overwritten

## How?

Select all wetlands where:

- >50% (>10%) of wetland is in the FEMA 100-yr or Active River Area floodplain
- Complexity of the wetland/stream interface is >3.4 (>1). Ditches and drains are excluded.



## Organic Soils

### Why?

- Denitrification, nutrient & pollution capture, habitat value

### How?

Select wetlands that intersect with:

- SSURGO soils with a surface O horizon or with organic matter >30% in the top 8 cm (3 in) of the soil profile OR
- WV vegetation plots containing peat, mucky peat, muck, or mucky modified mineral soil in the top 8 cm (3 in) of the soil profile OR
- Mapped WV peatlands OR
- NWI attribute soil modifier “g” for histosol



#### Relationship to field assessment

- Overwritten



# Microtopography

## Why?

- Sediment capture, chemical activity, habitat value

## How?

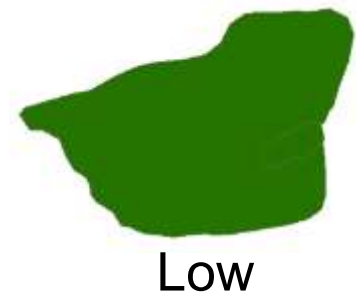
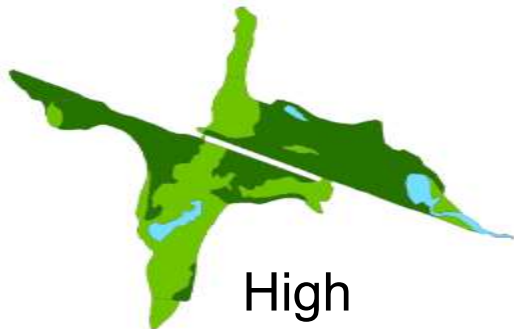
- Horizontal Interspersion (dimensionless) =  
$$\frac{\text{summed perimeters of NWI communities}}{\text{sqrt (Wetland Unit area)}}$$

*combined with...*

- Irregularity of upland edge (dimensionless) =  
$$\frac{\text{summed perimeter of Wetland Unit not bordering open water}}{\text{sqrt (Wetland Unit area)}}$$

### Relationship to field assessment

- Overwritten







# Watershed Runoff

## Why?

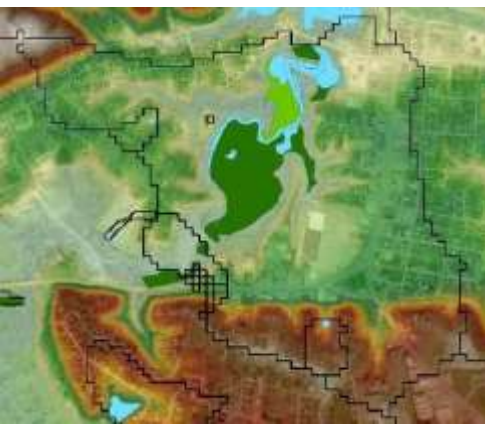
- Does the wetland have an opportunity to capture sediment and slow overland flow?

## How?

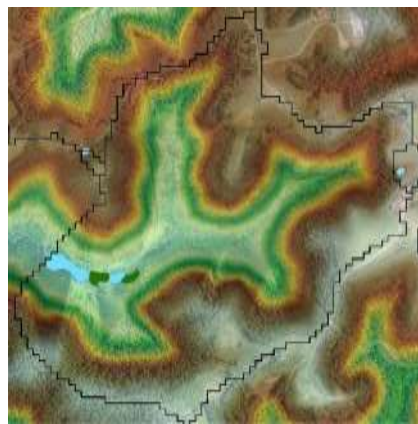
- Combine median percent slope with
- Land types that produce runoff
  - NLCD classes: developed, cultivated, or barren
  - SSURGO soils with high runoff/low infiltration
  - Timber harvests within the last 5 years

### Relationship to field assessment

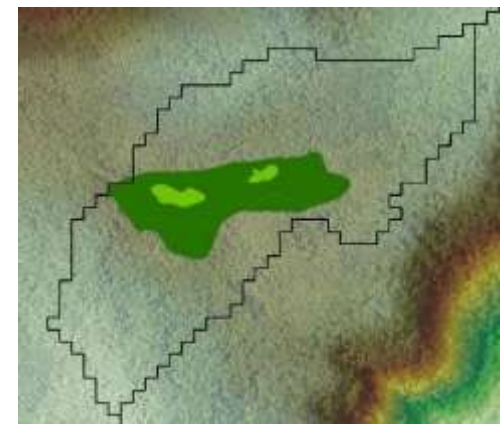
- GIS is final score



High

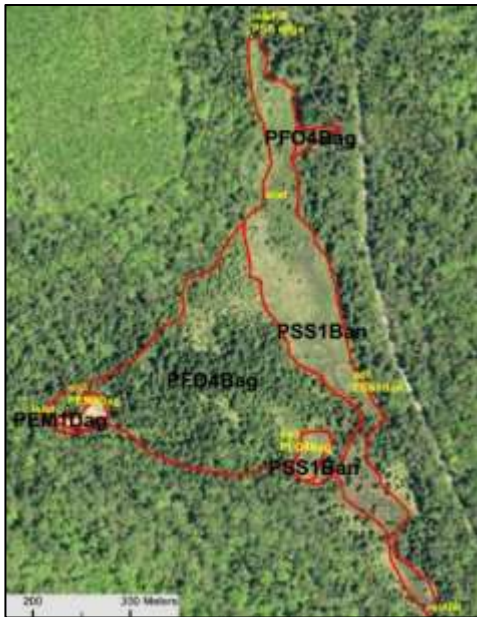


Medium



Low

# GIS plus rapid field assessment: the best of landscape-level assessment + metrics that must be obtained in the field

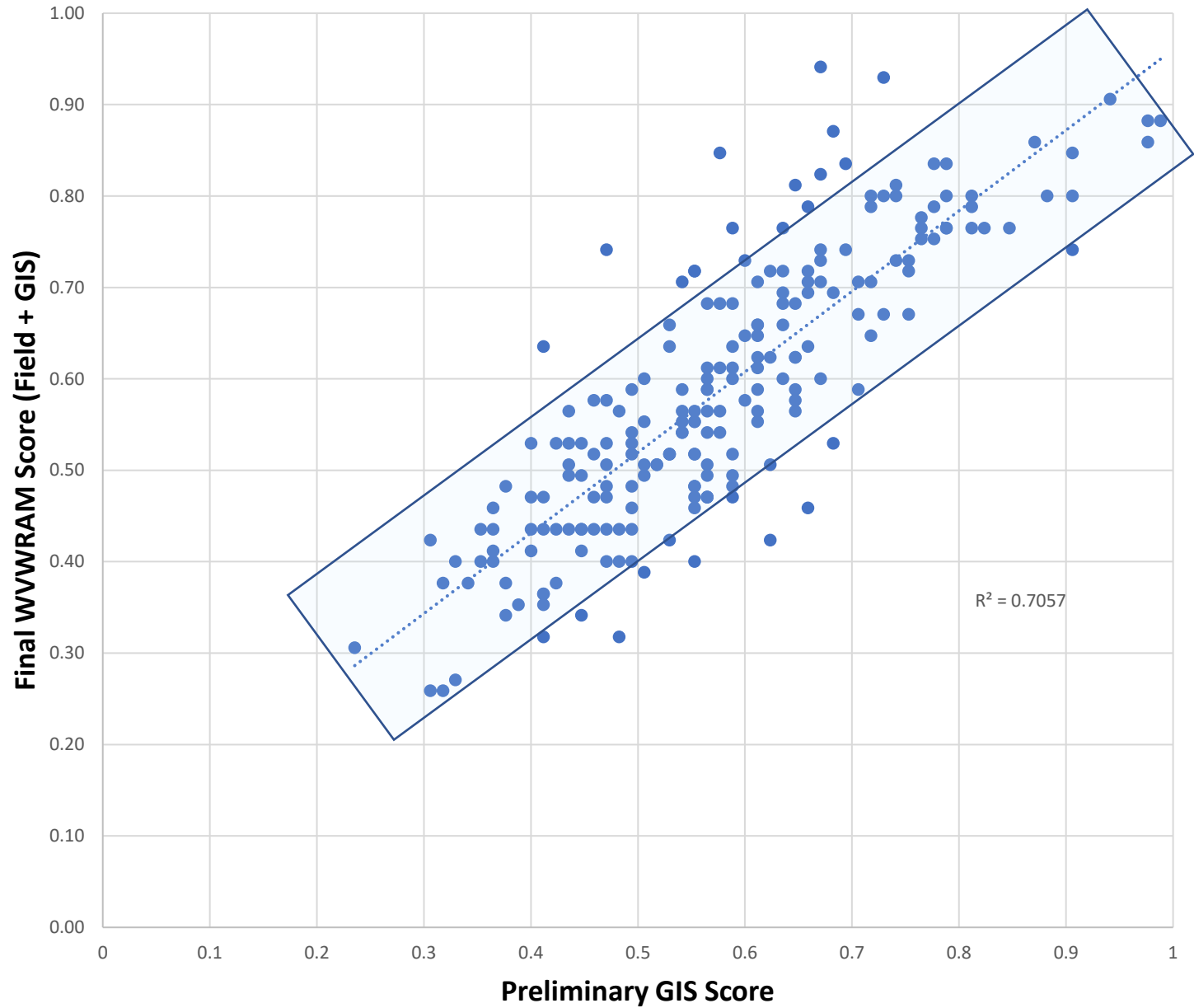


+



= **Field-verified  
WVWRAM  
score**

Comparison of Preliminary (GIS) and Final WVWRAM Scores for 210 sites



# GIS Tool: <https://mapwv.gov/wetlands/>

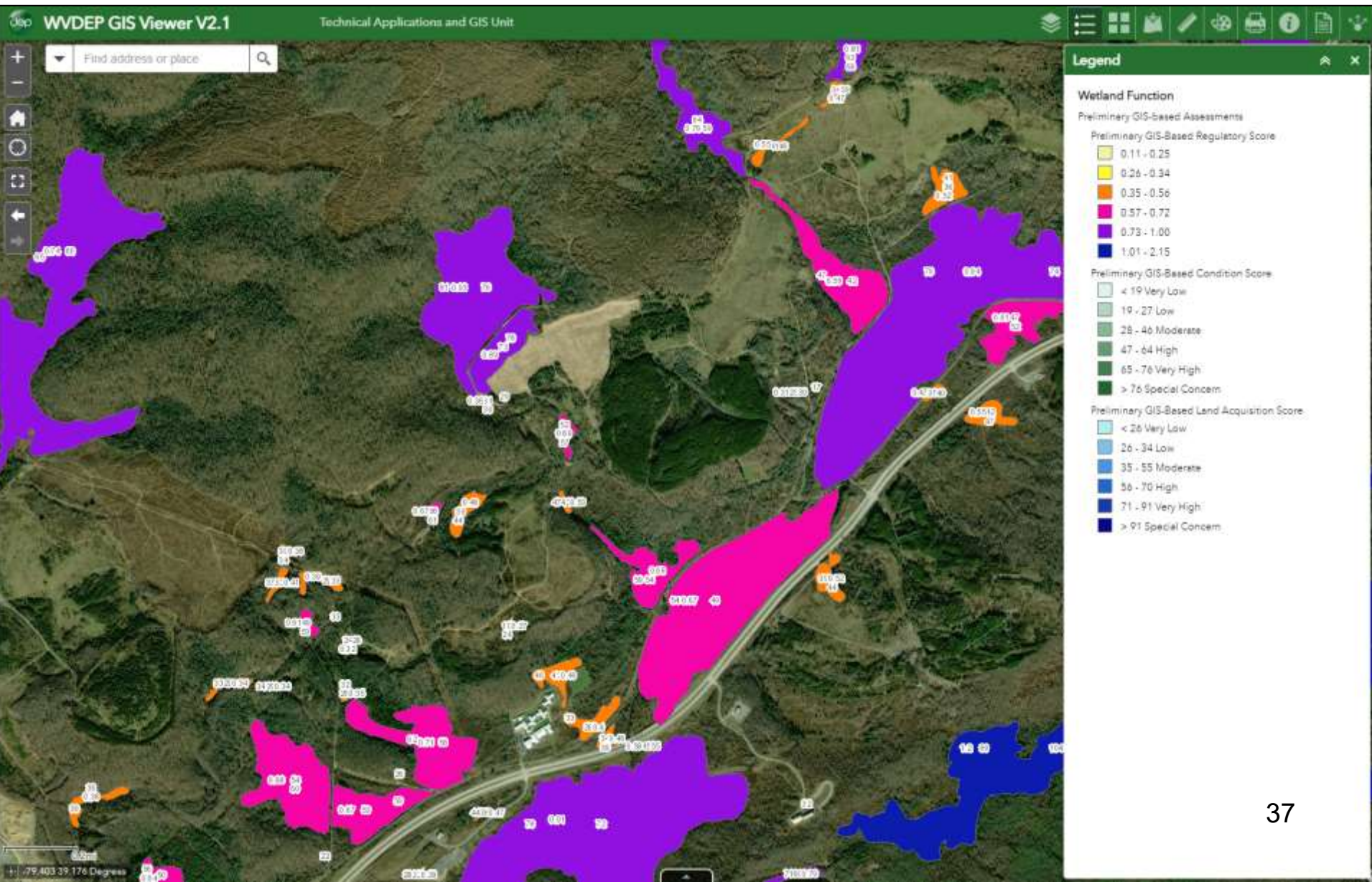
The image shows a web browser window displaying the WV Wetland Functional Assessment tool. The browser address bar shows the URL <https://mapwv.gov/wetlands/>. The application interface includes a sidebar with navigation options like 'Your Email', 'Project', and 'Input Wetland'. The main content area features a map with a red polygon drawn over a wetland area, and a 'Double-click to complete' tooltip. Below the map, there are controls for 'Click to Zoom/Pan' and 'Erase drawing'. The application also displays a 'WV Wetland Functional Assessment' form with fields for 'Your Email', 'Project Name', and 'Input Wetland'. The 'Input Wetland' section has three input methods: 'Shapetile', 'Draw Polygon', and 'KML'. The 'Draw Polygon' method is selected, and a text box contains the attribute 'e.g. PEM1Bdth'. Below the map, there is a 'Submit P' button.

Below the web application, a Microsoft Excel spreadsheet is visible. The spreadsheet has the following columns: OBJECTID, SiteEventID, WUKey, Length, Area, SiteName, SurveyDate, Function, RegPrelim, RegFunction, Condition, DNRLandAcq, BRank, FAFunction, FAOpportun, FAPotential, FASociety, HCondition, HFuncNoBR, HFunction, HOpportun, HPotent. The data in the spreadsheet is as follows:

| OBJECTID | SiteEventID | WUKey | Length     | Area        | SiteName | SurveyDate | Function | RegPrelim   | RegFunction | Condition | DNRLandAcq | BRank | FAFunction | FAOpportun | FAPotential | FASociety | HCondition | HFuncNoBR | HFunction | HOpportun | HPotent |
|----------|-------------|-------|------------|-------------|----------|------------|----------|-------------|-------------|-----------|------------|-------|------------|------------|-------------|-----------|------------|-----------|-----------|-----------|---------|
| 1        | 1           | 1     | 787.926464 | 18528.08788 |          |            | 61       | 0.647058785 | 33          | 47        |            | 53    | none       | 21         | 4           | 14        | 3          | 22        | 22        | 22        | 6       |

# WVDEP GIS Viewer

Wetland function, condition, and land acquisition scores for all mapped wetlands





# Timeline

**2015:** Begin development

**2017:** Field-testing & training with stakeholders

**2020:** public notice & WVDEP approval

**2021:** Peer review & Corps approval; begin status & trends monitoring

**Jan 2024:** Clean Water Act adoption

# Applications



## Good wetland maps & rankings promote proactive planning

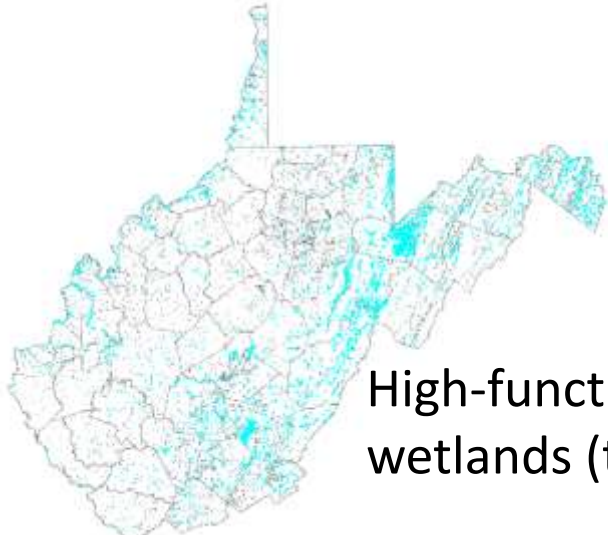
**Reduce impacts to wetlands by the regulated community**

- Predict mitigation costs of different sites or corridors



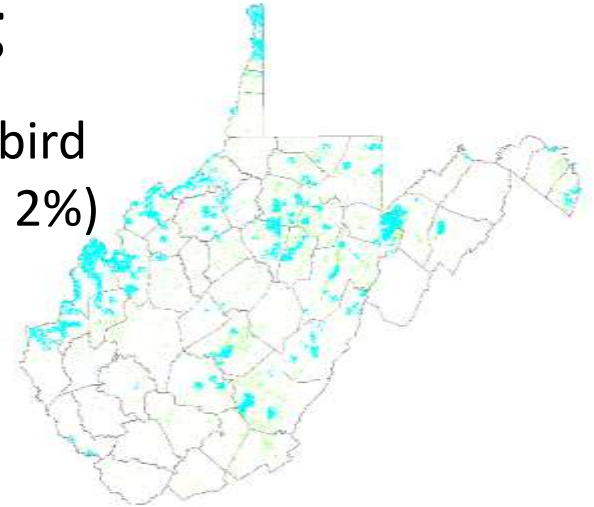


## Statewide Planning

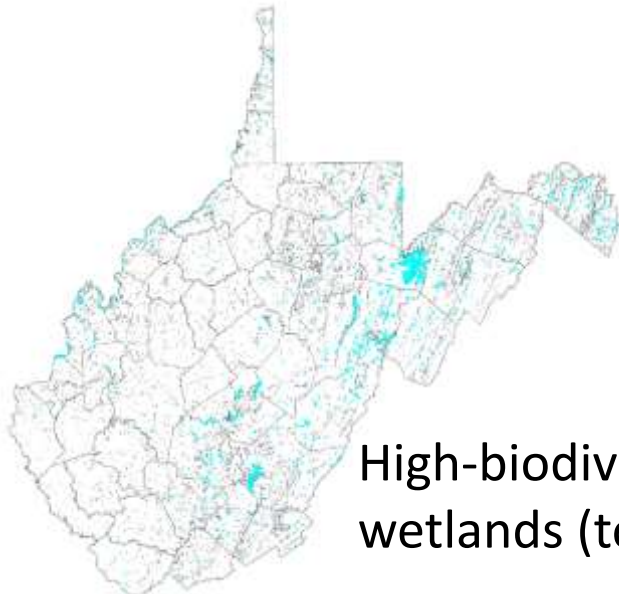


High-functioning wetlands (top 10%)

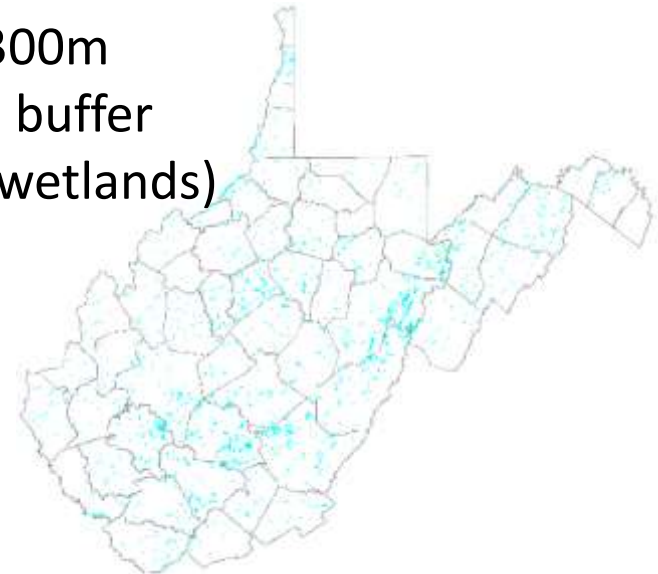
Key breeding bird wetlands (top 2%)



Intact 300m wildlife buffer (6% of wetlands)



High-biodiversity wetlands (top 2%)





## Monitor Status & Trends

- Identify potential reference wetlands
- Combine with field assessments for probabilistic monitoring statewide



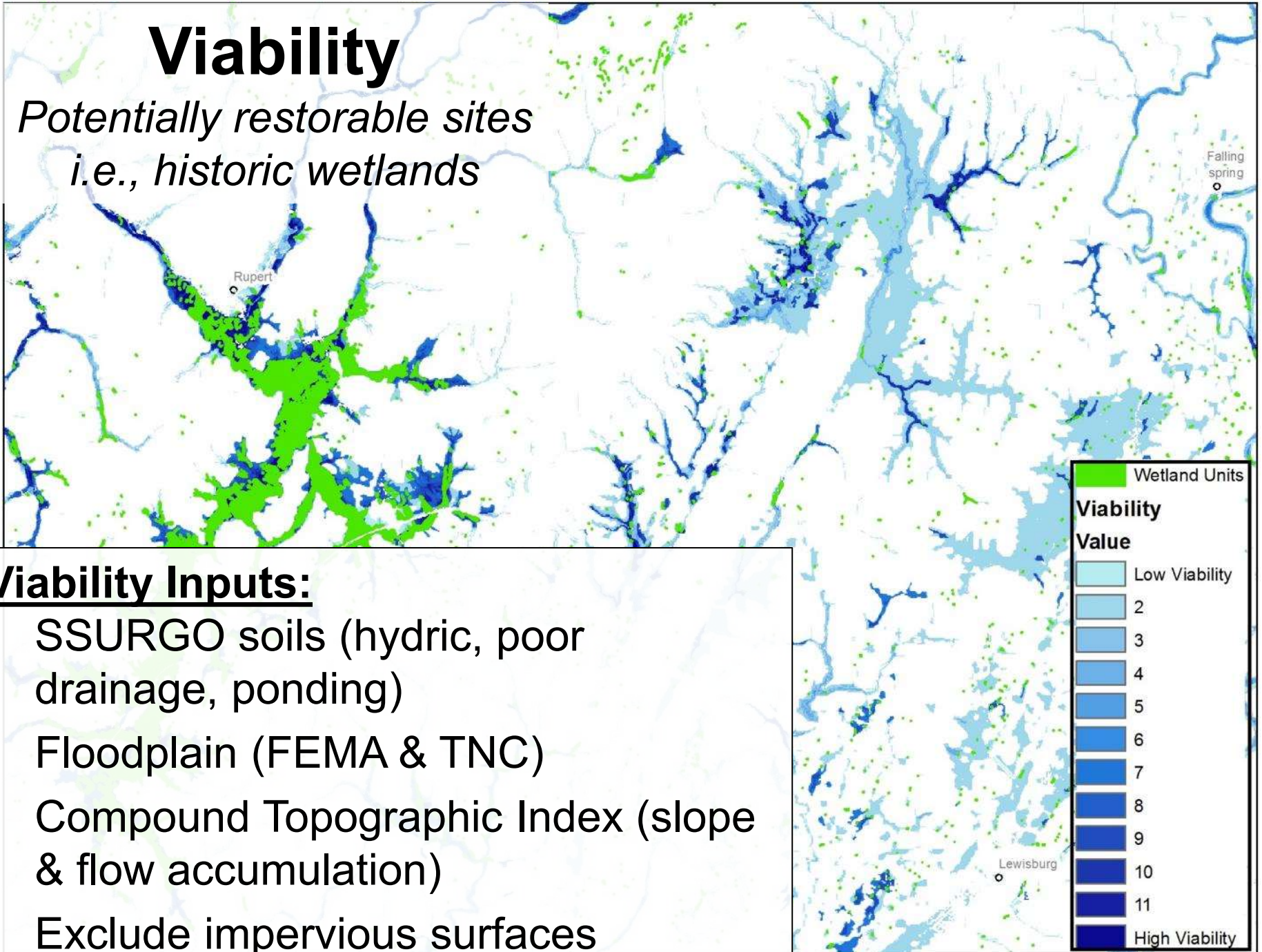
## Incentivise Best Restoration Practices

- Compare potential mitigation credits at different sites prior to land acquisition; find the good neighborhoods
- Restoration Manual guides projects, showing explicit point gains for restoration actions (field assessment required)



# Viability

*Potentially restorable sites  
i.e., historic wetlands*



## Viability Inputs:

- SSURGO soils (hydric, poor drainage, ponding)
- Floodplain (FEMA & TNC)
- Compound Topographic Index (slope & flow accumulation)
- Exclude impervious surfaces



## Conservation Planning

- WVDNR land acquisition decisions
- Outdoor Heritage Conservation Fund
- Municipalities and counties
- Land trusts and conservation organizations
- Engaged citizens



### **Degraded marsh, Hardy County**

Regulatory Function: 0.39 (low)

Condition: Poor, bottom one-third in state

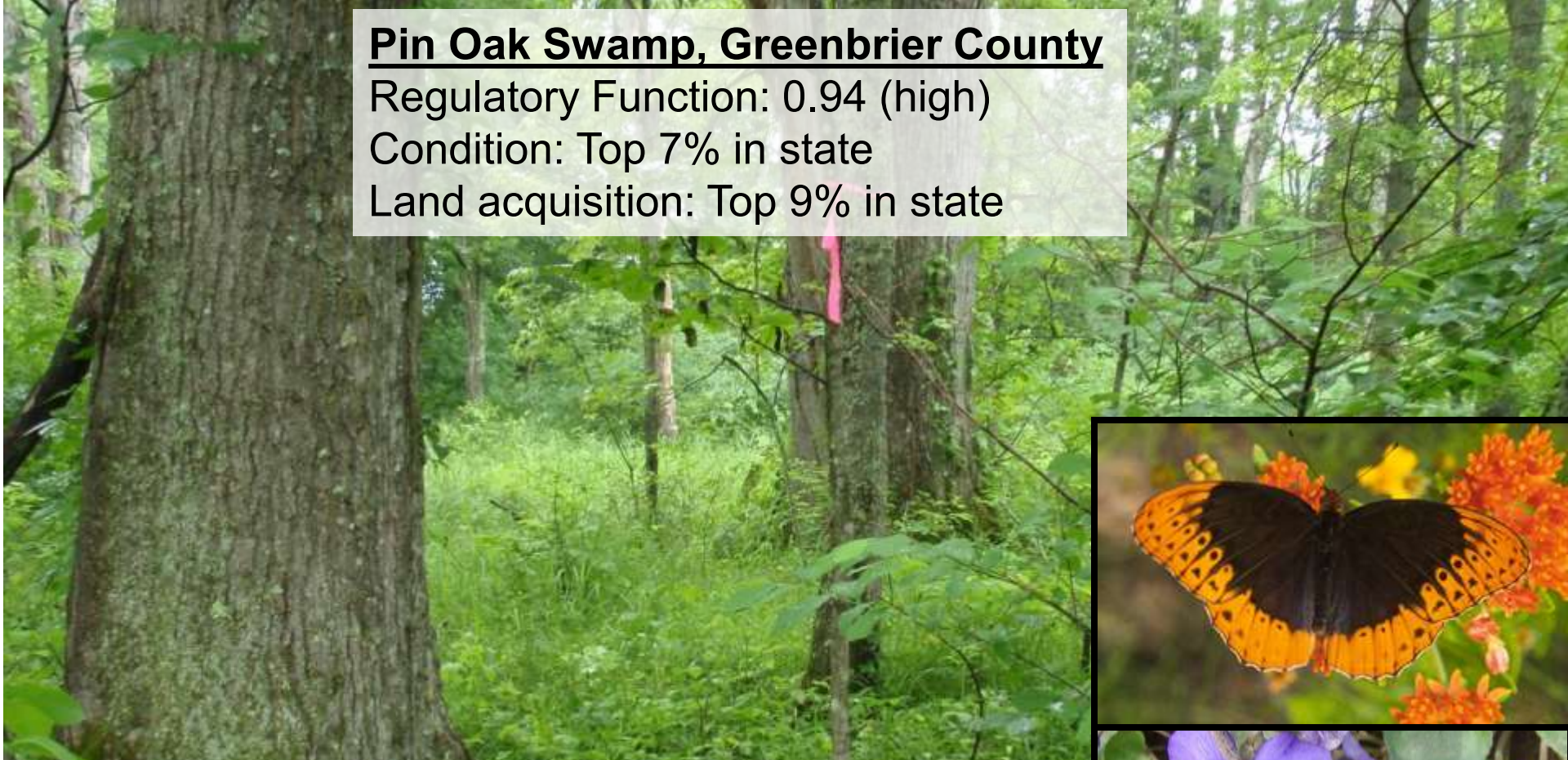
Land acquisition: Bottom one-third in state

**Pin Oak Swamp, Greenbrier County**

Regulatory Function: 0.94 (high)

Condition: Top 7% in state

Land acquisition: Top 9% in state

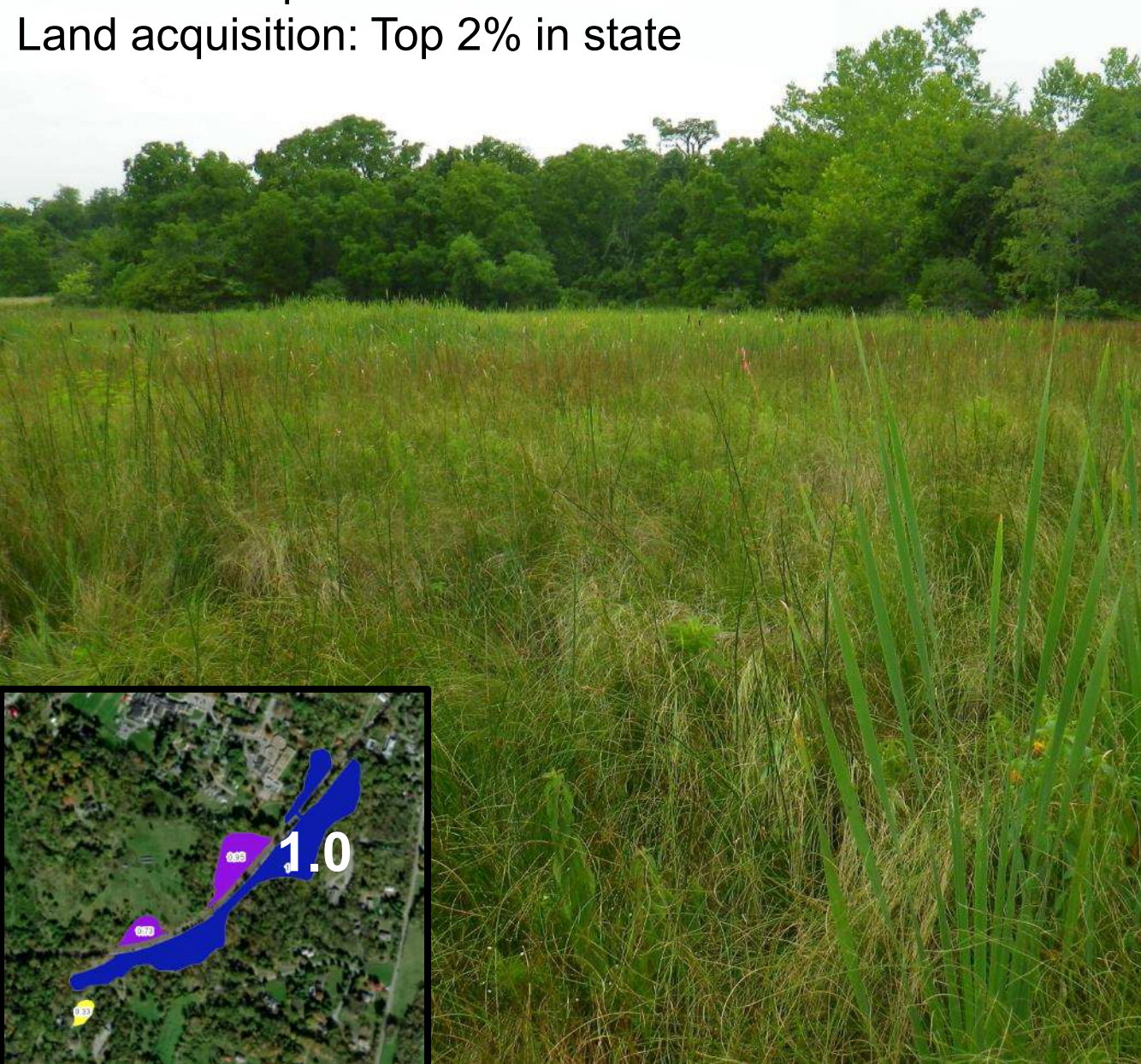


# Shepherdstown Marl Fen

Regulatory Function: 1.00 (Exemplary)

Condition: Top 2% in state

Land acquisition: Top 2% in state





With thanks to:



For more information, type "WVWRAM" into your search engine, or contact [Elizabeth.A.Byers@wv.gov](mailto:Elizabeth.A.Byers@wv.gov)