WV WATERSHED ASSESSMENT PILOT PROJECT

Gauley River ©Kent Mason

Expert Workshop #1, Round 2

Bridgeport Conference Center, October 10 & 11, 2012

Outline

- Project Background
- Methodology & Model Structure
- Relative vs. Objective Ranking Methods
- *Break*
- Gauley Results
- *Lunch*
- Upper Guyandotte Results
- Objective Threshold Break-Out Groups

Project Background

1. Objectives
2. Study Area
3. Process & Timeline

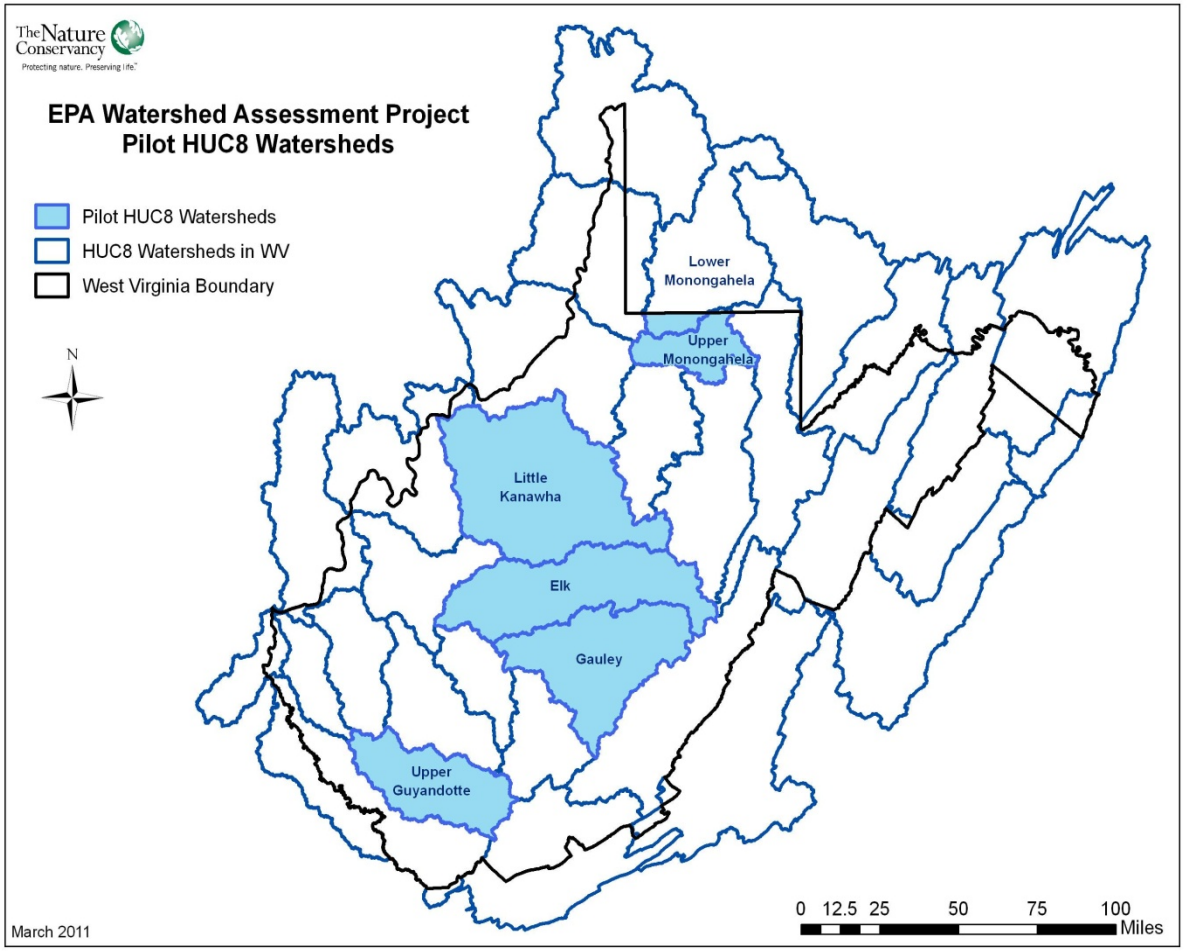
Project Objectives

- Design and test a watershed assessment process that can be replicated in WV's remaining watersheds
- Find datasets & develop metrics to measure Current Condition/Function & Future Threats
- Rank planning units in terms of Restoration & Protection Priorities
- Provide a decision support tool to assist partners, stakeholders, and regulatory staff with decisions affecting aquatic resources
- Identify data gaps & data needs

Project Study Area

5 HUC8 Watersheds:

- YEAR 1:
  - Monongahela
  - Elk
- **YEAR 2:**
  - **Gauley**
  - **Little Kanawha**
  - **Upper Guyandotte**



Project Process & Timeline

- First 2 Watersheds:
  - April 2011 – Project Start: Data Compilation
  - June 2011 – Technical Advisory Team Meeting
  - October 2011 – Expert Workshop #1
  - January 2012 – Expert Workshop #2
  - April 2012 – Stakeholder/Partner Workshops
  - June 2012 – Draft Watershed Reports completed
- Final 3 Watersheds:
  - June 2012 – Start Data Compilation
  - **October 2012 - Expert Workshop #1**
  - December 2012 - Expert Workshop #2
  - February 2013 - Stakeholder/Partner Workshops
  - April 2013 – Final reports & interactive web application completed

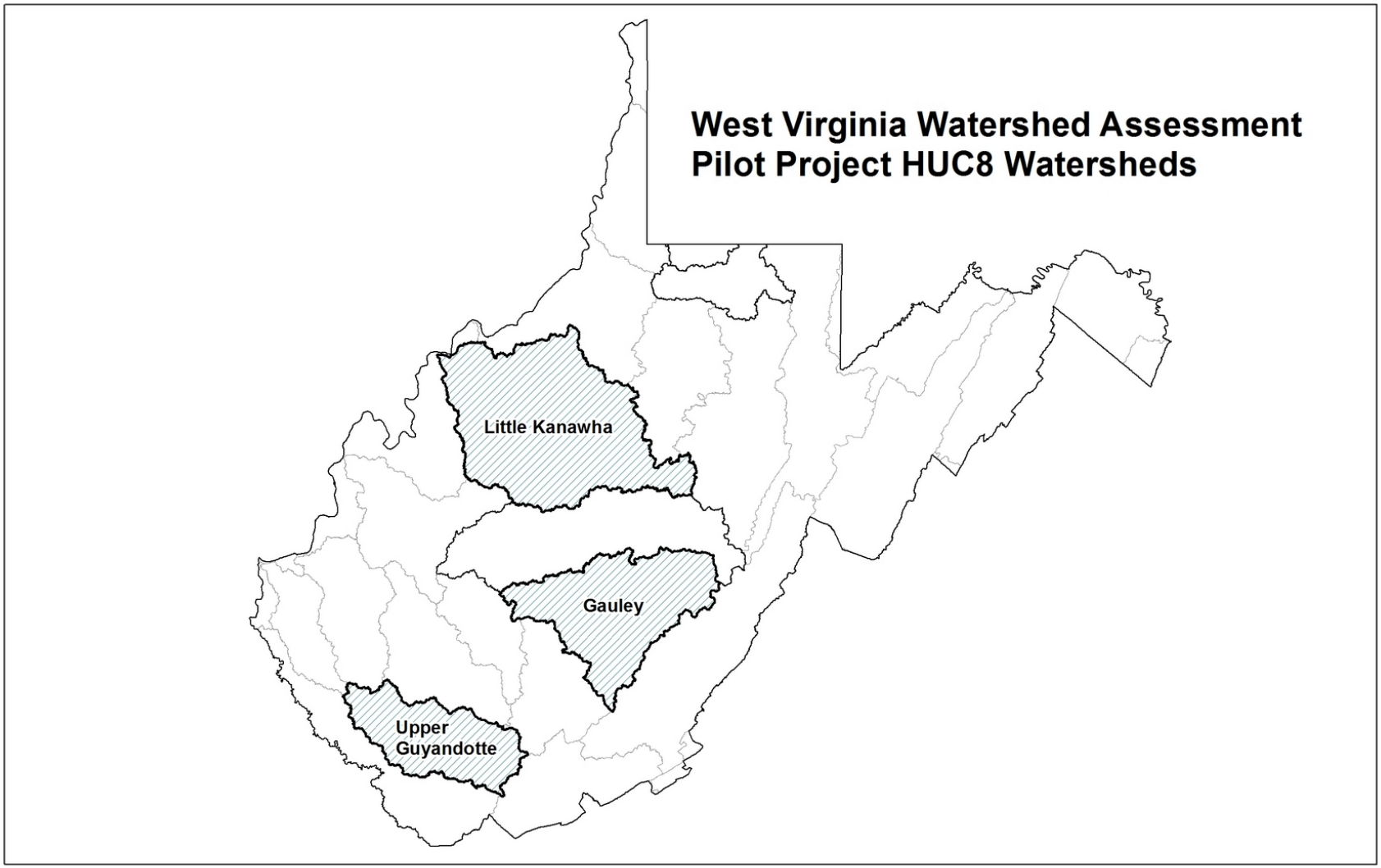
Methodology

1. Planning Units
2. Watershed Characterization
3. Model Structure
4. Prioritization Methods
5. Datasets & Metrics

Watershed Characterization

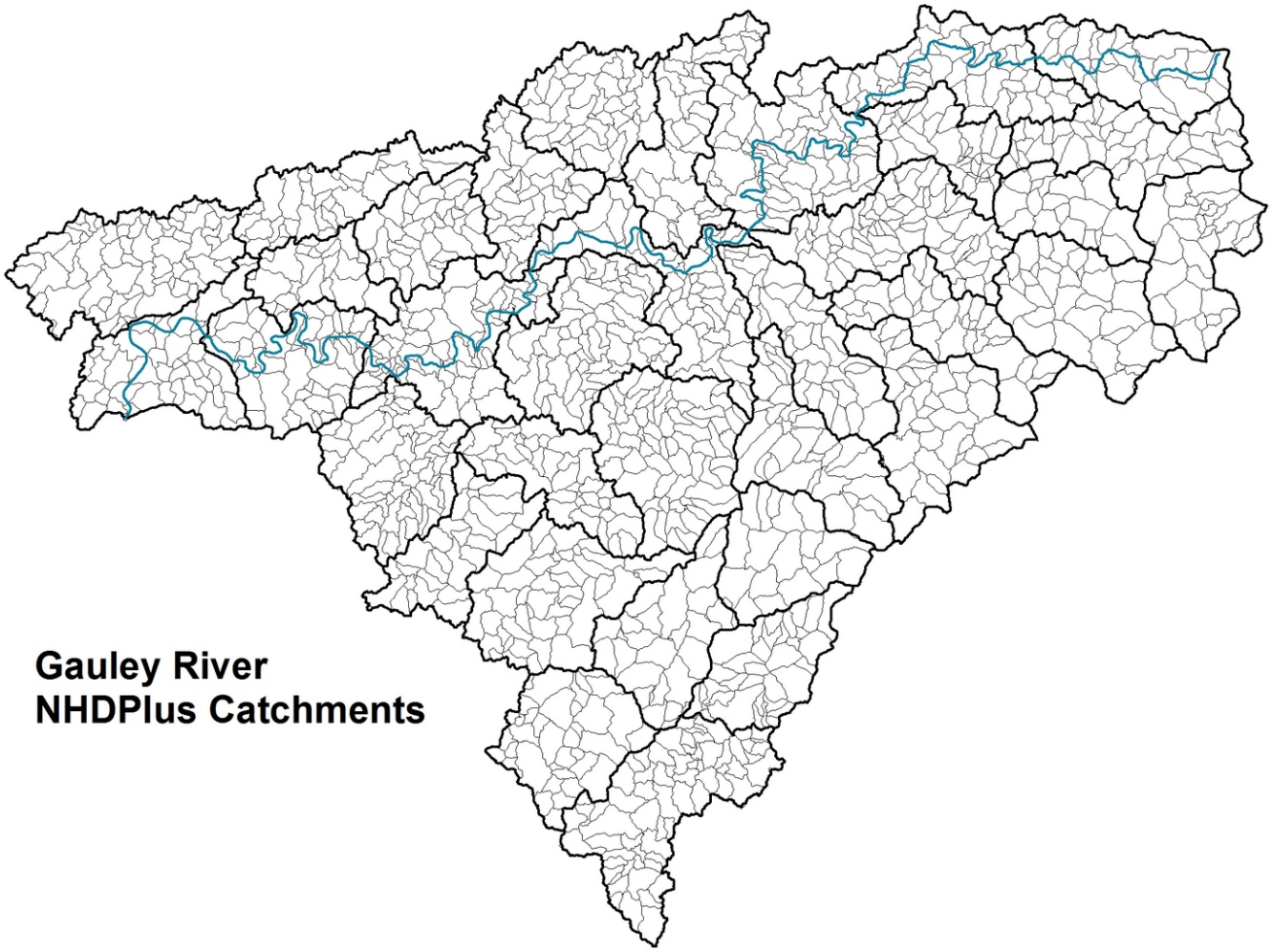
- Two Scales of Planning Units:
  - HUC-12 watersheds
  - Catchments

Project HUC8 Watersheds

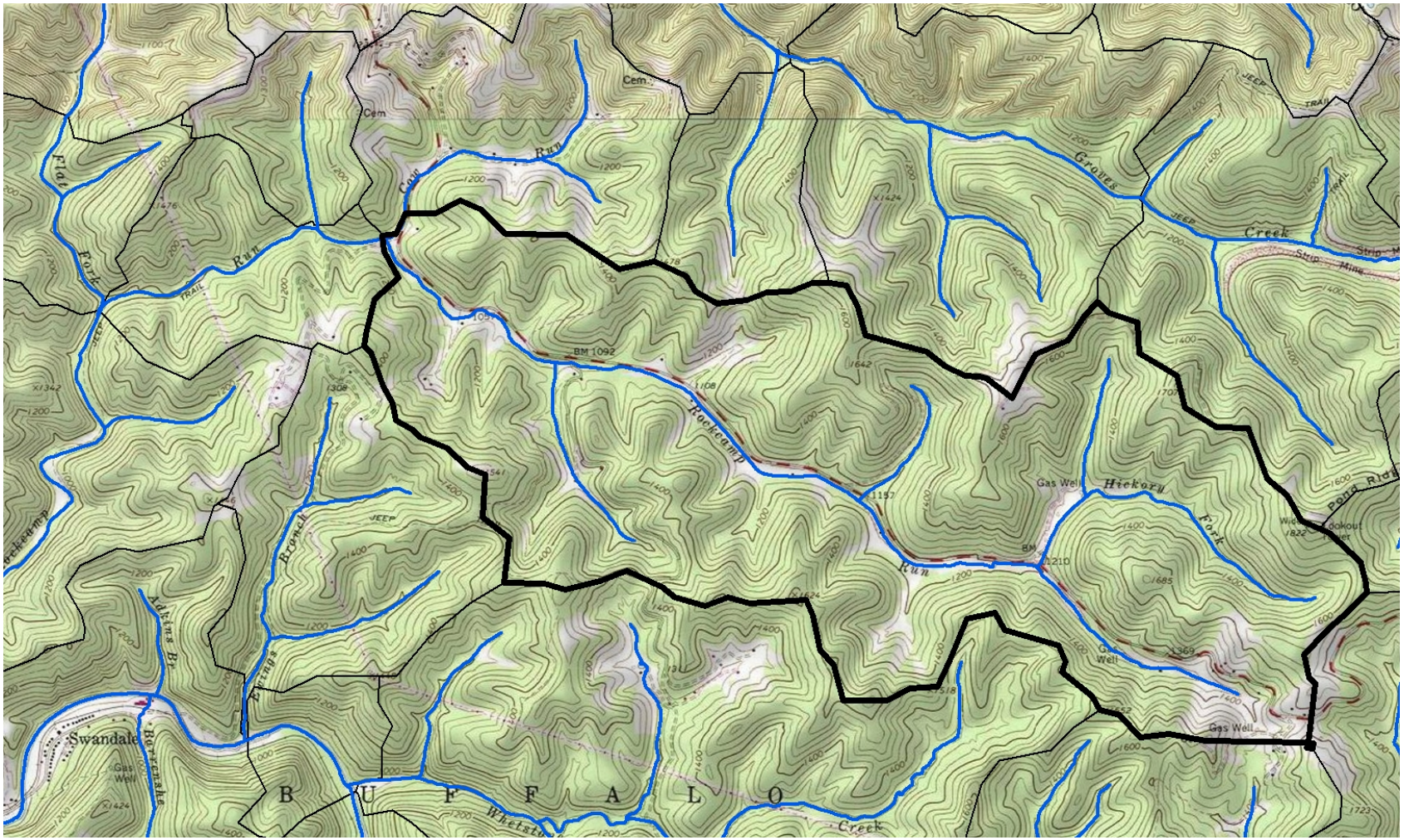


Planning Units 1: HUC12s

Planning Units 2: Catchments

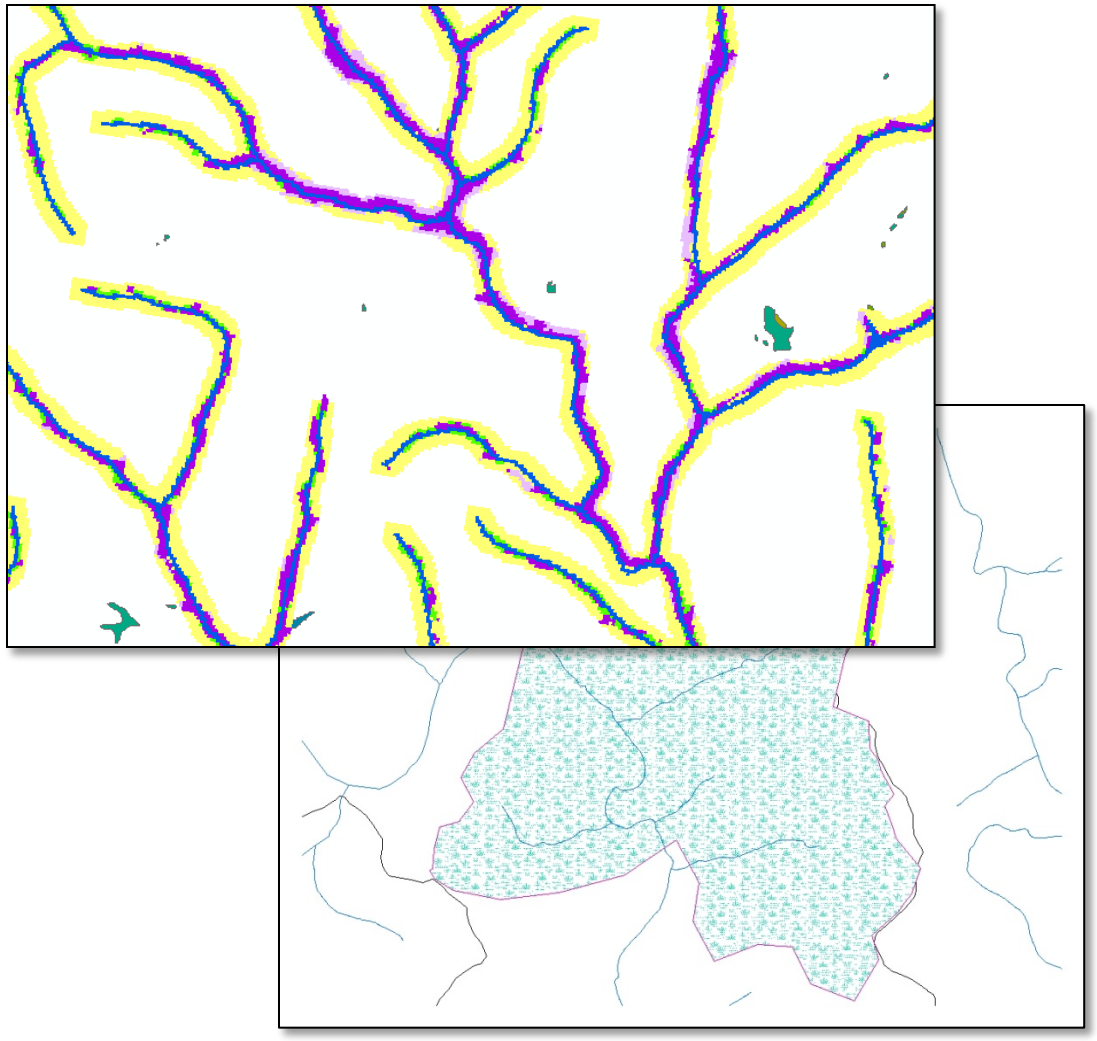


NHDPlus Catchments (modified)



Landscape Types

- Stream/Riparian Areas
- Wetlands
- Uplands



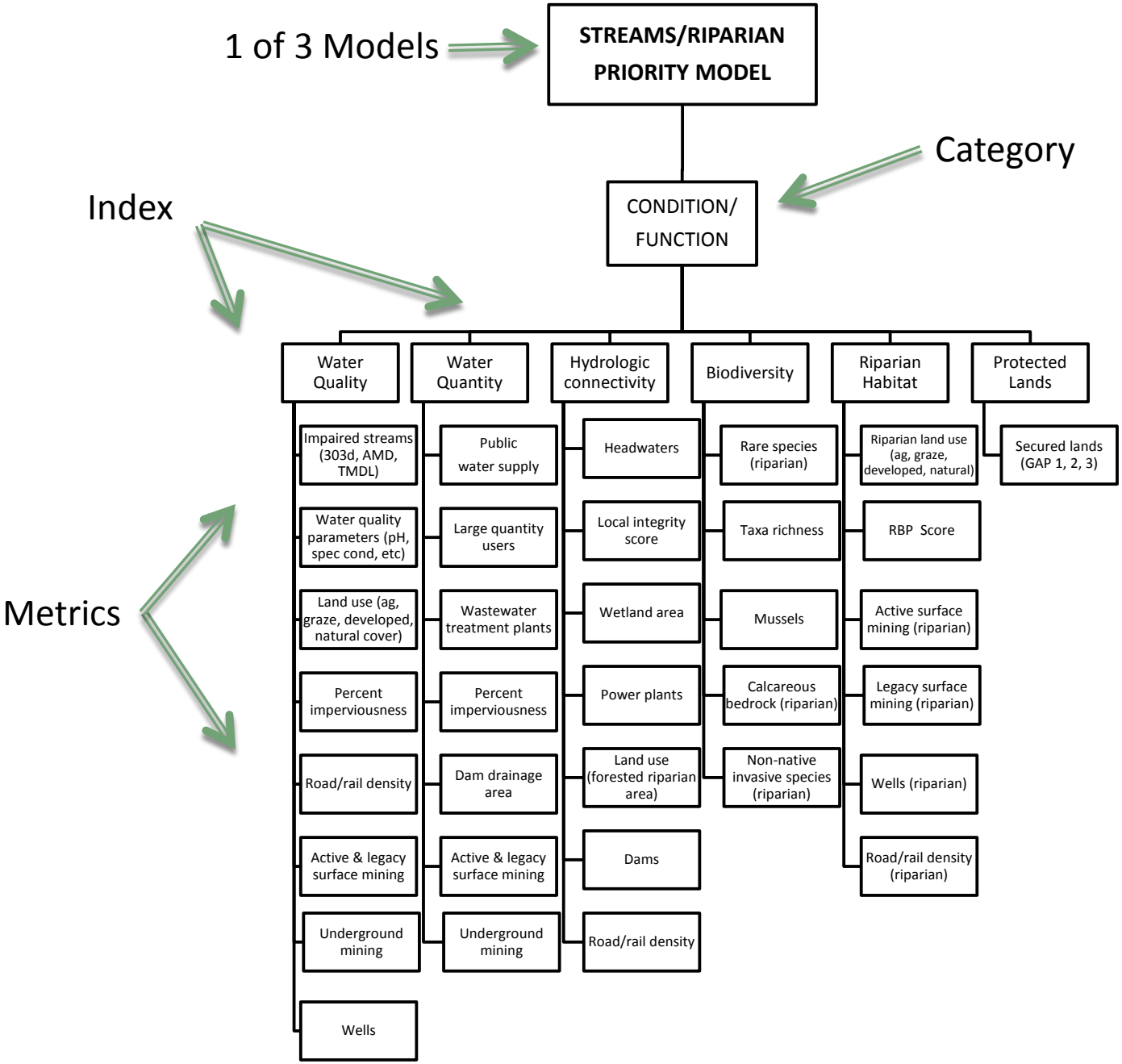
Planning Unit Prioritization

- **Phase I:**
  - Ranking of planning units according to current Condition/Function
- **Phase II – Consolidated Analysis:**
  - Cumulative Watershed Effects
  - Historical and Future Conditions
  - Evaluate target areas within planning units

Model Structure

Hierarchical Structure:

- 3 Models:
  - Streams
  - Wetlands
  - Uplands
- 2 Categories:
  - Condition/Function
  - Consolidated Analysis
- Several Indices per Category
- Multiple Metrics to define each index


1 of 3 Models
STREAMS/RIPARIAN PRIORITY MODEL
Category
CONDITION/ FUNCTION
Index
Water Quality
Water Quantity
Hydrologic connectivity
Biodiversity
Riparian Habitat
Protected Lands
Metrics
Impaired streams (303d, AMD, TMDL)
Water quality parameters (pH, spec cond, etc)
Land use (ag, graze, developed, natural cover)
Percent imperviousness
Road/rail density
Active & legacy surface mining
Underground mining
Wells
Public water supply
Large quantity users
Wastewater treatment plants
Percent imperviousness
Dam drainage area
Active & legacy surface mining
Underground mining
Headwaters
Local integrity score
Wetland area
Power plants
Land use (forested riparian area)
Dams
Road/rail density
Rare species (riparian)
Taxa richness
Mussels
Calcareous bedrock (riparian)
Non-native invasive species (riparian)
Riparian land use (ag, graze, developed, natural)
RBP Score
Active surface mining (riparian)
Legacy surface mining (riparian)
Wells (riparian)
Road/rail density (riparian)
Secured lands (GAP 1, 2, 3)

Redundant Metrics

- Perform Correlation Analysis to find highly correlated metrics
- Performed on HUC12 analysis
- PCA Analysis: to find metrics with greatest impact on water quality
- Eliminated several metrics

Metrics in Multiple Indices

- Some metrics appropriate in multiple indices:
  - Percent impervious cover
  - Surface mining
  - Oil and Gas wells
  - Road/railroad density
  - Landcover
- Indices are rated independently of each other
- Potential for double-counting of these metrics in overall model

Weighting

- Some metrics influence condition more than others – need to weight accordingly
- Preliminary weighting based on literature review, expert opinion, and “best guess”
- Weighted both individual metrics and individual indices

Relative vs. Objective Classification

- Relative ranking compares planning units with each other, but gives no information on which are good quality and which are not
- Need to define Thresholds for each metric to be able to assign to a category
- Literature review has only yielded a handful of objective thresholds
- Used the DEP's reference streams and stressed points to define thresholds

FEEDBACK/QUESTIONS?

Metrics: Condition/Function

1. Streams & Riparian Areas
2. Wetlands
3. Uplands

Indices: Streams

CONDITION/ FUNCTION

- Water quality
- Water quantity
- Hydrologic Connectivity
- Biodiversity
- Riparian Habitat
- Protected Lands

Water Quality Metrics

- DEP's Water Quality Data
- GLIMPSS
- Surface & Underground Mining
- Impervious Surface
- Landuse/Landcover:
  - Agricultural
  - Grazed
  - Natural
  - Developed
- Oil and Gas Wells
- Road/railroad density
- Karst

Water Quantity Metrics

- No good direct measurements for most streams, especially headwaters, had to find surrogates:
  - Dam drainage area
  - Impervious surface
  - Large Quantity users
  - Mining: Surface & Underground

Hydrologic Connectivity Metrics

- Unimpeded Streams (stream lengths without impoundments or waterfalls)
- Percent riparian area with forested cover
- Roads/railroads
- Culverts
- Bridges
- Percent of stream miles that are headwaters

Biodiversity Metrics

- Rare and threatened species (includes DNR's SGNC species), including mussels, fish, crayfish, odonates
- Rare species index (calculated from # geology classes, elevation range, calcareous bedrock)
- Trout streams
- Non-native invasive species
- Mussel streams

Riparian Habitat Metrics

- Riparian land use
- Active surface mining
- Oil and gas wells
- Road/railroad density
- Pipelines, transmission lines, buildings

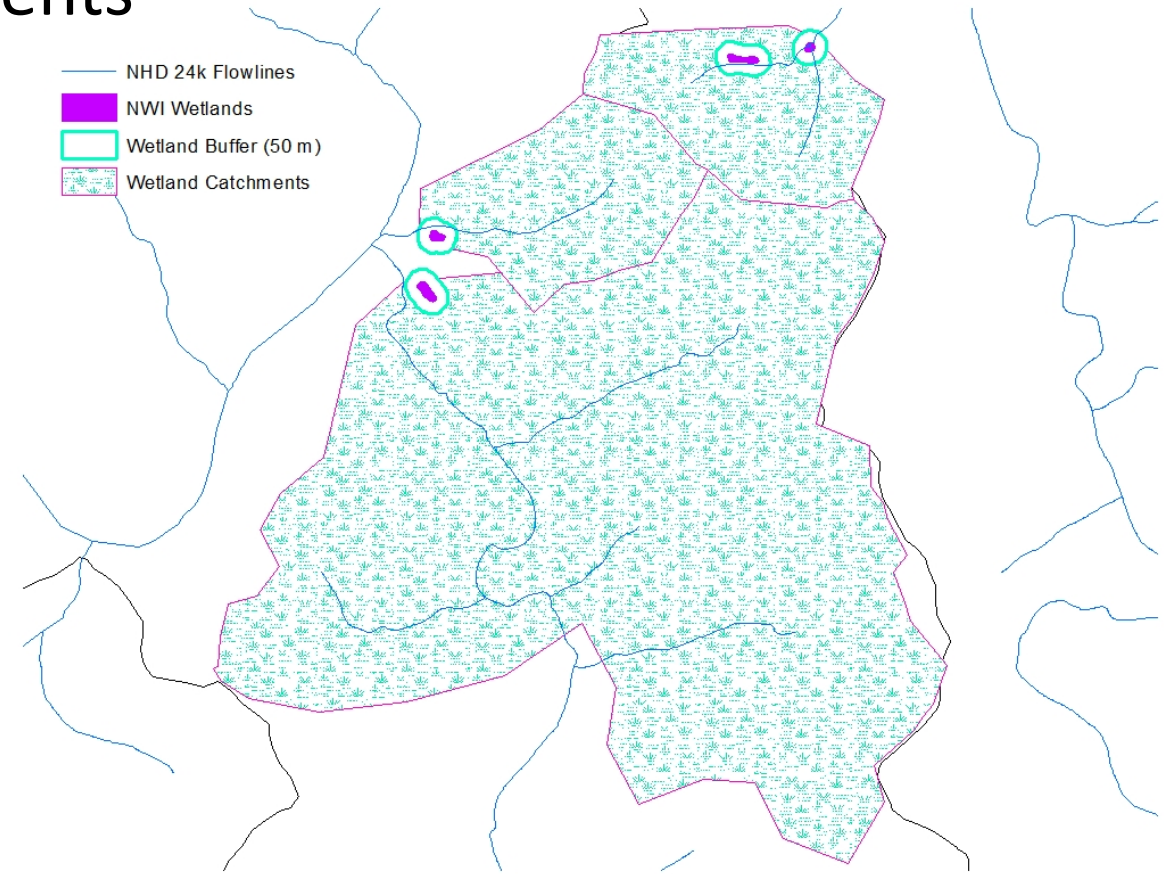
Indices: Wetlands

CONDITION/ FUNCTION

- Water quality: Pollutant filtration/sediment retention
- Hydrology: Flood storage/connectivity
- Biodiversity
- Wetland Habitat
- Protected Lands

Wetland Buffer vs. Catchment

- Wetland buffer (50 m)
- Wetland catchments (delineated using contributing NHDPlus catchments)



Planning Units without Wetlands

- Several planning units did not have mapped NWI wetlands
- Null values for metrics dependent on presence of wetlands
- Only 2 indices had values for all planning units:
  - Wetland Hydrology (presence of hydric soils)
  - Biodiversity

Water Quality Metrics

- Forested headwater wetlands
- Landcover in wetland catchments (% ag, grazing, urban, forested, natural)
- % imperviousness in catchment
- Roads/railroads in catchment
- Mining and oil & gas wells in catchment
- Septic systems, landfills, timbering in catchment

Wetland Hydrology Metrics

- Wetland area and size
- Ratio of wetland catchment area to wetland area
- Distance to nearest surface water
- Hydric soils (potential for wetland restoration)
- Forested flood plain wetlands
- Floodplain area

Indices: Uplands

CONDITION/ FUNCTION

- Habitat Connectivity
- Upland Habitat
- Biodiversity
- Protected Lands

Habitat Connectivity metrics

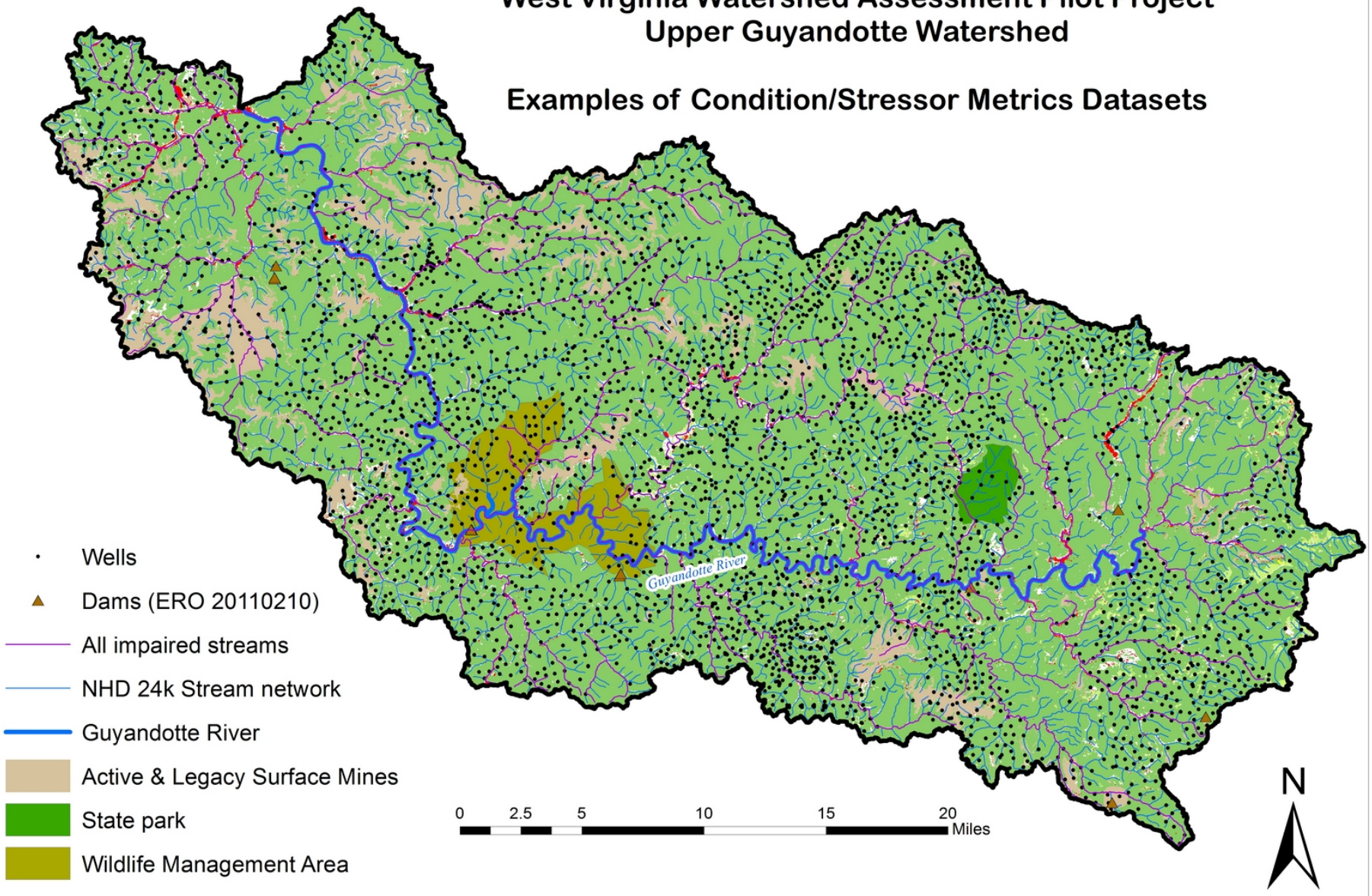
- Forest Block Sizes
- Active surface mining, coal production
- Oil & gas wells
- Road/railroad density
- Transmission lines, pipelines
- Wind turbines, FCC towers
- Buildings, landfills
- Timber harvests

Biodiversity Metrics

- Rare and threatened species (includes DNR's SGNC species)
- Non-native invasive species
- Number of vegetation types
- Calcareous bedrock
- Pests and Pathogens: Percent loss (basal area), hardwood decline
- Rare species index (calculated from # geology classes, elevation range, calcareous bedrock)
- Number of ecoregional subdivisions

West Virginia Watershed Assessment Pilot Project
Upper Guyandotte Watershed

Examples of Condition/Stressor Metrics Datasets

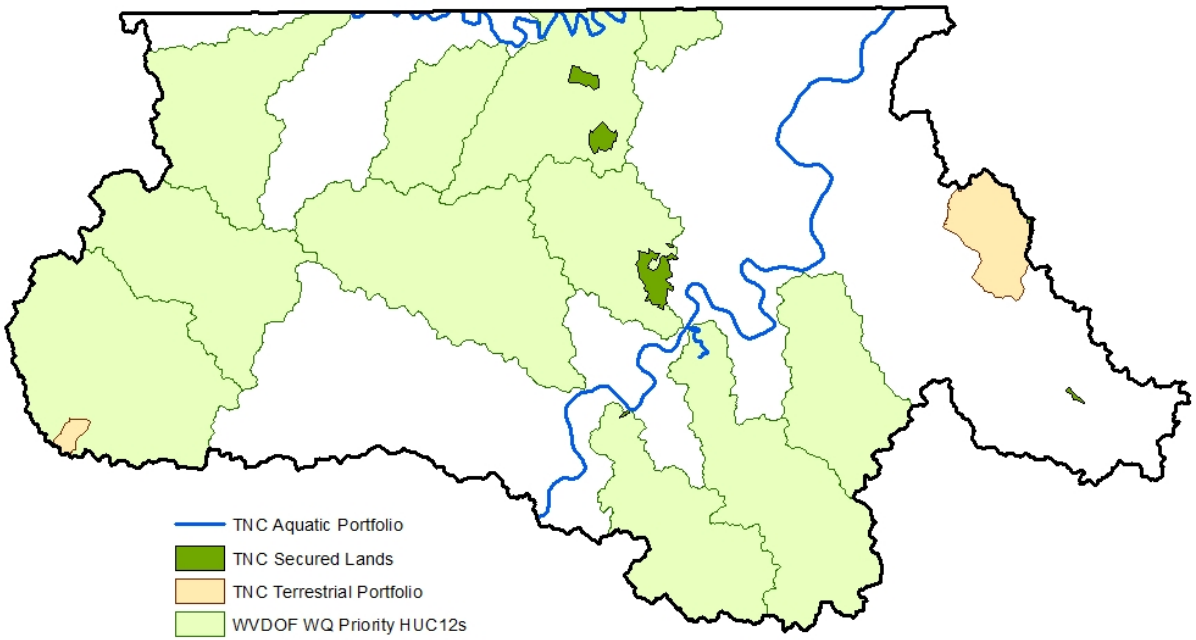


Metrics: Consolidated Analysis

1. Priority Interest Areas
2. Future Threats

Priority Interest Areas

- USFS Forest Proclamation Boundary
- WV Division of Forestry priority areas
- TNC aquatic and terrestrial portfolios



Future Threats

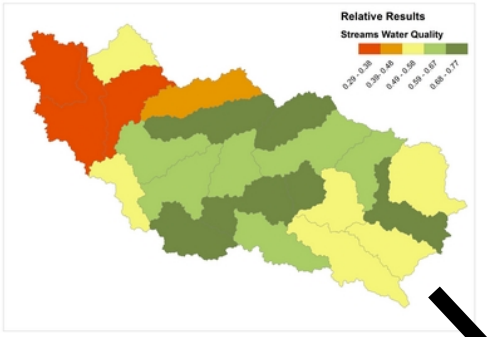
- Energy
  - Marcellus Shale thickness, proposed wells
  - Unmined coal, permitted mines
  - Wind potential
  - Proposed transmission lines, pipelines
- Population/Development
  - Future Growth Areas/Population projections
  - Proposed Roads
- Climate Change
- Projected Land Use
  - Projected Agriculture/mining/urban development

Index and Model Results

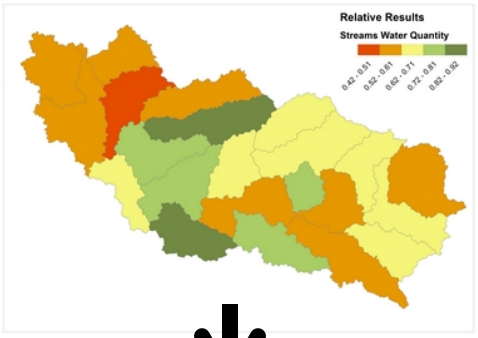
Rollup of Metrics – Relative Method

- Standardized metrics:
  - Set highest quality value to 1, lowest to 0
  - Distributed rest of values between 0 and 1
- For index scores: averaged all metrics according to metric weights
- For model scores: averaged all Indices according to index weights
- Resulted in Ranks for each index and model
- Grouped into Equal Interval Categories
- Done independently at HUC12 and Catchment levels

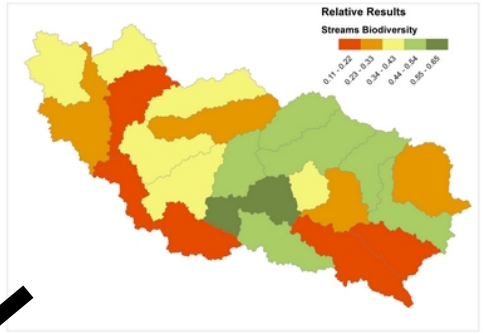
Water Quality



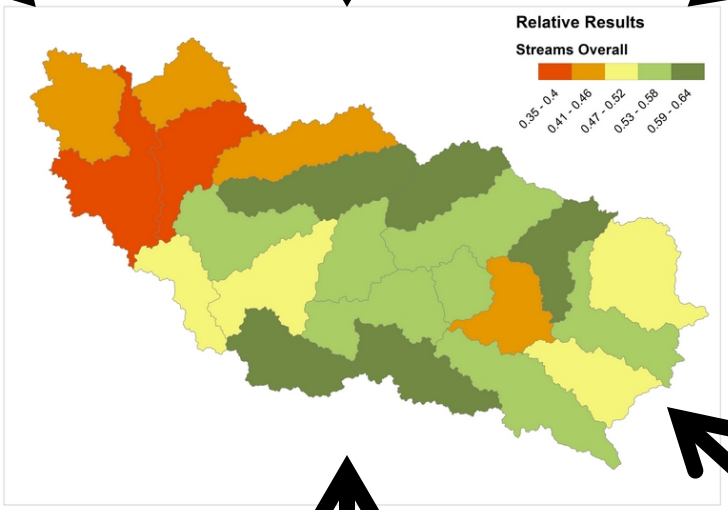
Water Quantity

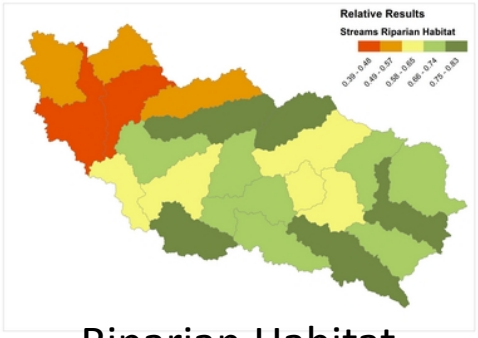


Biodiversity

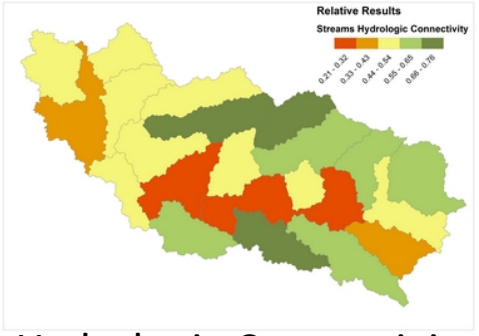


Streams: Upper Guyandotte Overall Ranking HUC12s

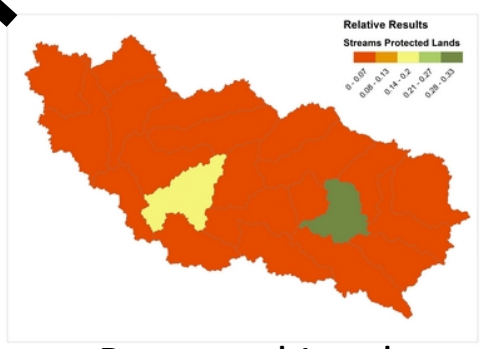




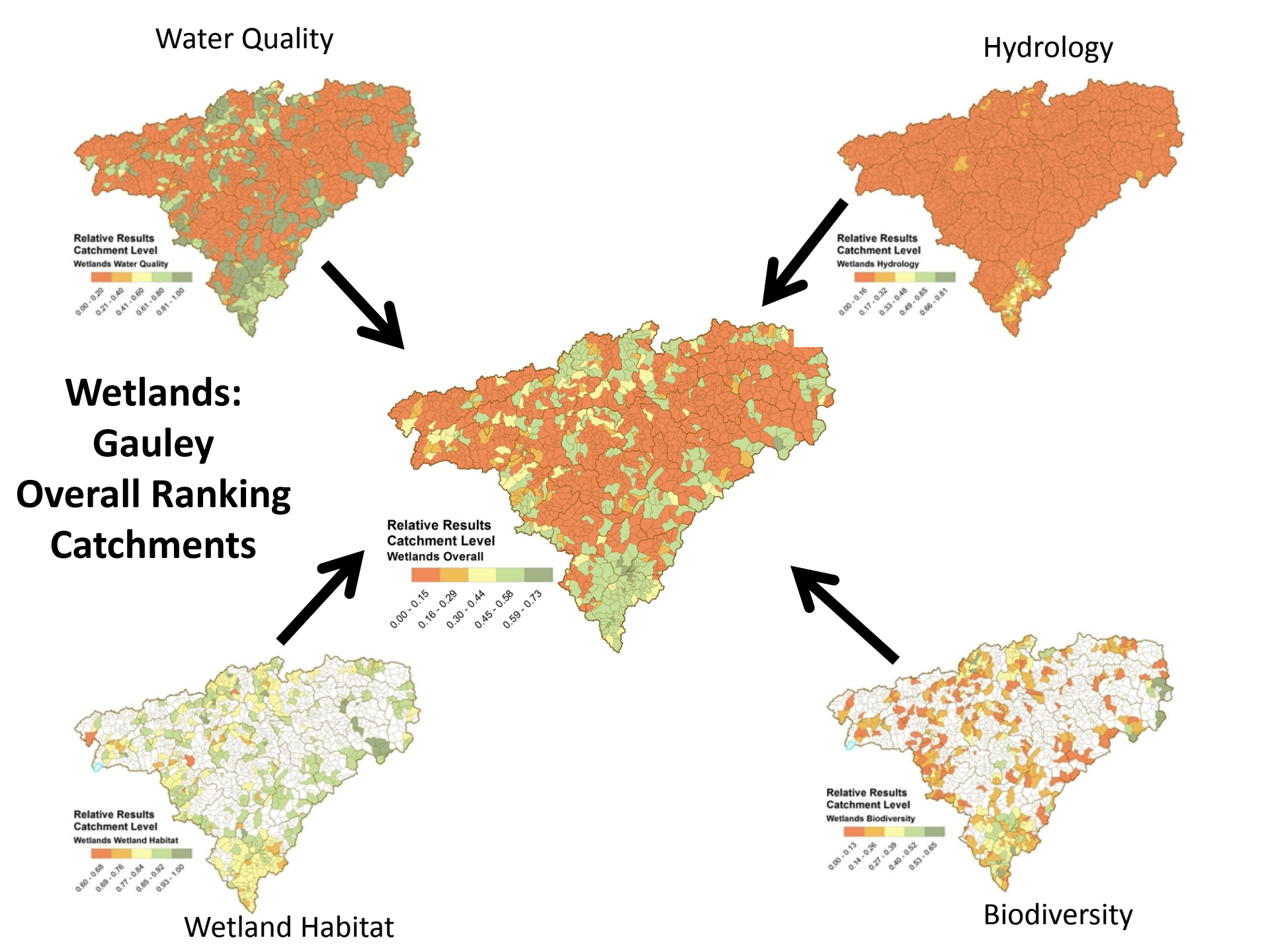
Riparian Habitat



Hydrologic Connectivity



Protected Lands


Water Quality
Relative Results
Catchment Level
Wetlands Water Quality
0.00 - 0.20
0.21 - 0.40
0.41 - 0.60
0.61 - 0.80
0.81 - 1.00
Hydrology
Relative Results
Catchment Level
Wetlands Hydrology
0.00 - 0.16
0.17 - 0.32
0.33 - 0.48
0.49 - 0.65
0.66 - 0.81
Wetlands:
Gauley
Overall Ranking
Catchments
Relative Results
Catchment Level
Wetlands Overall
0.00 - 0.15
0.16 - 0.29
0.30 - 0.44
0.45 - 0.58
0.59 - 0.73
Relative Results
Catchment Level
Wetlands Wetland Habitat
0.60 - 0.68
0.69 - 0.76
0.77 - 0.84
0.85 - 0.92
0.93 - 1.00
Wetland Habitat
Relative Results
Catchment Level
Wetlands Biodiversity
0.00 - 0.13
0.14 - 0.26
0.27 - 0.39
0.40 - 0.52
0.53 - 0.65
Biodiversity

Final Product Overview

Project Outputs

- **Five watershed assessment reports**

Will include specific priorities and strategies, as well as detailed methodology, references and lessons learned

- **Interactive web mapping application**

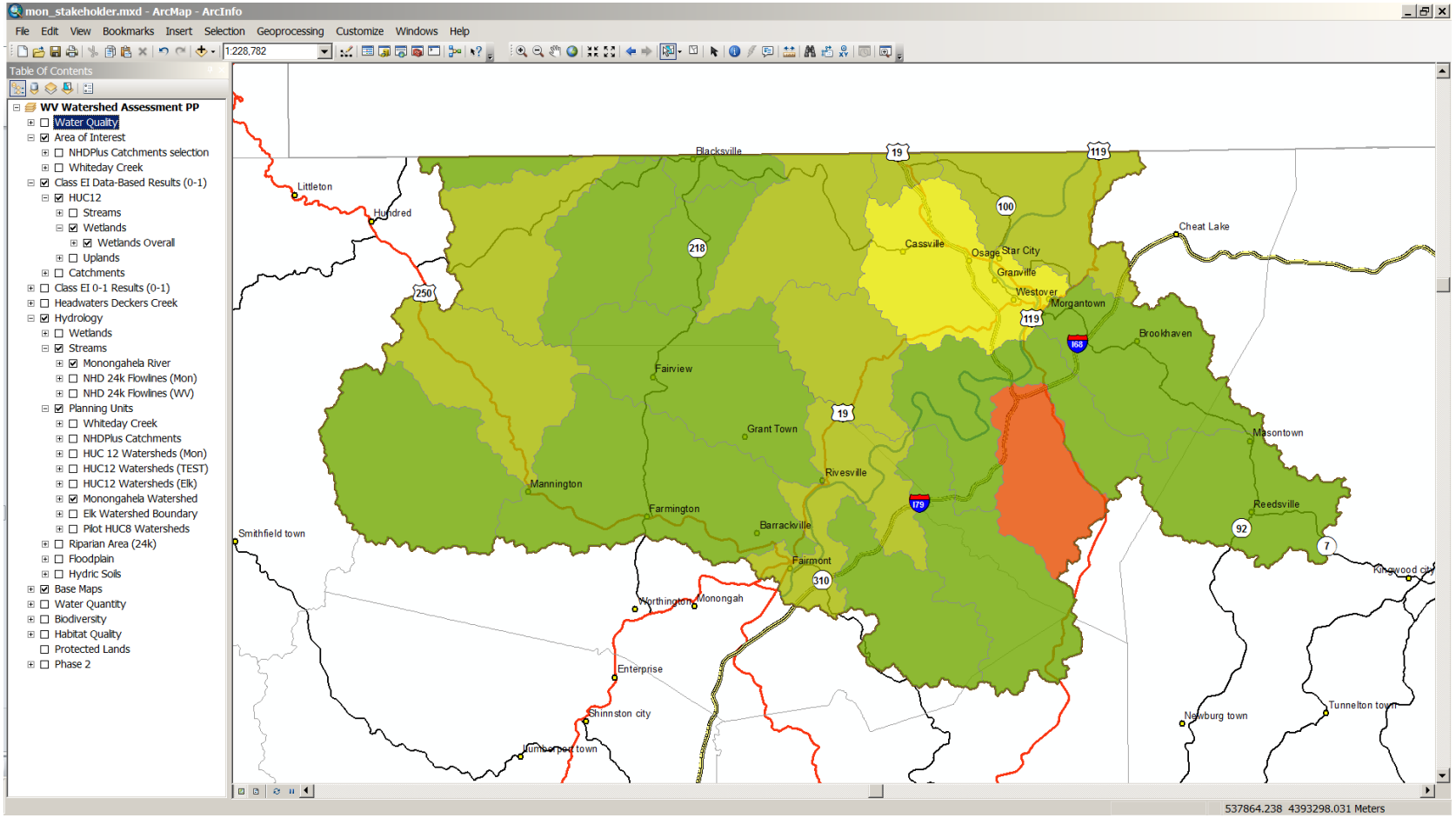
A spatial decision support tool to assist stakeholders in identifying target areas, strategies and actions

Interactive Web Mapping Application

Desktop tool that will allow users to:

- View the various datasets in one application
- View results of all scores and rankings
- Develop customized scenarios to rank target areas for restoration and/or protection projects according to users' priorities

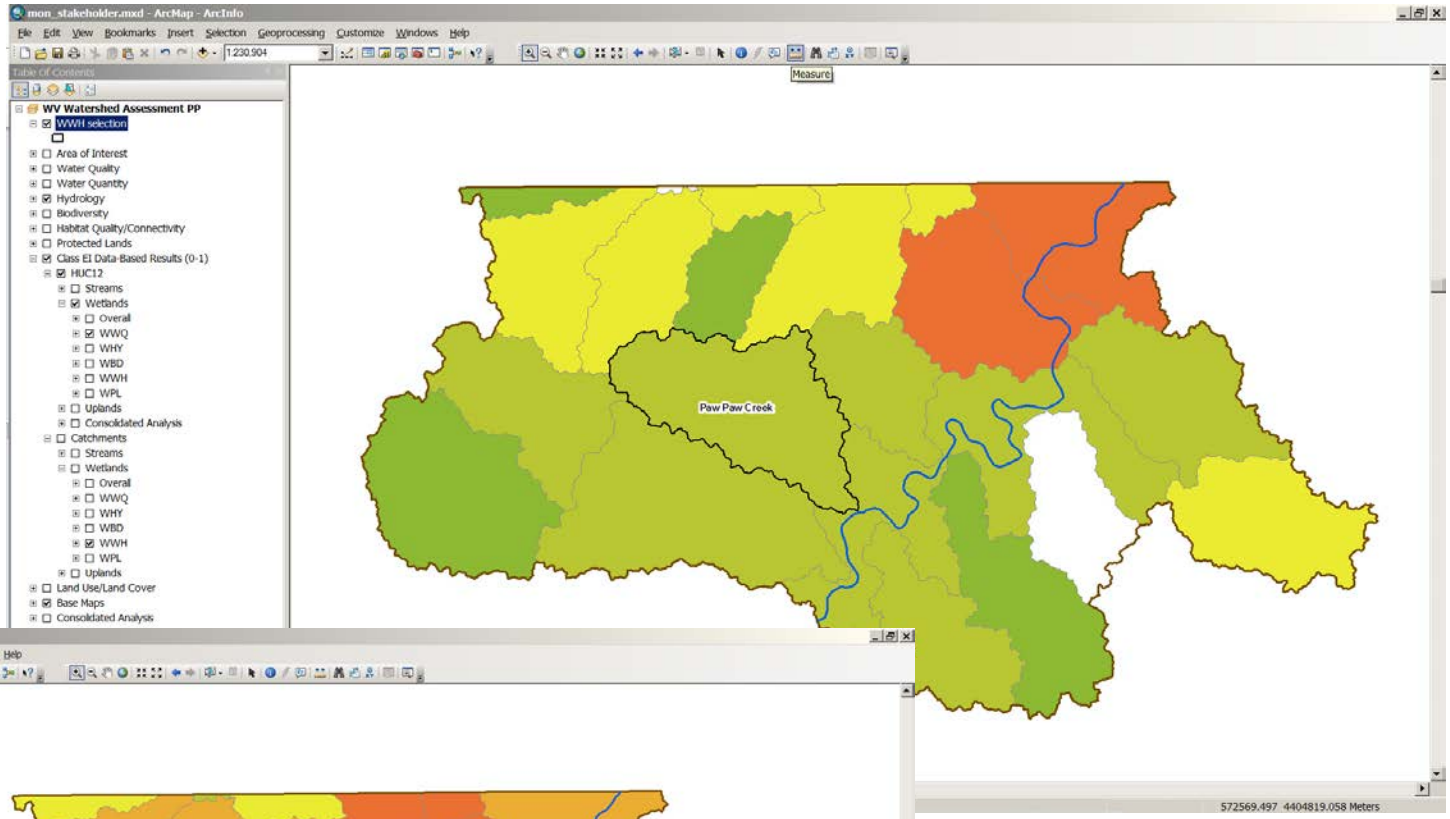
Wetlands Restoration

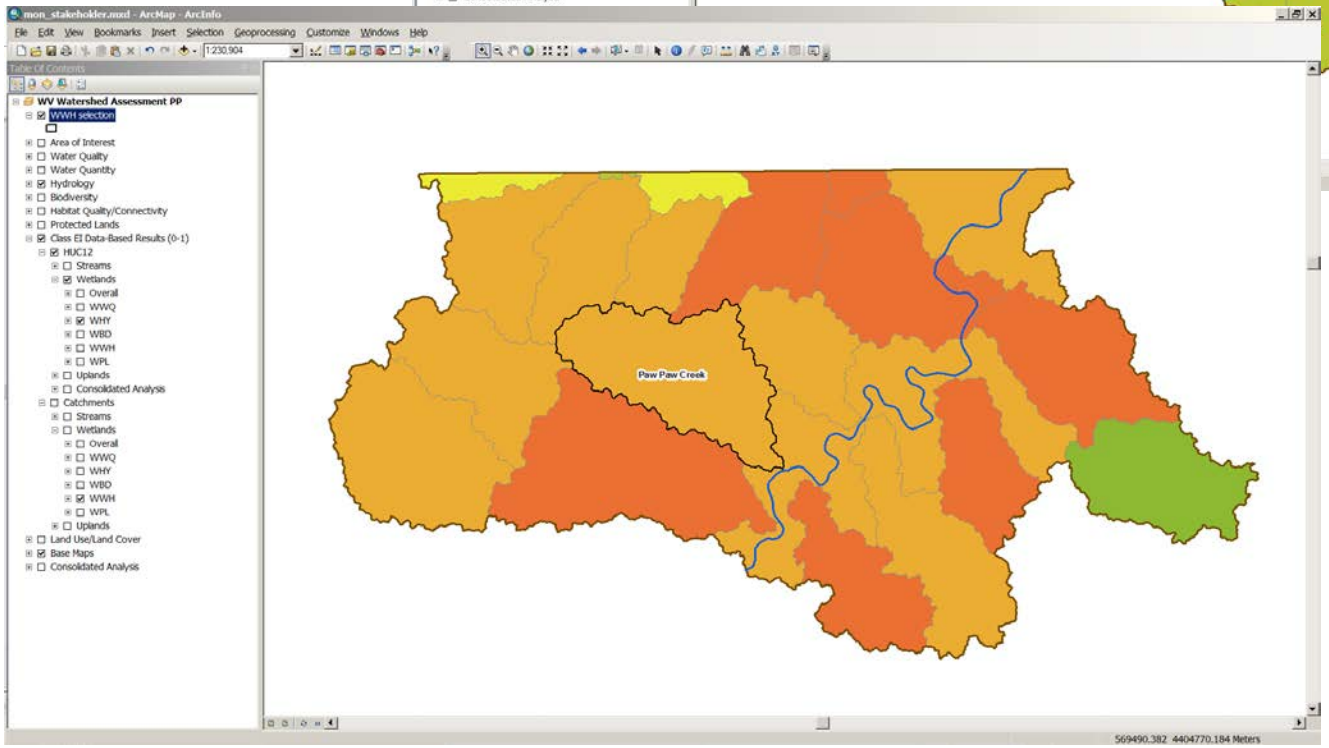


Monongahela – HUC12 Level
Wetlands Overall Results*

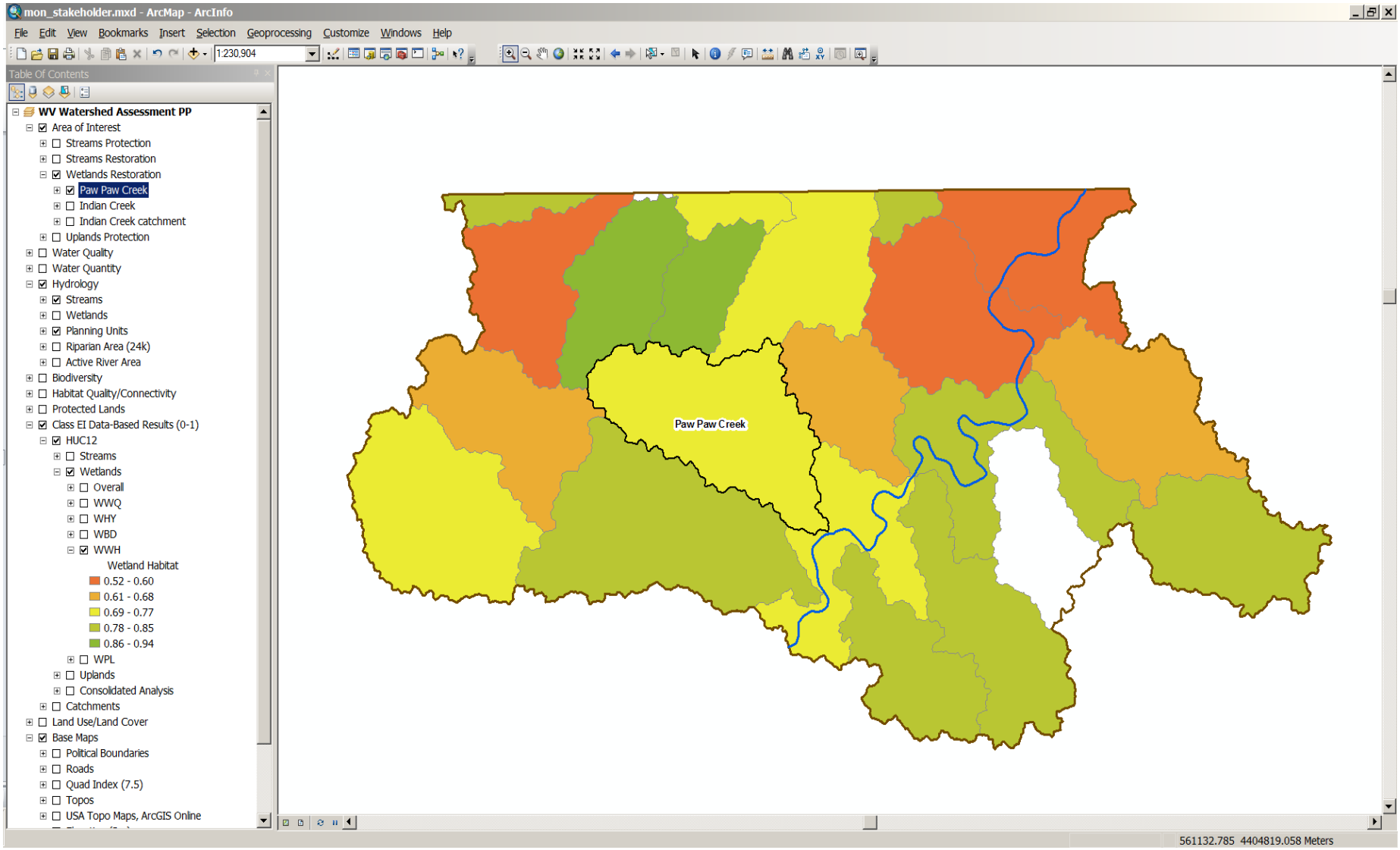
(*All results presented are **preliminary** and currently used for illustrative purposes only)

Wetlands
HUC12 Level
Water Quality

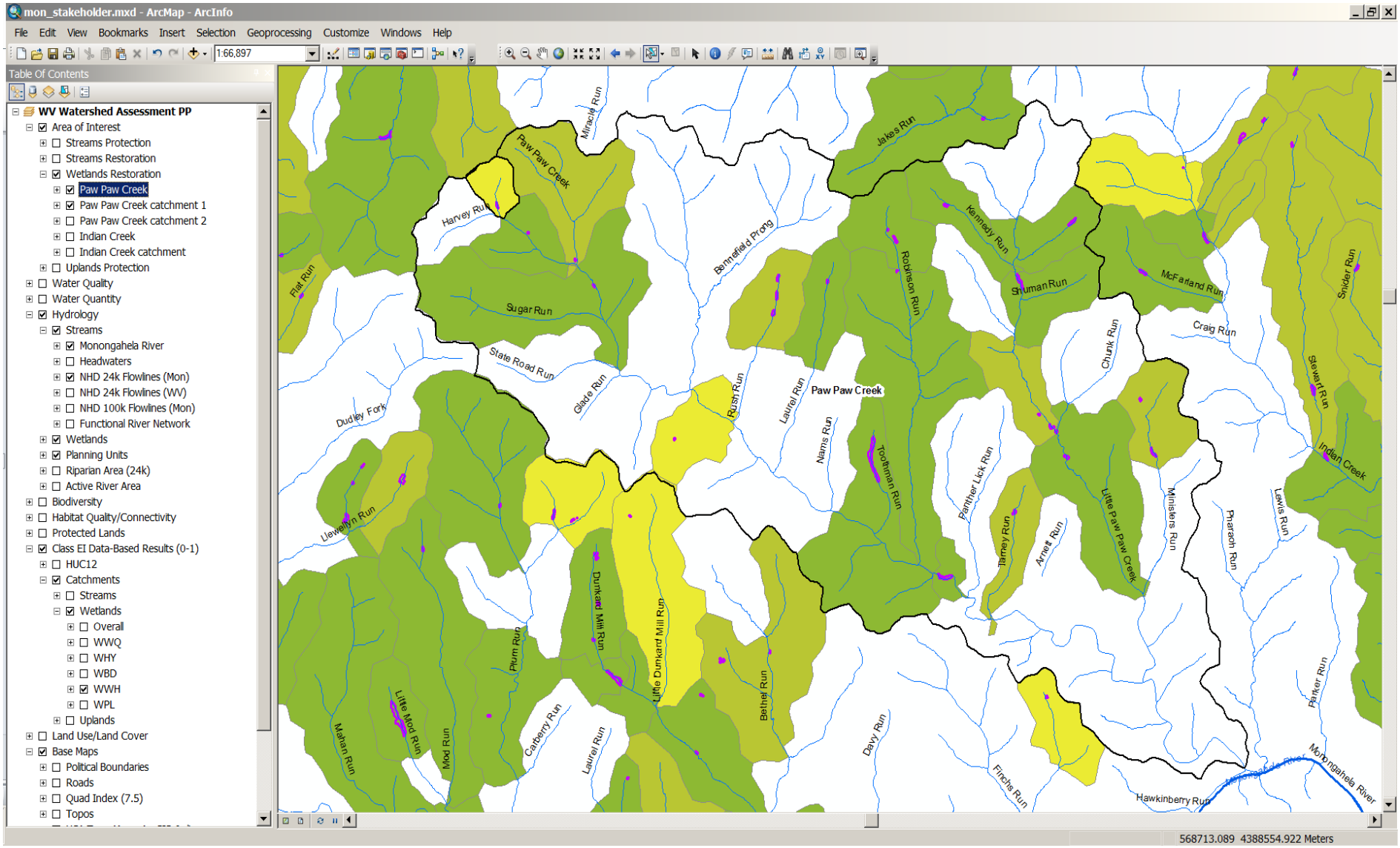




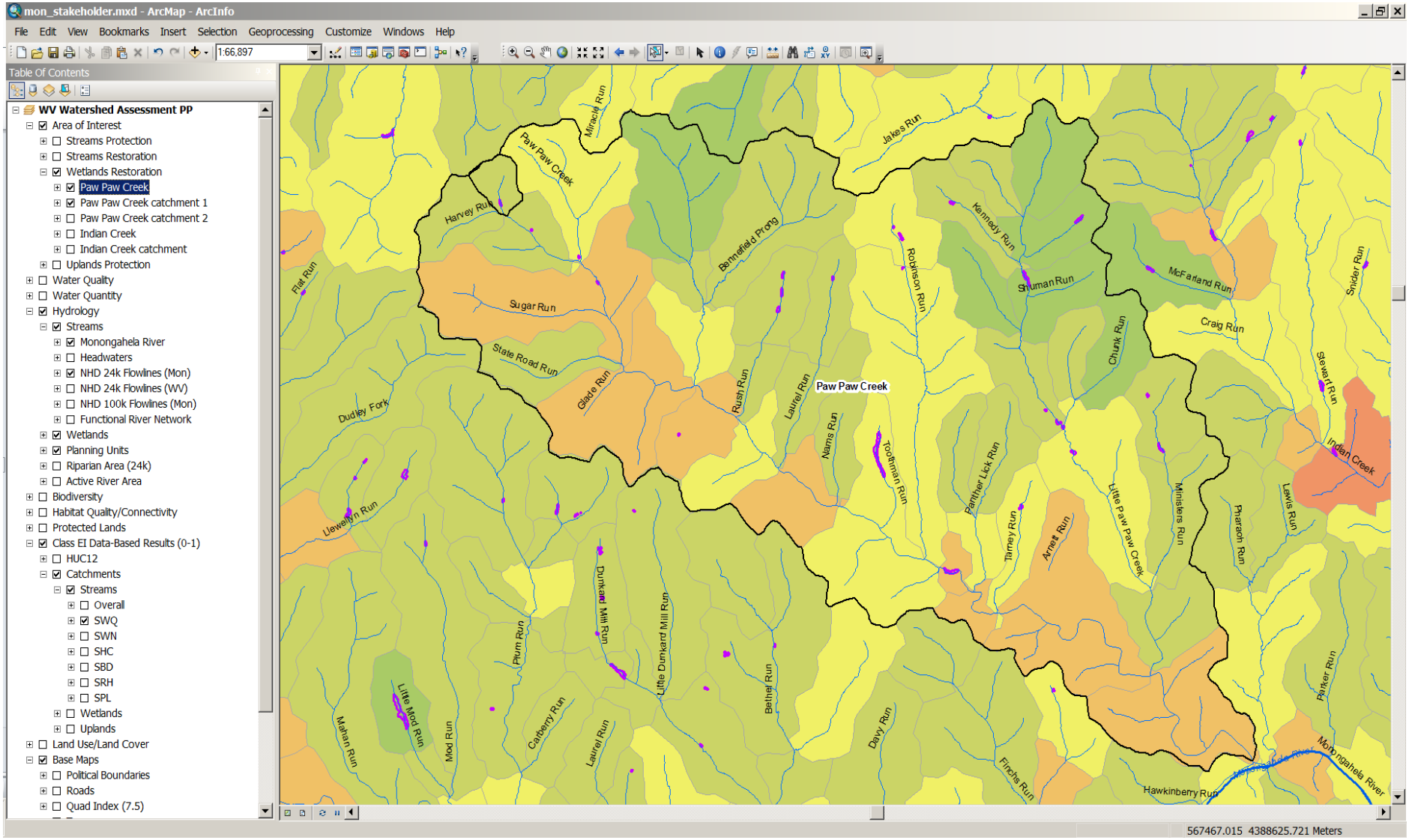
Wetlands
HUC12 Level
Hydrology



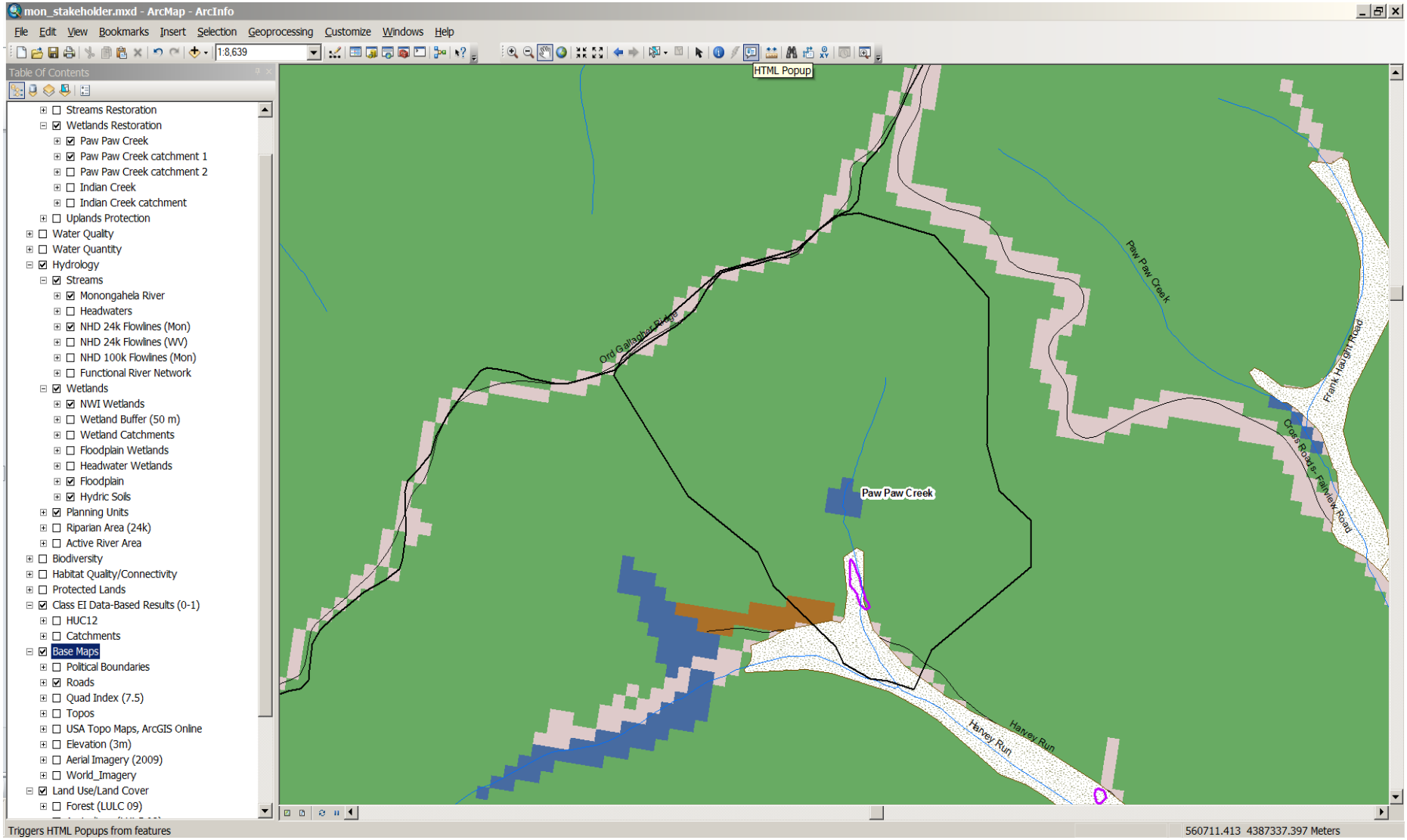
Wetlands - HUC12 Level
Wetland Habitat



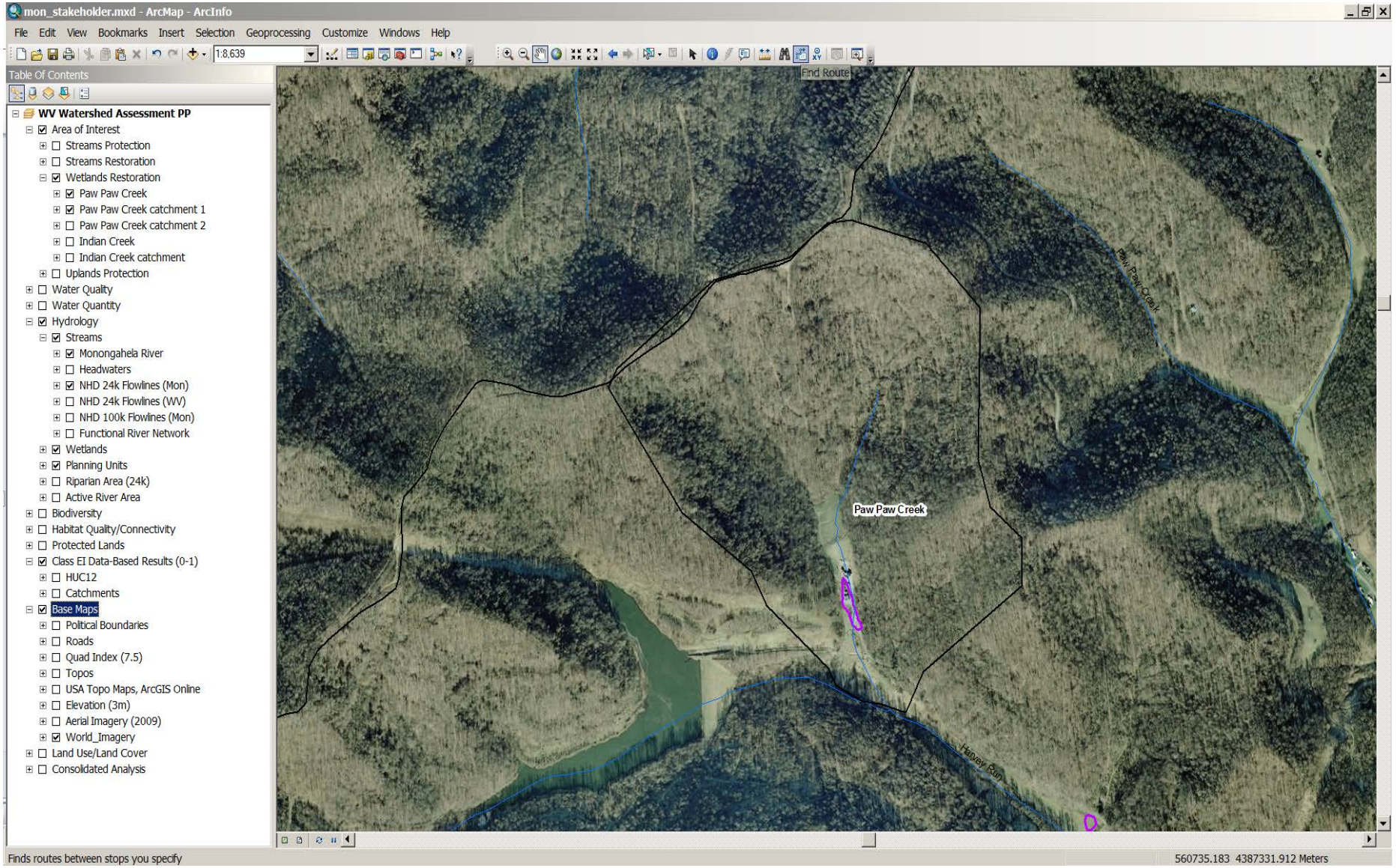
Wetlands - Catchment Level
Wetland Habitat Results



Streams - Catchment Level
Water Quality Results



Wetlands Catchment Level – Roads, LULC, Hydric soils, (Floodplain)



Wetlands Catchment Level – Aerial Imagery

Word of Caution for Users

- This is purely a GIS-based analysis with no field verification
- Suggested Strategy for selecting potential protection/restoration sites:
  - Select several candidate planning units using the GIS tool
  - Conduct site visits to evaluate current conditions on the ground
  - Make final decision based on results from GIS analysis and site visits

FEEDBACK/QUESTIONS?

Objective Ranking Methodology

Relative vs. Objective Classification

- Relative ranking compares planning units with each other, but gives no information on which are good quality and which are not
- Need to define Thresholds for each metric to be able to assign to a category
- Literature review has only yielded a handful of objective thresholds
- Used the DEP's reference streams and stressed points to define thresholds

Objective Analysis Categories

- Very Good: Ecologically desirable status; requires little intervention for maintenance
- Good: Indicator within acceptable range of variation; some intervention required for maintenance

Restoration Threshold

- Fair: Outside acceptable range of variation; requires human intervention
- Poor: Restoration increasingly difficult; may result in extirpation of target

Reference Criteria

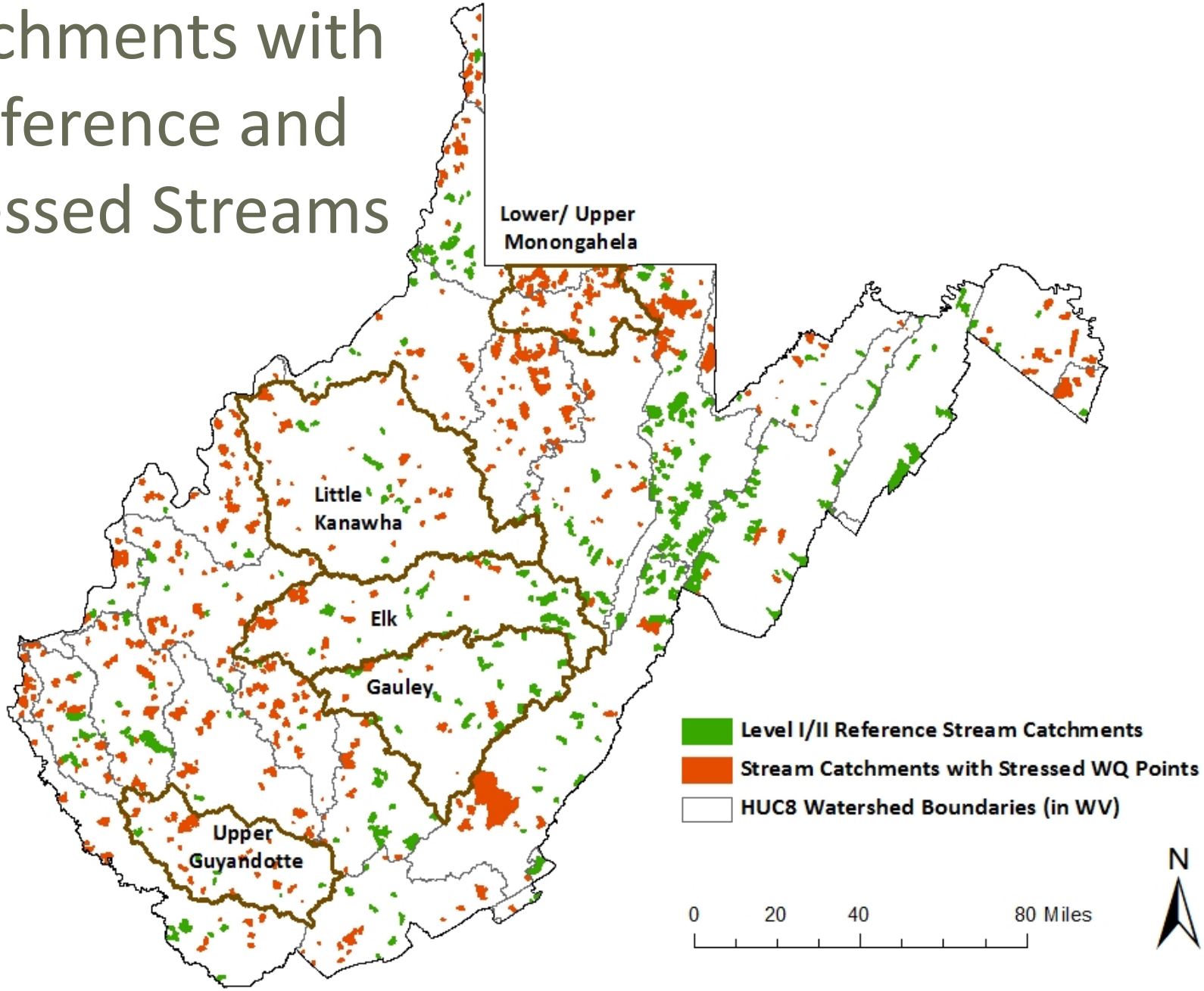
- Dissolved Oxygen: ≥ 6.0 mg/l
- pH: ≥ 6.0 and ≤ 9.0
- Conductivity: <500 µmhos/cm
- Fecal coliform: <800 colonies/100 ml
- No obvious sources of non-point-source pollution
- RBP Epifaunal substrate score: ≥11
- RBP Channel alteration score: ≥11
- RBP Sediment deposition score: ≥11
- RBP Bank disruptive score: ≥11
- RBP Riparian vegetation zone width score: ≥6
- RBP Total habitat score: 65% of maximum 240
- Evaluation of anthropogenic activities and disturbances
- No known point source discharges upstream of assessment site

Stressed Criteria

- Dissolved Oxygen: <4.0 mg/l
- pH: <4.0 or >9.0
- Conductivity: >1000 µmhos/cm
- Fecal coliform: >5,000 colonies/100 ml
- RBP Epifaunal substrate score: <7
- RBP Channel alteration score: <7
- RBP Sediment deposition score: <7
- RBP Bank disruptive score: <7
- RBP Riparian vegetation zone width score: <4
- RBP Total habitat score: <120

Site was considered stressed if it met at least 2 of the criteria

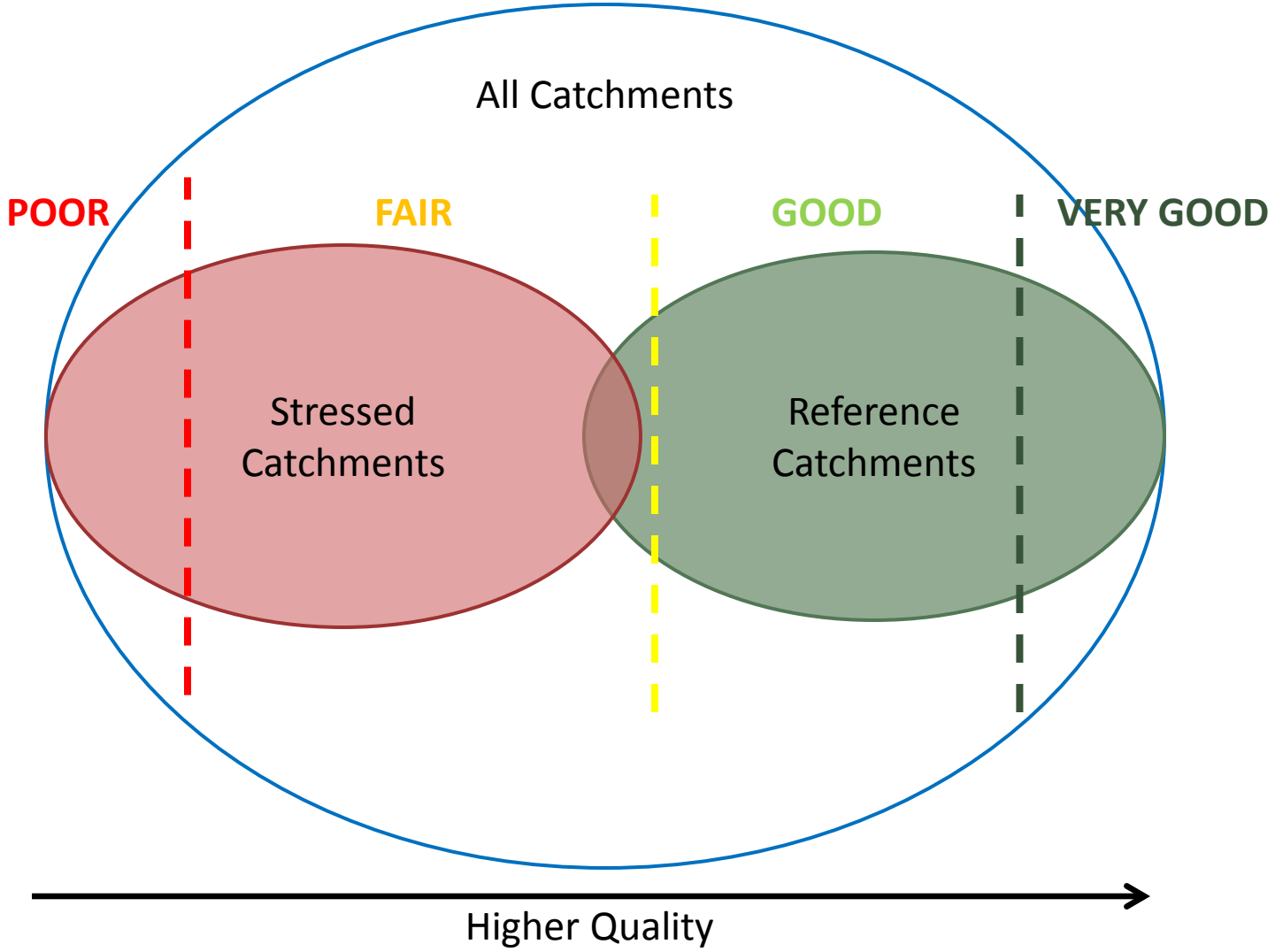
Catchments with Reference and Stressed Streams



Objective Ranking Methodology

- Calculated metrics for stressed and reference catchments separately:
  - Reference catchments to define very good/good and fair/good thresholds
  - Stressed catchments to define fair/poor threshold
- Examined the distribution of values for each metric, considered using median, $25^{th}/75^{th}$, $90^{th}/10^{th}$, or $95^{th}/5^{th}$ percentiles
- Results were most consistent using the $25^{th}/75^{th}$ percentiles

Objective Ranking Methodology



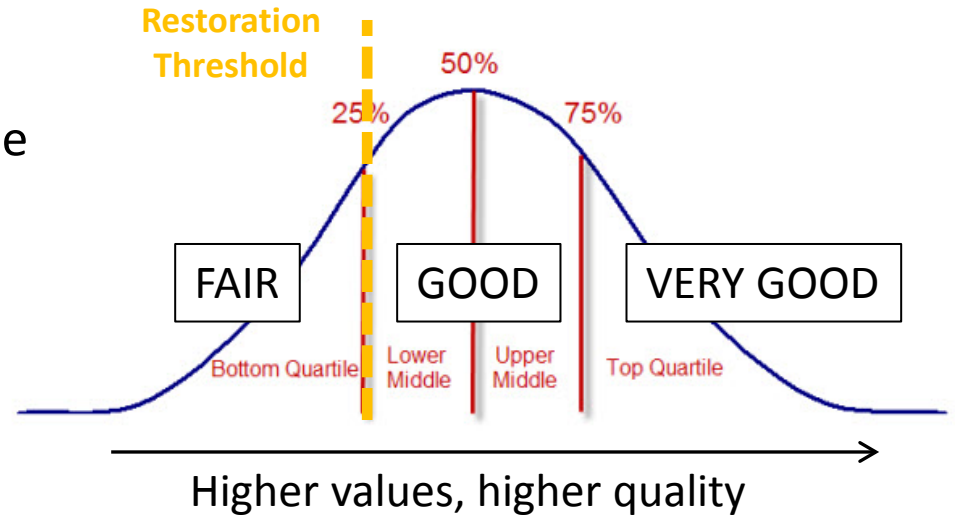
Thresholds Definition: Reference

- Top 25% of reference catchments in Very Good category (ideal ecological condition)
- Top 75% of reference catchments in Good category (acceptable ecological condition)

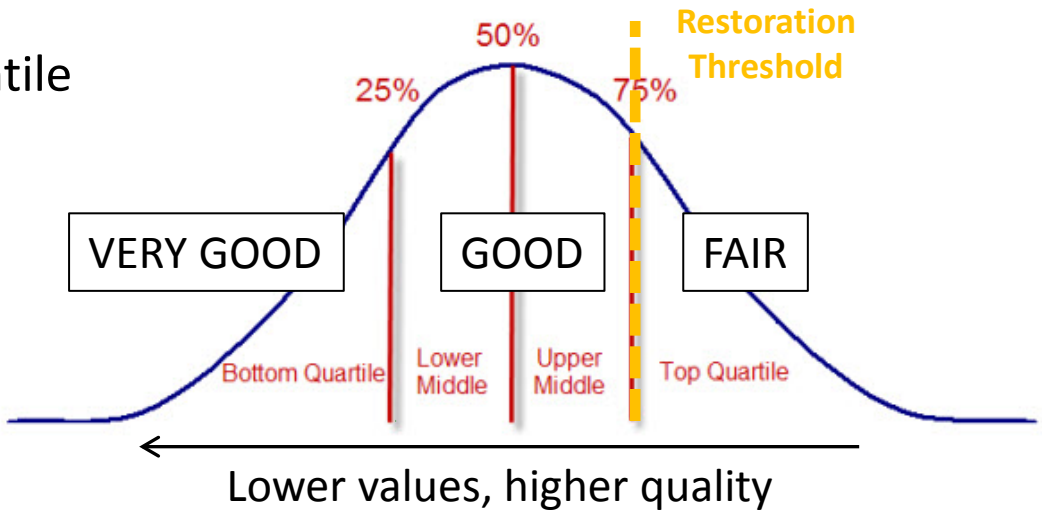
  - Positive metrics (higher values indicate higher quality):
    - Very good/good: 75th percentile
    - Good/fair: 25th percentile
  - Negative metrics (higher values indicate lower quality):
    - Very good/good: 25th percentile
    - Good/fair: 75th percentile

Threshold Definition: Reference

- Positive Factors:
  - Very good/good: 75th percentile
  - Good/fair: 25th percentile



- Negative Factors:
  - Very good/good: 25th percentile
  - Good/fair: 75th percentile

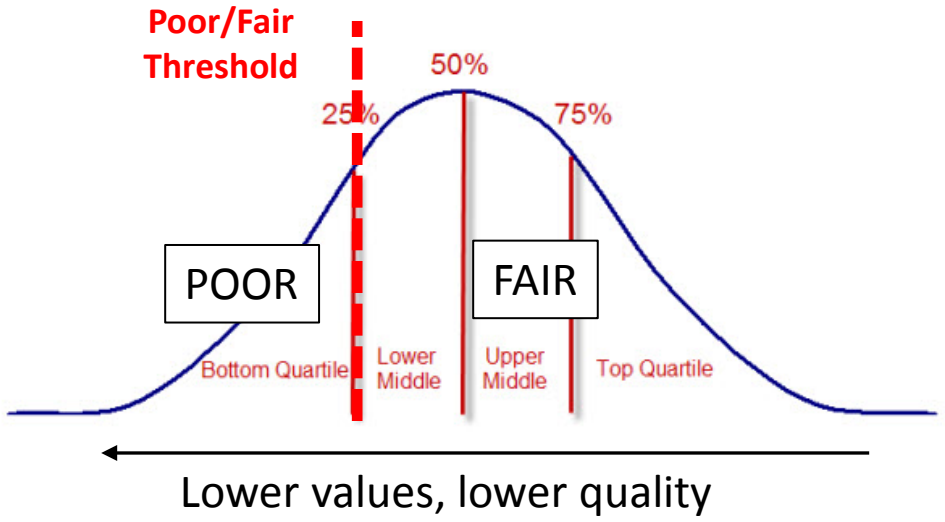


Threshold Definition: Stressed

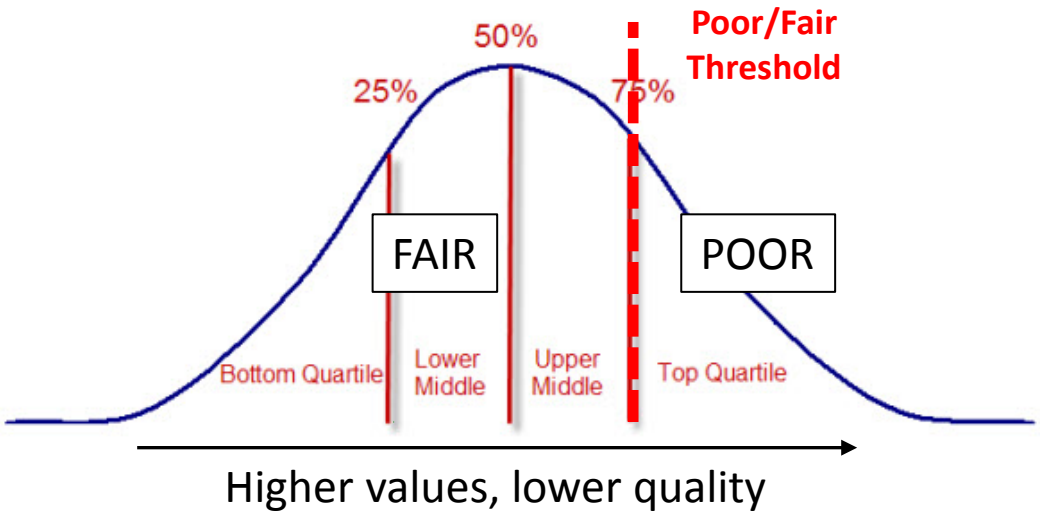
- Worst 25% of stressed catchments in Poor category
- Majority of stressed catchments in Fair category
  - Positive metrics:
    - Fair/poor: 25th percentile
  - Negative metrics:
    - Fair/poor: 75th percentile

Threshold Definition: Stressed

- Positive Factors:
  - Fair/poor: 25th percentile



- Negative Factors:
  - Fair/poor: 75th percentile



Objective Methodology Issues

Only Fair/Good Threshold Defined

- For some metrics some or all thresholds were 0
- Assigned these to a presence/absence metric:
  - Fair/good Threshold at 0
    - Positive metrics: If >0 defined as good, if =0 defined as fair
    - Negative metrics: If >0 defined as fair, if =0 defined as good
- Issue: No Very Good or Poor categories, results in less variability
  - In essence, forcing a 2-category system into 4 categories
- Possible solution: Assign intermediate categories for those thresholds

Only Two Thresholds Defined

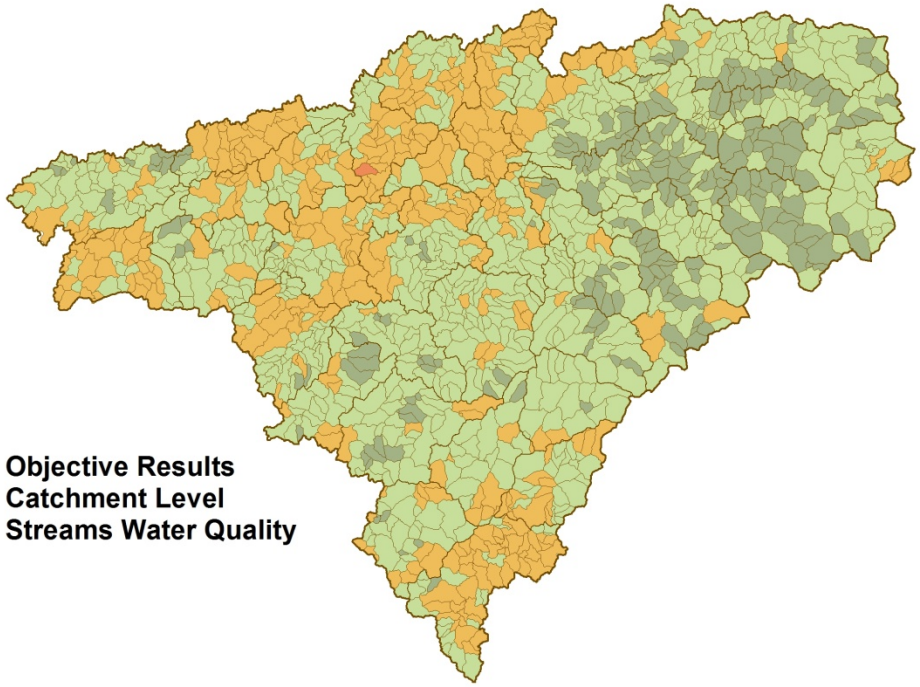
- For some metrics could only define a good/fair and either fair/poor or very good/good threshold
- Resulted in presence being defined as:
  - Good for positive metrics
  - Fair for negative metrics
- Issue: these metrics would still have:
  - Fair and Poor categories for positive metrics, but no Very Good
  - Very Good and Good categories of negative metrics, but no Poor
- Less overall variability in results

Some Thresholds Very Stringent

- Percent Imperviousness:
  - Very Good: <0.014%
  - Good: <0.16%
  - Fair: <2.7%
  - Poor: >=2.7%
- Percent Natural Cover:
  - Very Good: >99%
  - Good: >94%
  - Fair: >75%
  - Poor: <=75%

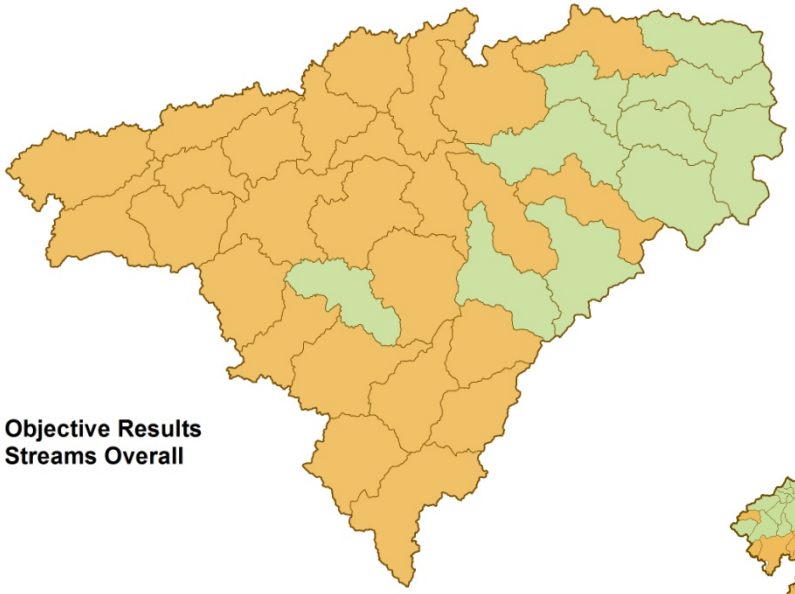
HUC12s Show Little Variability

Only Good and Fair Categories represented for many HUC12 results

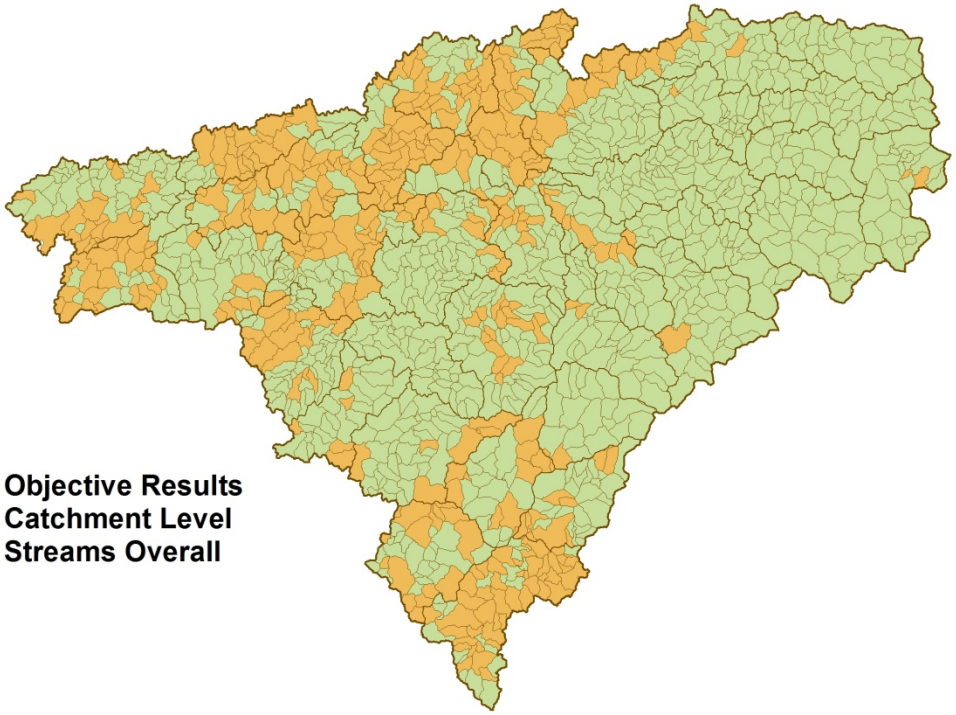


Full Range of Categories for catchment results

Model Results Show Little Variability



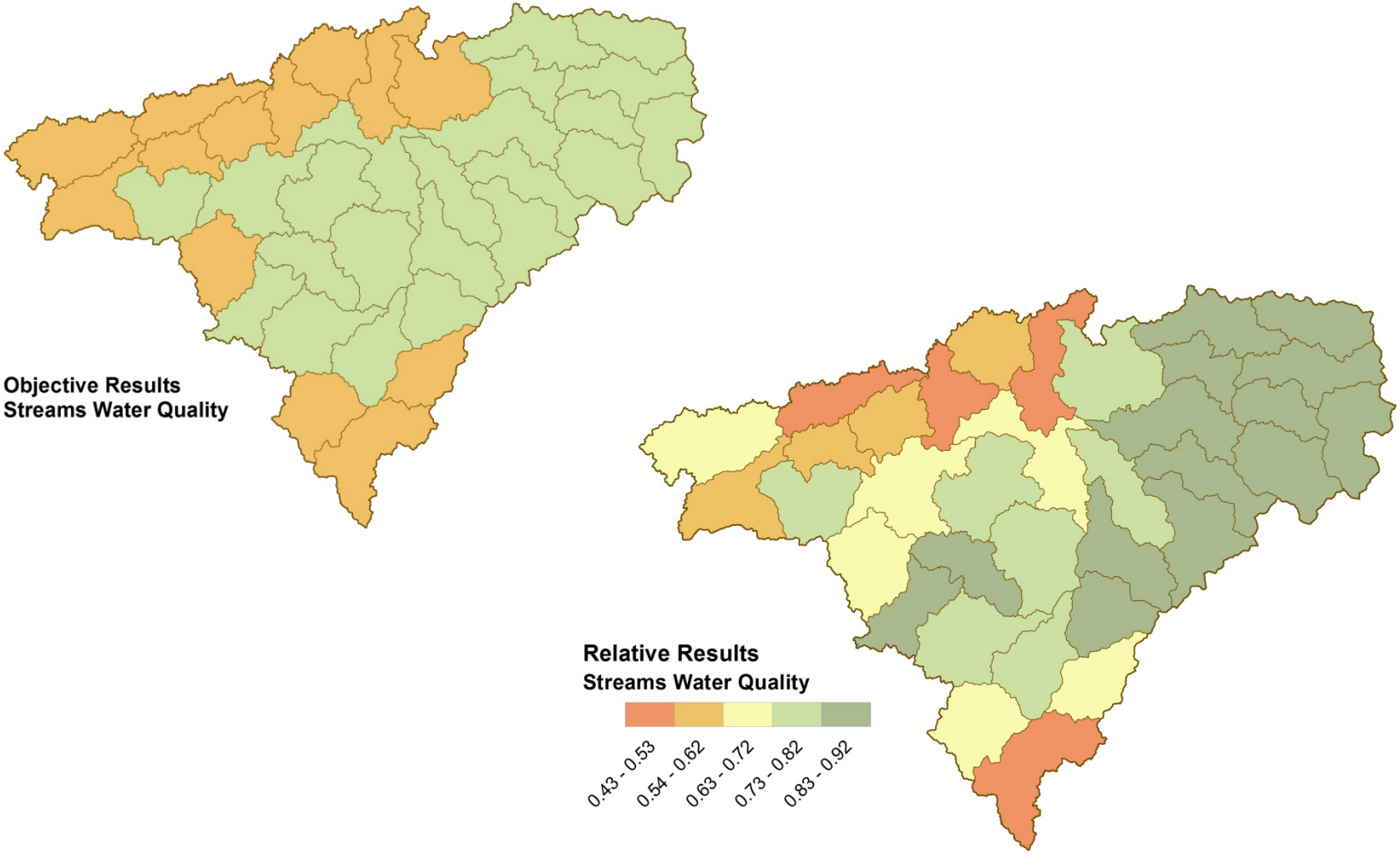
Objective Results
Streams Overall



Objective Results
Catchment Level
Streams Overall

Only Good and Fair categories represented for both catchments and HUC12s

Objective Vs. Relative Results



Use of Interactive Web Tool

Possible steps to define priority areas:

1) Start at HUC12 level:
   a) Objective ranking:
      i. Good/Very Good HUC12s to identify protection candidates
      ii. Fair HUC12s to identify restoration candidates
      iii. Poor HUC12s may be too degraded for restoration
   b) Refine with relative ranking:
      i. Within candidate HUC12s, find relatively better ones
2) Zoom in to Catchment level:
   a) Objective ranking to identify candidate catchments
   b) Refine with catchment relative ranking
3) Zoom in to individual catchments to target specific sites for protection and restoration

Concerns

- Will users find lack of variability among objective results confusing?
- Is it confusing to have two different ranking strategies in one web tool?

Group Discussion After Results Presentations

- Are thresholds defined appropriately?
  - Is the Very Good/Good threshold too stringent? Very difficult to attain
  - Is the Poor/Fair threshold too stringent?
  - Should an alternate definition (i.e., quantiles, other?) be used where thresholds don't work?
- How should metrics with missing thresholds be handled?
  - Keep as presence/absence
  - Assign intermediate very good/good and poor/fair categories instead of forcing into good and fair only
  - Assign arbitrary/"best guess" thresholds for all thresholds
- How should results be presented in interactive web tool?
  - Suggest potential workflow for users