WEST VIRGINIA WATERSHED ASSESSMENT PILOT PROJECT

Gauley River ©Kent Mason

Second Expert Workshop, Jan. 31st, 2012

Presentation Outline

- Project Introduction
- Methodology & Model Structure
- Revisions after First Workshop
- Metrics
- Relative Ranking Results
- Categorization Ranking Preliminary Results

Project Introduction

1. Objectives
2. Process
3. Study Area

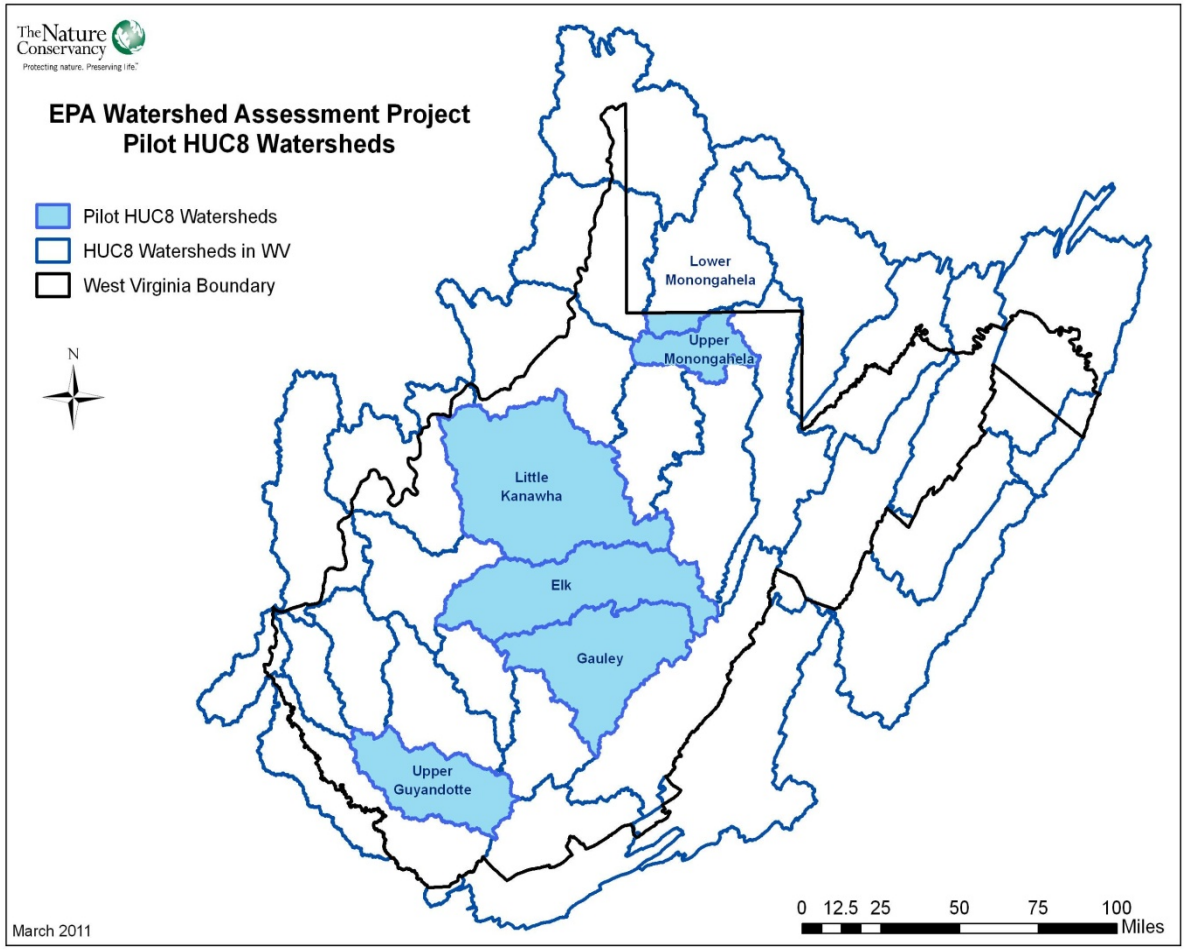
Project Objectives

- Design and test a **watershed assessment process**, which includes analysis of cumulative watershed effects.
- **Establish priorities** for protection and restoration of aquatic resources and evaluate/rank areas within watersheds accordingly.
- Provide relevant information, strategies/actions, and a **decision support tool** to assist partners, stakeholders and regulatory staff with decisions affecting aquatic resources.

Project Study Area

Five WV HUC8 Watersheds:

- **Monongahela**
- **Elk**
- Gauley
- Little Kanawha
- Upper Guyandotte



Project Process – First 2 Watersheds

- 4/1/2011 – Project Start
- Define watershed assessment methodology
- 6/13/2011 - Technical advisory team meeting
- Complete watershed characterization
- 10/25 & 10/26/2011 - Expert workshop one
- Complete draft consolidated analysis
- **1/31/2012 - Expert workshop two**
- Complete draft watershed assessments
- By 4/1/2012 - Decision maker/end user workshop
- Complete final watershed assessments
- 6/1/2012 – Final reports & draft (not live) interactive web application completed

Project Process – Final 3 Watersheds

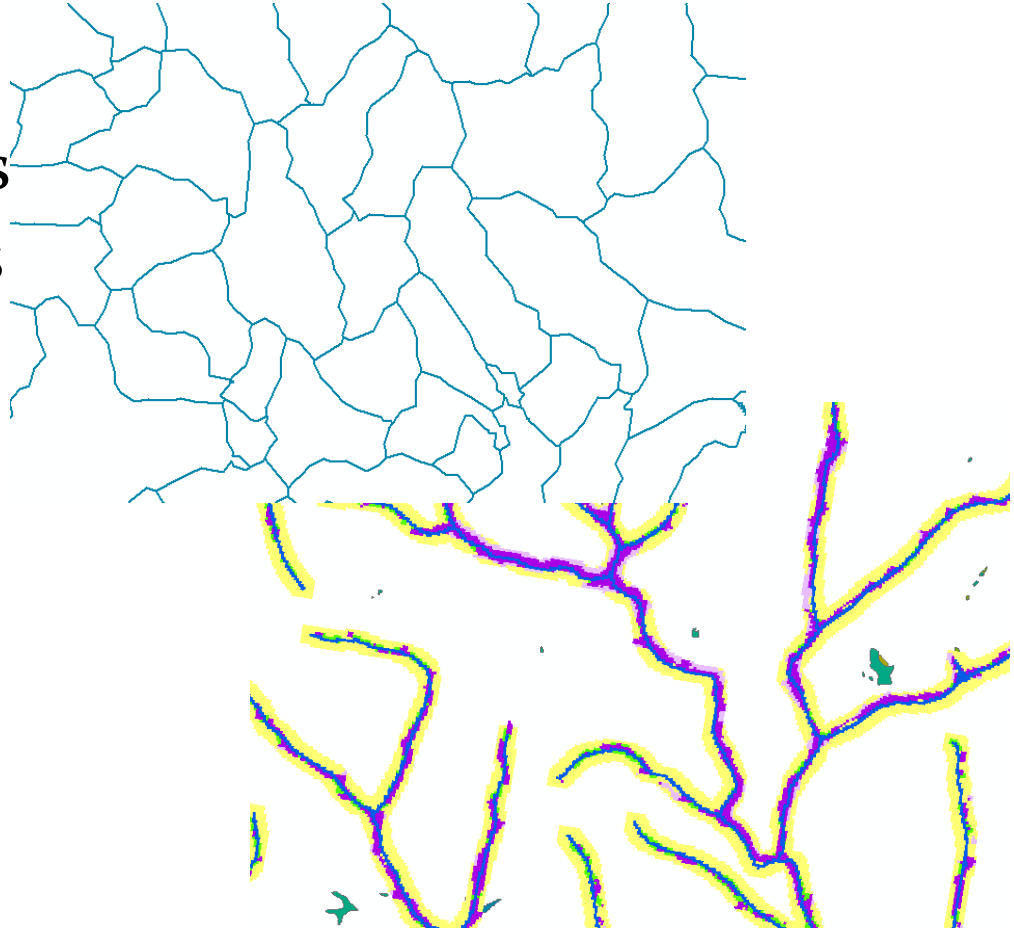
- Complete watershed characterization
- By 10/1/2012 - Expert workshop one
- Complete consolidated analysis
- By 12/1/2012 - Expert workshop two
- Complete draft watershed assessments
- By 2/1/2013 - Decision maker/end user workshop
- Complete final watershed assessments
- 4/1/2013 – Final reports & interactive web application completed

Methodology

1. Watershed Characterization
2. Priority Models

Watershed Characterization

- Planning Units:
  - HUC-12 watersheds
  - Modified NHDPlus catchments
- Landscape types:
  - Stream/Riparian
  - Wetlands
  - Uplands



Priority Models

- Stream/Riparian
- Wetlands
- Uplands

Metrics are individually defined for each Priority Model

Methodology

I. Develop a **relative** ranking of planning units within a watershed
II. Develop **non-relative** index of watershed condition and threat based on pre-defined quality scale (e.g., 1-4 scale where 1= poor, 2=fair, 3= good, 4= excellent)

- **First phase:** comparison of planning units
- **Second phase/ consolidated analysis:** detailed analysis of target areas and potential actions within each planning unit

Consolidated Analysis

- **Cumulative Watershed Effects**
  - Land use changes
  - Landscape losses
  - Ecosystem function/ service degradation
  - Cumulative impacts/ stresses
- **Historical and Future Conditions**
  - Trends analysis (water use, permitting, population growth, climate change, etc.)
  - Future scenarios analysis (within targeted areas and for proposed strategies/actions)

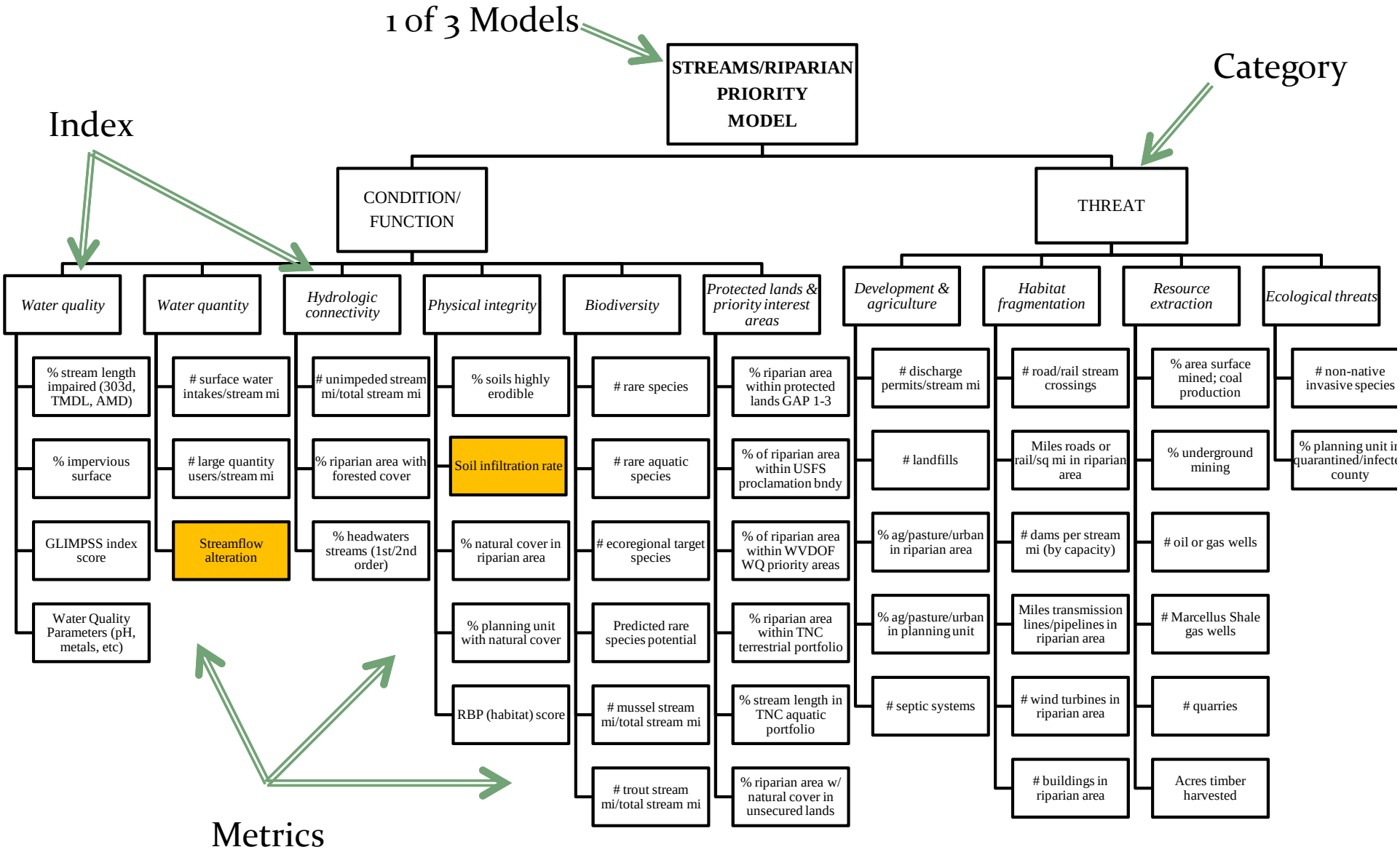
Overview of Model Structure

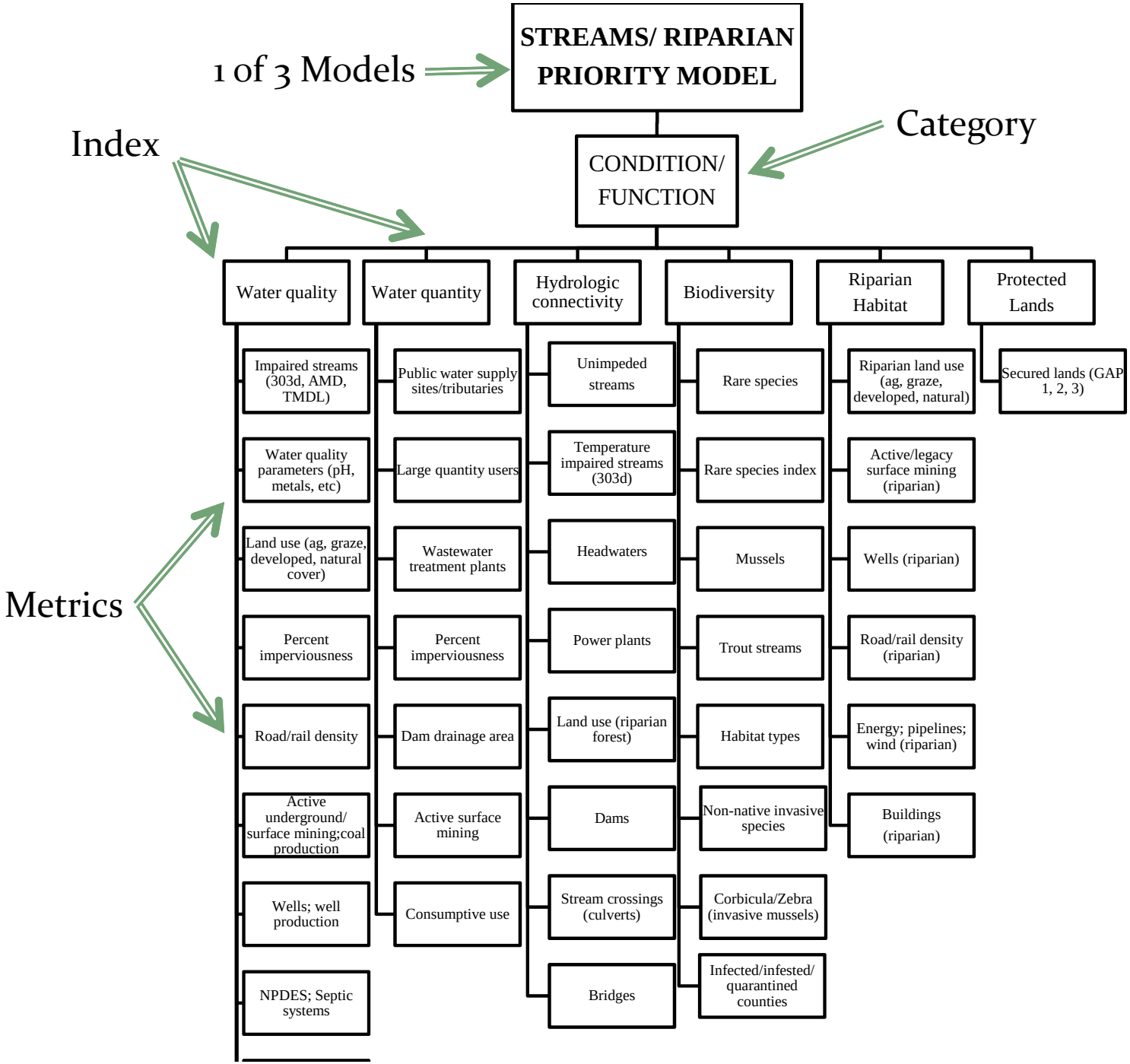
Hierarchical Structure:

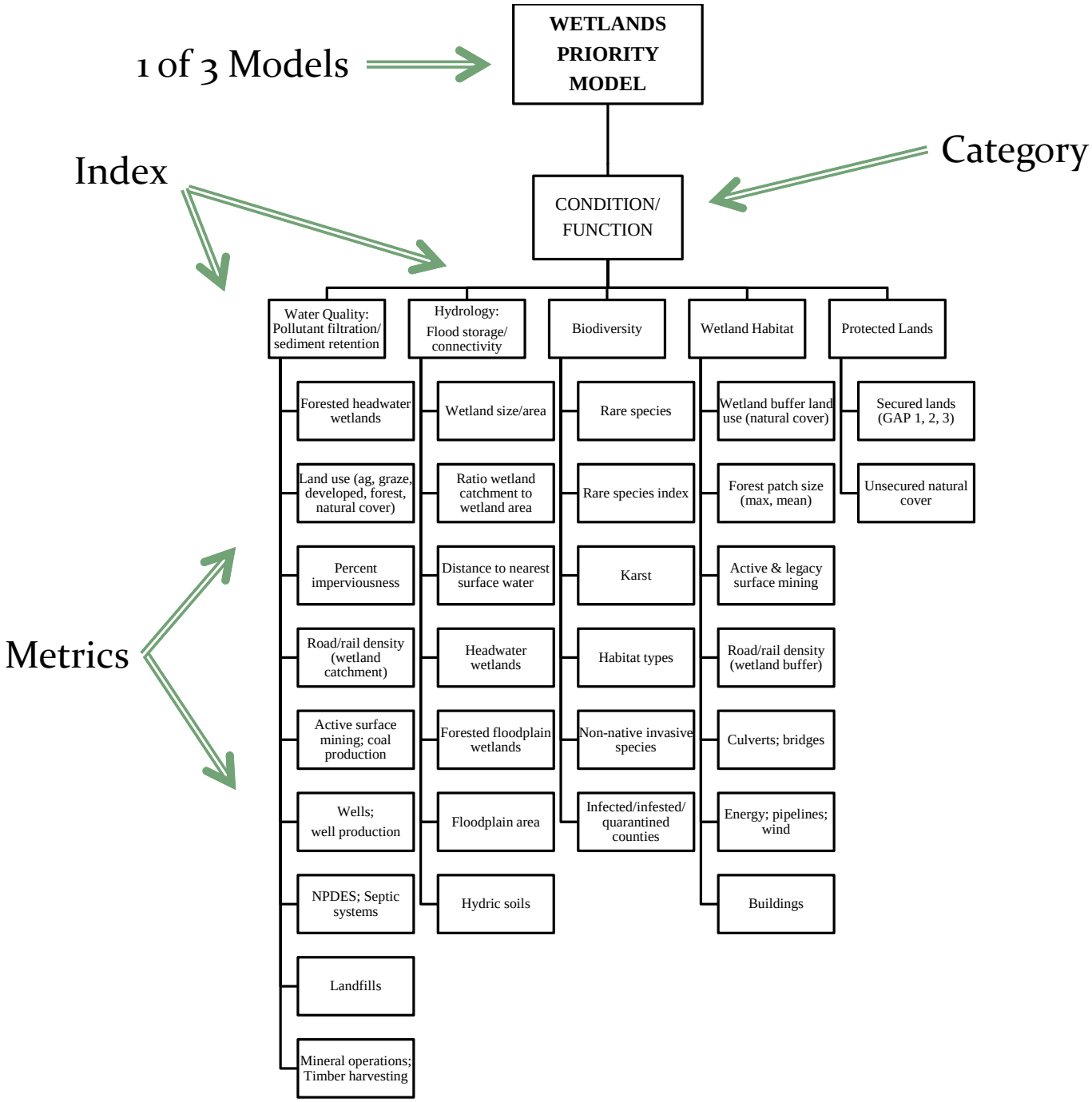
- 3 Models: Streams, Wetlands, Uplands
- 1 Category in Phase I: Condition/Function (includes former “Threats” Category)
- Several Indices under Condition/Function
- Multiple Metrics to define each index

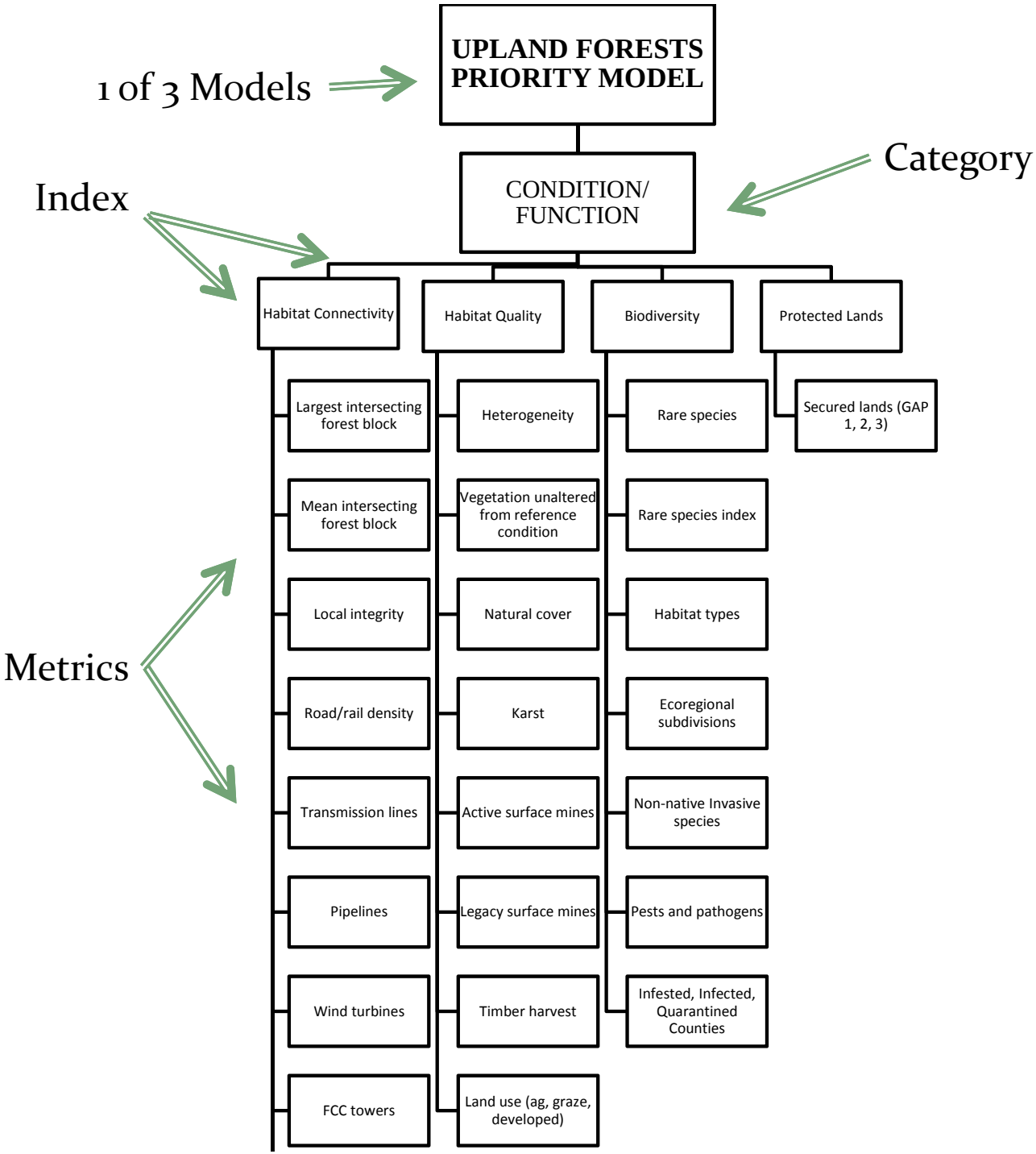
Changes to Model Structure

- **Combined Condition/Function & Threats under new Condition/Function Category**
  - Includes both Quality Indicators and Stressors within each Index
- **Changed Wetlands Model Indices and Metrics considerably**
  - Reflects wetland functions
  - Many metrics calculated on a wetland contributing catchment basis, not just wetland buffer


1 of 3 Models
STREAMS/RIPARIAN PRIORITY MODEL
Category
Index
CONDITION/ FUNCTION
THREAT
Water quality
Water quantity
Hydrologic connectivity
Physical integrity
Biodiversity
Protected lands & priority interest areas
Development & agriculture
Habitat fragmentation
Resource extraction
Ecological threats
% stream length impaired (303d, TMDL, AMD)
% impervious surface
GLIMPSS index score
Water Quality Parameters (pH, metals, etc)
surface water intakes/stream mi
large quantity users/stream mi
Streamflow alteration
unimpeded stream mi/total stream mi
% riparian area with forested cover
% headwaters streams (1st/2nd order)
% soils highly erodible
Soil infiltration rate
% natural cover in riparian area
% planning unit with natural cover
RBP (habitat) score
rare species
rare aquatic species
ecoregional target species
Predicted rare species potential
mussel stream mi/total stream mi
trout stream mi/total stream mi
% riparian area within protected lands GAP 1-3
% of riparian area within USFS proclamation bndy
% of riparian area within WVDOF WQ priority areas
% riparian area within TNC terrestrial portfolio
% stream length in TNC aquatic portfolio
% riparian area w/ natural cover in unsecured lands
# discharge permits/stream mi
# landfills
% ag/pasture/urban in riparian area
% ag/pasture/urban in planning unit
# septic systems
# road/rail stream crossings
Miles roads or rail/sq mi in riparian area
dams per stream mi (by capacity)
Miles transmission lines/pipelines in riparian area
wind turbines in riparian area
buildings in riparian area
% area surface mined; coal production
% underground mining
# oil or gas wells
# Marcellus Shale gas wells
# quarries
Acres timber harvested
non-native invasive species
% planning unit in quarantined/infecte county
Metrics


1 of 3 Models
STREAMS/ RIPARIAN PRIORITY MODEL
Index
Category
CONDITION/ FUNCTION
Water quality
Water quantity
Hydrologic connectivity
Biodiversity
Riparian Habitat
Protected Lands
Metrics
Impaired streams (303d, AMD, TMDL)
Water quality parameters (pH, metals, etc)
Land use (ag, graze, developed, natural cover)
Percent imperviousness
Road/rail density
Active underground/ surface mining;coal production
Wells; well production
NPDES; Septic systems
Public water supply sites/tributaries
Large quantity users
Wastewater treatment plants
Percent imperviousness
Dam drainage area
Active surface mining
Consumptive use
Unimpeded streams
Temperature impaired streams (303d)
Headwaters
Power plants
Land use (riparian forest)
Dams
Stream crossings (culverts)
Bridges
Rare species
Rare species index
Mussels
Trout streams
Habitat types
Non-native invasive species
Corbicula/Zebra (invasive mussels)
Infected/infested/ quarantined counties
Riparian land use (ag, graze, developed, natural)
Active/legacy surface mining (riparian)
Wells (riparian)
Road/rail density (riparian)
Energy; pipelines; wind (riparian)
Buildings (riparian)
Secured lands (GAP 1, 2, 3)


1 of 3 Models
WETLANDS PRIORITY MODEL
Index
Category
CONDITION/ FUNCTION
Water Quality: Pollutant filtration/ sediment retention
Hydrology: Flood storage/ connectivity
Biodiversity
Wetland Habitat
Protected Lands
Forested headwater wetlands
Land use (ag, graze, developed, forest, natural cover)
Percent imperviousness
Road/rail density (wetland catchment)
Active surface mining; coal production
Wells; well production
NPDES; Septic systems
Landfills
Mineral operations; Timber harvesting
Wetland size/area
Ratio wetland catchment to wetland area
Distance to nearest surface water
Headwater wetlands
Forested floodplain wetlands
Floodplain area
Hydric soils
Rare species
Rare species index
Karst
Habitat types
Non-native invasive species
Infected/infested/ quarantined counties
Wetland buffer land use (natural cover)
Forest patch size (max, mean)
Active & legacy surface mining
Road/rail density (wetland buffer)
Culverts; bridges
Energy; pipelines; wind
Buildings
Secured lands (GAP 1, 2, 3)
Unsecured natural cover
Metrics


1 of 3 Models
UPLAND FORESTS PRIORITY MODEL
Category
CONDITION/ FUNCTION
Index
Habitat Connectivity
Habitat Quality
Biodiversity
Protected Lands
Largest intersecting forest block
Mean intersecting forest block
Local integrity
Road/rail density
Transmission lines
Pipelines
Wind turbines
FCC towers
Heterogeneity
Vegetation unaltered from reference condition
Natural cover
Karst
Active surface mines
Legacy surface mines
Timber harvest
Land use (ag, graze, developed)
Rare species
Rare species index
Habitat types
Ecoregional subdivisions
Non-native Invasive species
Pests and pathogens
Infested, Infected, Quarantined Counties
Secured lands (GAP 1, 2, 3)
Metrics

Quality Indicators vs. Stressors

- To help inform potential strategies divided metrics into quality indicators and stressors
- Rolled each group up separately within each index, in addition to overall rating for each index
- Will help guide restoration/protection decisions

Redundant Metrics

- Perform Correlation Analysis to find highly correlated metrics
- Performed on HUC12 analysis
- Eliminated several metrics
- Regression Analysis/PCA Analysis: to find metrics with greatest impact on water quality – preliminary results not conclusive

Weighting

- Hoping to use Regression Analysis to inform weighting of metrics in model
- So far no “good fit” model found
- Preliminary weighting based on literature review and “best guess”

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


Elk River at Birch Run, WV ©www.over-land.com

FEEDBACK/QUESTIONS?

Indices: Streams

CONDITION/ FUNCTION

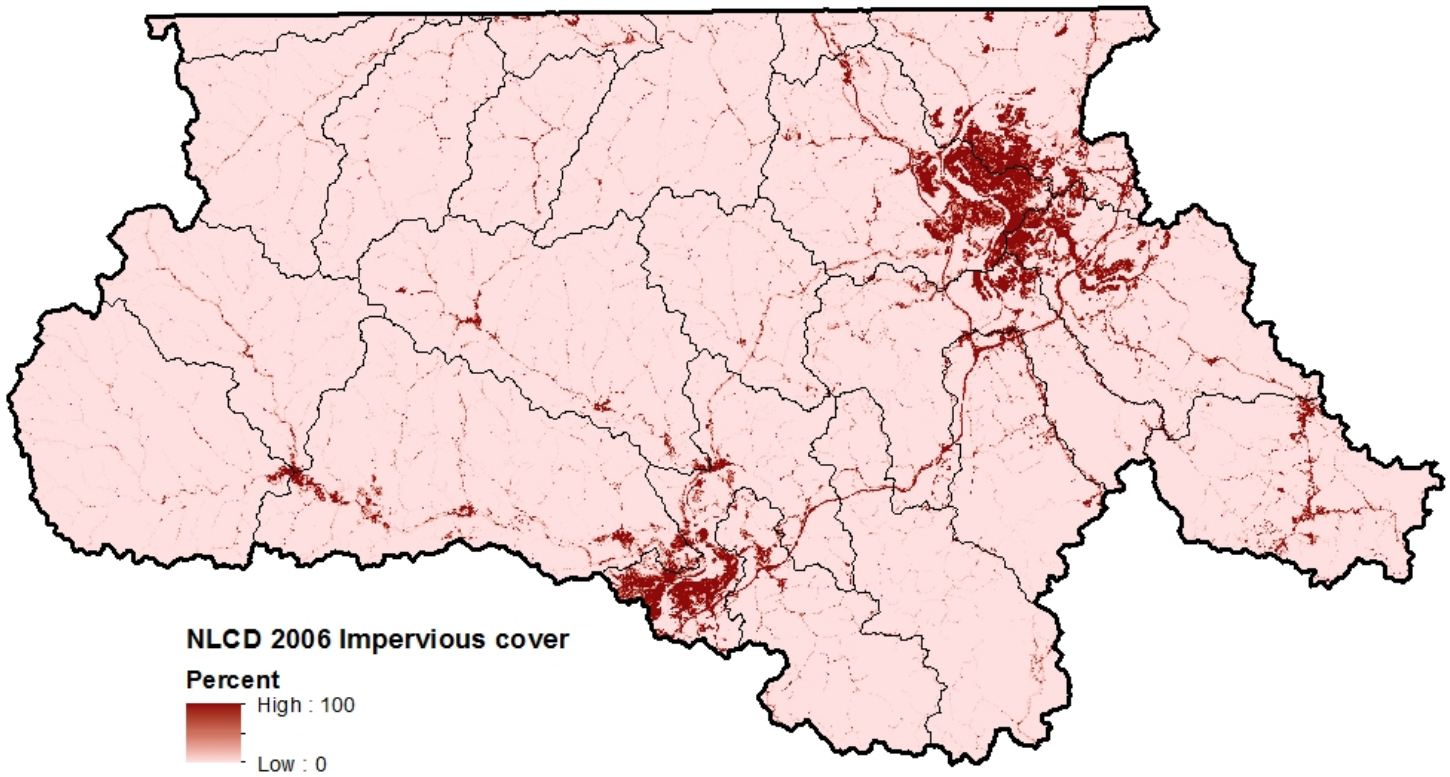
- Water quality
- Water quantity
- Hydrologic Connectivity
- Biodiversity
- Riparian Habitat
- Protected Lands

Model: Streams/Riparian Areas

Water Quality

Metric: Percent imperviousness

- Impervious cover (1-100 percent)



Metric: Mining

- SURFACE: A combination of abandoned mine lands, GES mining footprint, DEP valley fills and refuse structures, Appalachian Voices surface mining digitization, TNC-generated surface mining from topos and aerial imagery
- UNDERGROUND: GES underground mining footprint

Other Water Quality Metrics

- Impaired Streams (303(d), TMDL, AMD)
- DEP's Water Quality sampling stations
  - GLIMPSS (CF)
  - pH, Sulfate, RBP scores, metals, etc.
- Oil and Gas wells
- Gas well production
- NPDES: Septic Systems
- Highly erodible soils

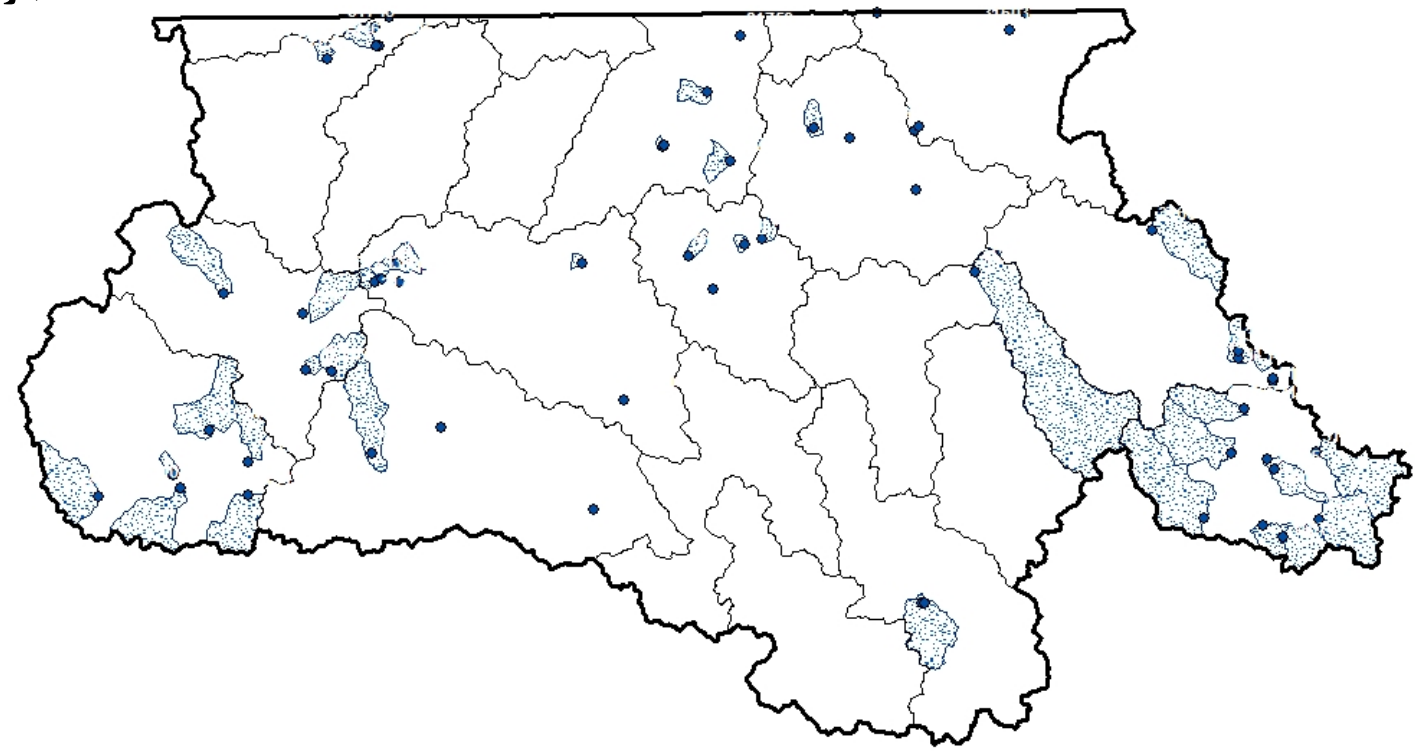
Model: Streams/Riparian Areas

Water Quantity

No good direct measurements, had to find representative surrogates

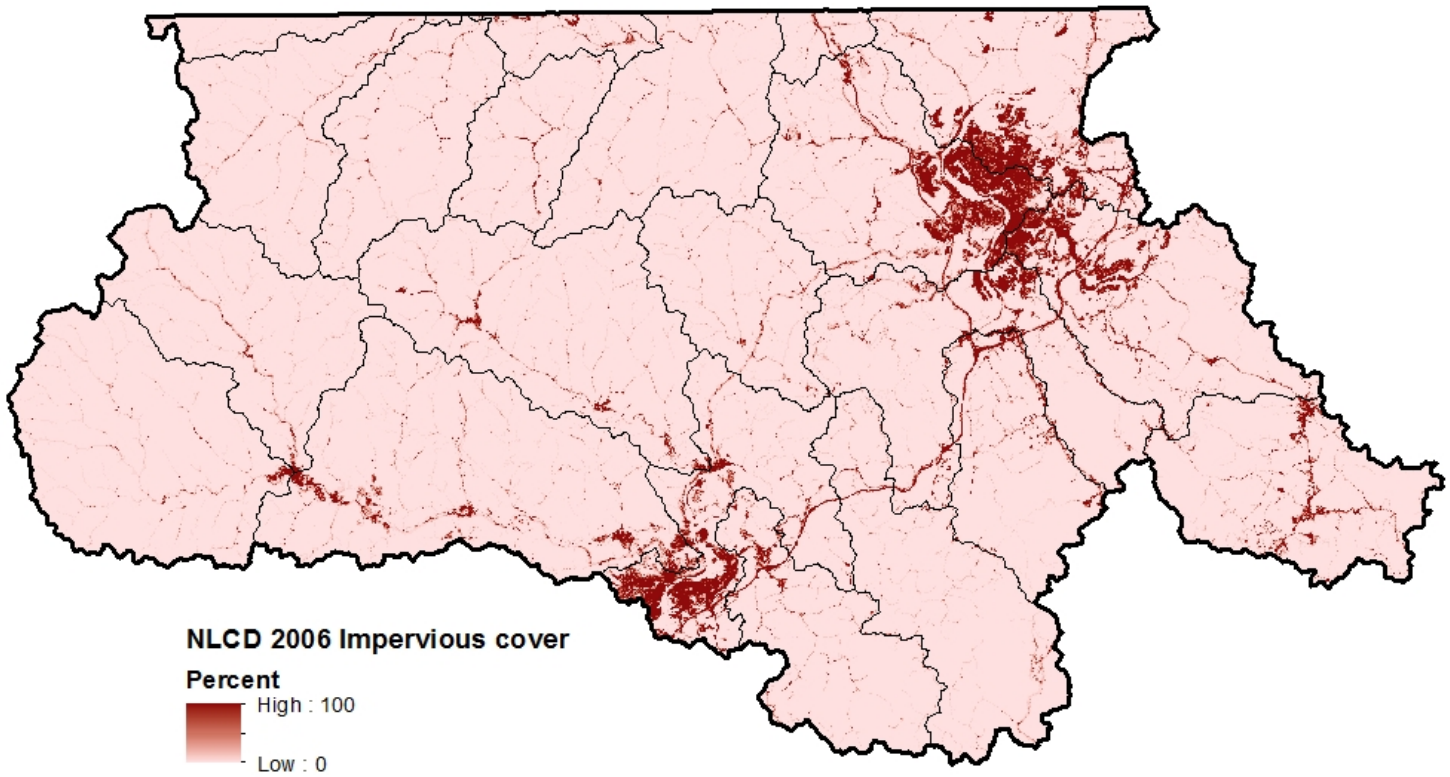
Metric: Dam drainage area

- Catchment area for dams (delineated using contributing NHDPlus catchments for dams visible on 2010 aerial imagery)



Metric: Percent imperviousness

- Impervious cover (1-100 percent)



Other Water Quantity metrics

- Surface mining
- Large Quantity users
- Public Water Supply data
- Wastewater treatment plants
- Consumptive/nonconsumptive use

Model: Streams/Riparian Areas

Hydrologic Connectivity

Metric: Unimpeded streams

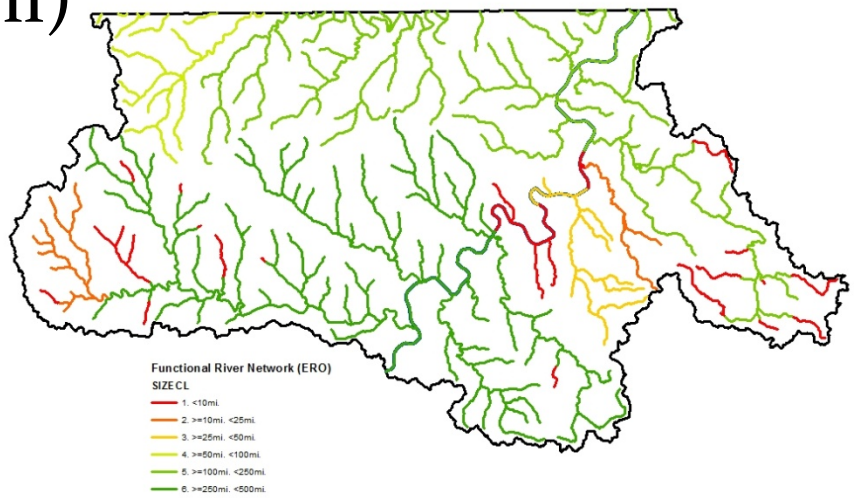
- Developed based on TNC-ERO Functional River Network, which identifies stream lengths without impoundments or waterfalls (impediments to hydrologic connectivity)
- Thresholds (by ERO Stream Size Class)

Very good: 5/6 (100-<250 mi)

Good: 3/4 (25-<100 mi)

Fair: 2 (10-<25 mi)

Poor: 1 (<10 mi)



Other Hydrologic Connectivity Metrics

- Length of headwater streams/total stream length
- % riparian area with forested cover
- Number of dams
- Culverts (estimated by using road crossings over small streams)
- Bridges
- Temperature-impaired streams

Model: Streams/Riparian Areas

Biodiversity

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

Model: Streams/Riparian Areas

Riparian Habitat

Riparian Habitat Metrics

- Riparian land use (also in other indices)
- Active surface mining (also in other indices)
- Oil and gas wells (also in other indices)
- Road/railroad density (also in other indices)
- Pipelines, transmission lines, buildings

Model: Streams/Riparian Areas

Protected Lands:

GAP 1 – 3 lands

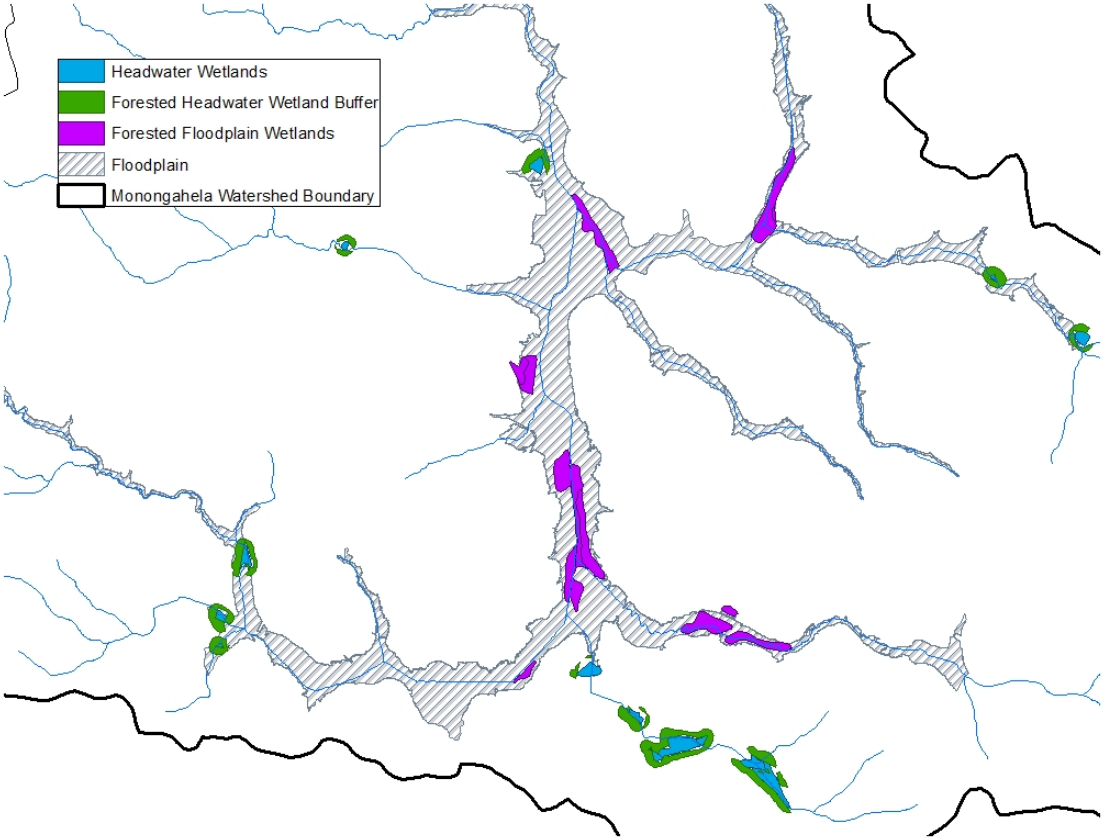
Indices: Wetlands

CONDITION/ FUNCTION

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

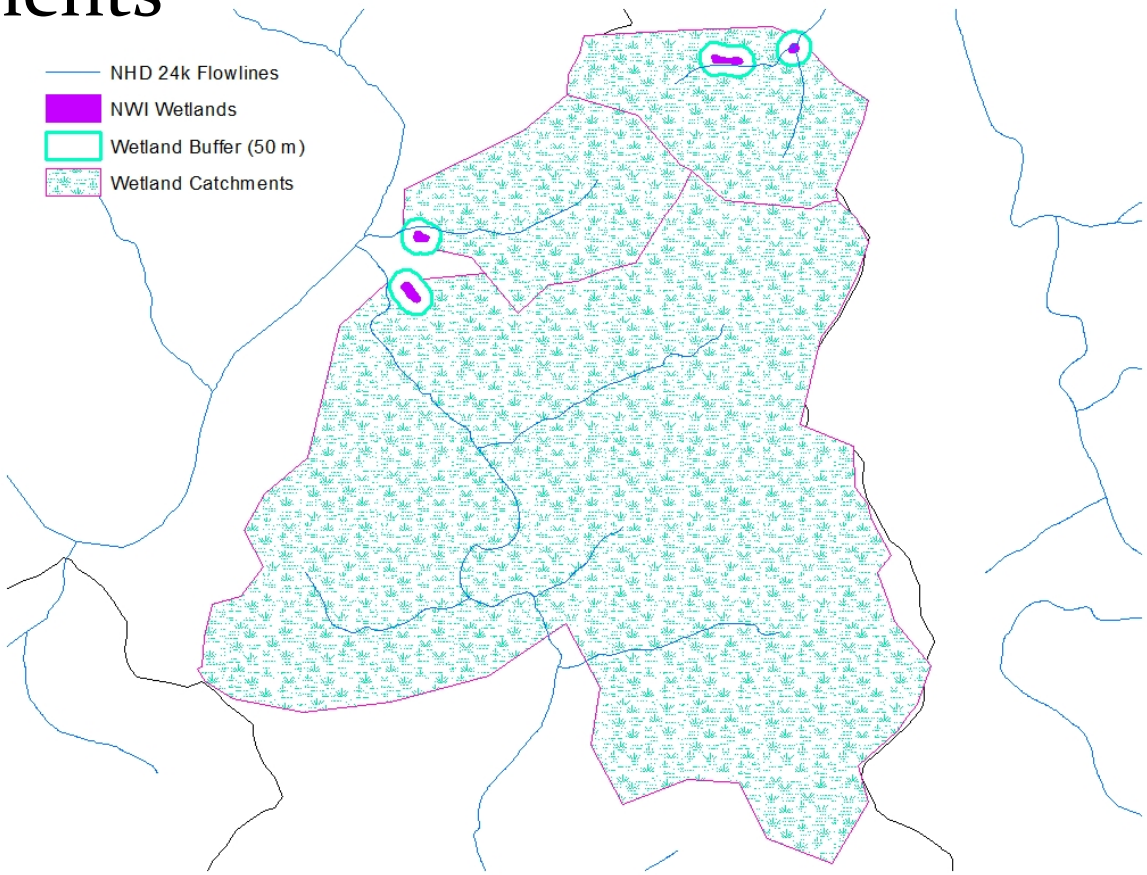
Wetland Function Metrics

- Headwater wetlands, forested headwater wetlands, forested floodplain wetlands, etc



Wetland Buffer vs. Catchment

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



Model: Wetlands

Water Quality:
Pollutant Filtration/Sediment Retention

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

Model: Wetlands

Hydrology:
Flood Storage/Connectivity

Wetland Hydrology Metrics

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

Model: Wetlands

Biodiversity

Biodiversity Metrics

- Rare and threatened species (includes DNR's SGNC species) in wetland buffer
- Calcareous bedrock in wetland buffer
- Non-native invasive species in wetland buffer

Model: Wetlands

Wetland Habitat

Wetland Habitat Metrics

- Land use in wetland buffer
- Active surface mining in wetland buffer
- Oil and gas wells in wetland buffer
- Road/railroad density in wetland buffer
- Pipelines, transmission lines, buildings in wetland buffer

Model: Wetlands

Protected Lands:

GAP 1 – 3 lands

Indices: Uplands

CONDITION/ FUNCTION

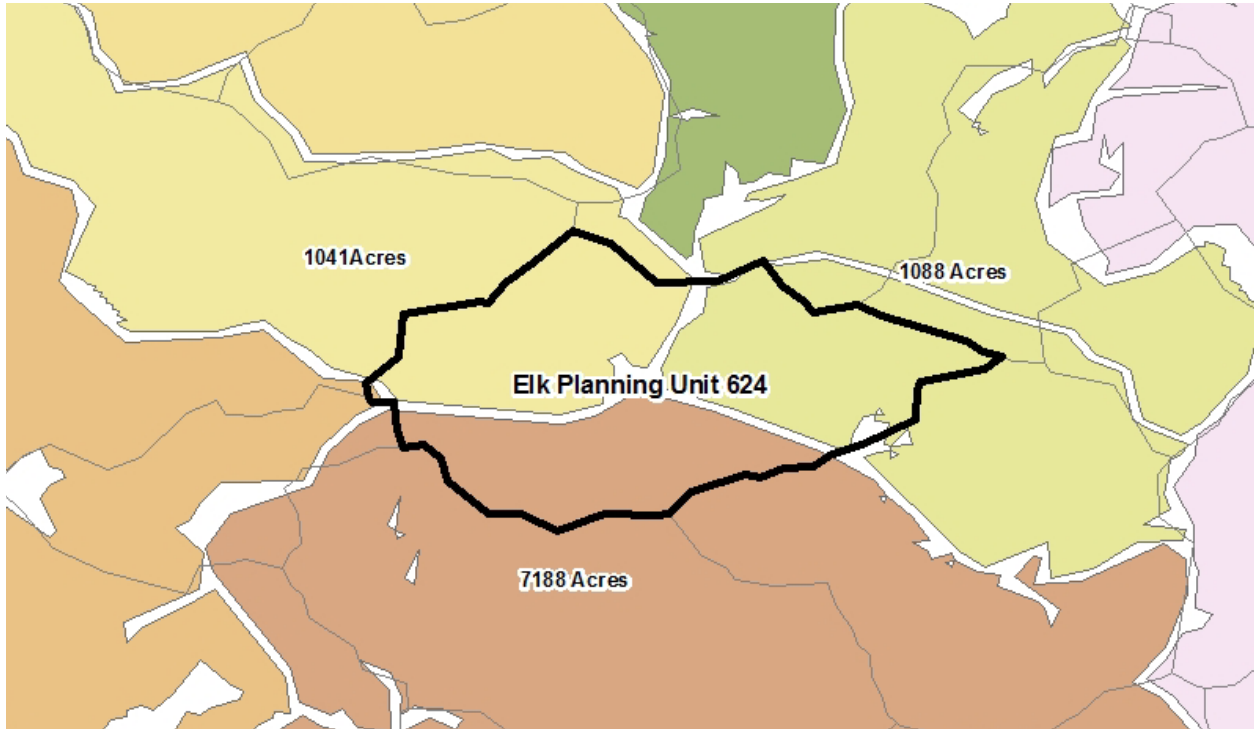
- Habitat Connectivity
- Upland Habitat
- Biodiversity
- Protected Lands

Model: Uplands

Habitat Connectivity

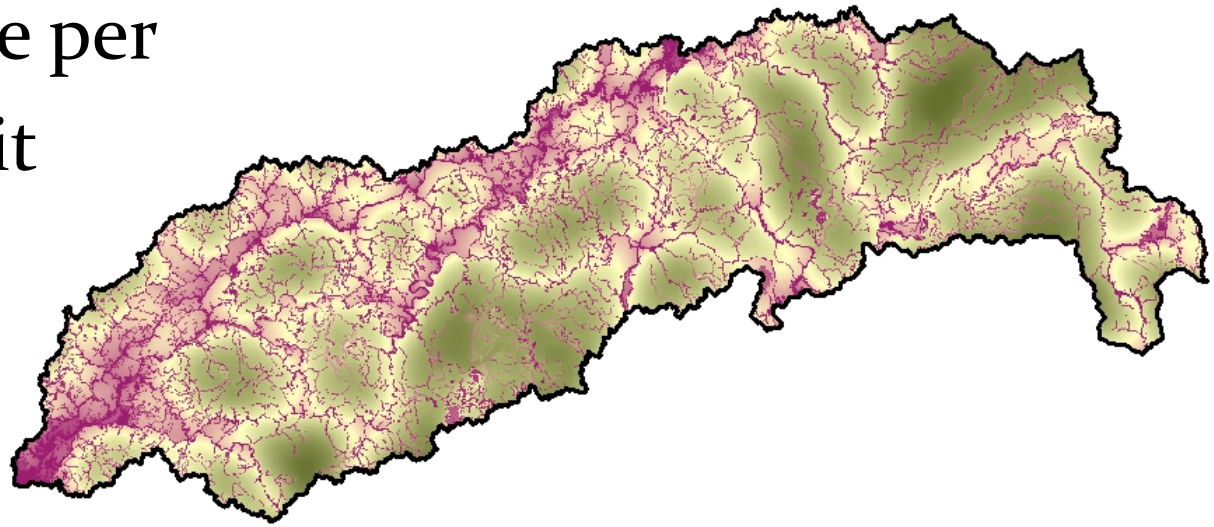
Metric: Forest Block Sizes

- TNC-ERO generated maps of forest blocks greater than 100 acres
- Calculated largest and mean intersecting block size



Metric: Local Integrity

- A measure of connectivity of natural cover in the landscape
- Metric developed for Conservation Assessment & Prioritization System at UMass Amherst
- Average score per planning unit



Other Habitat Connectivity metrics

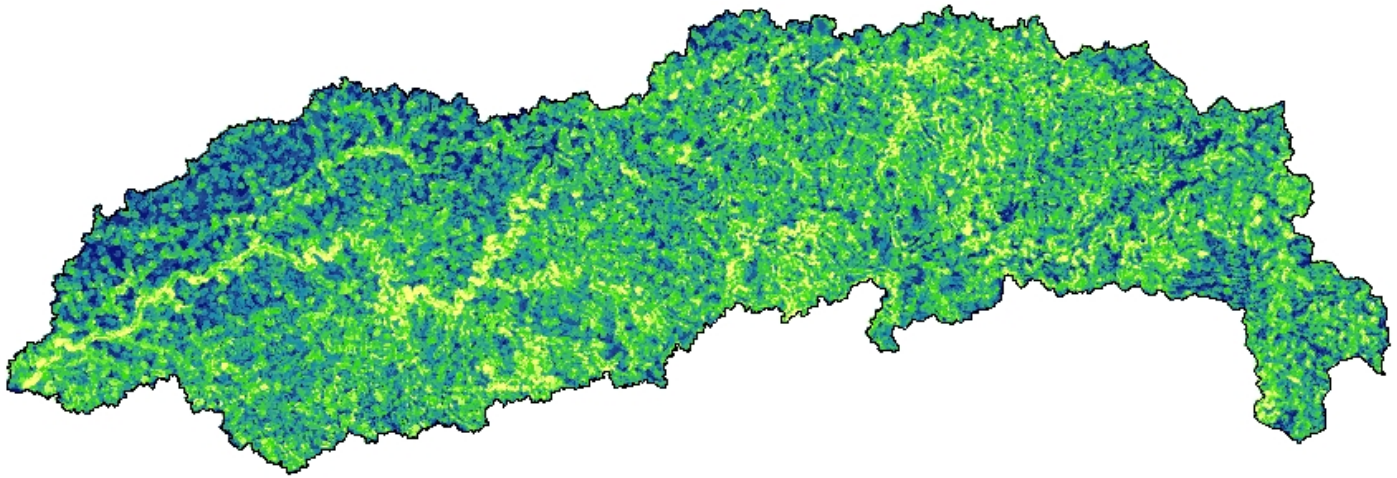
- Active surface mining, coal production
- Oil & gas wells
- Road/railroad density
- Transmission lines, pipelines
- Wind turbines, FCC towers
- Buildings, landfills
- Timber harvests

Model: Uplands

Habitat Quality

Metric: Landscape Heterogeneity

- Landform variety + Elevation range within 100 acres of each cell, normalized and summed
- Higher heterogeneity = higher habitat diversity



Other Habitat Quality Metrics

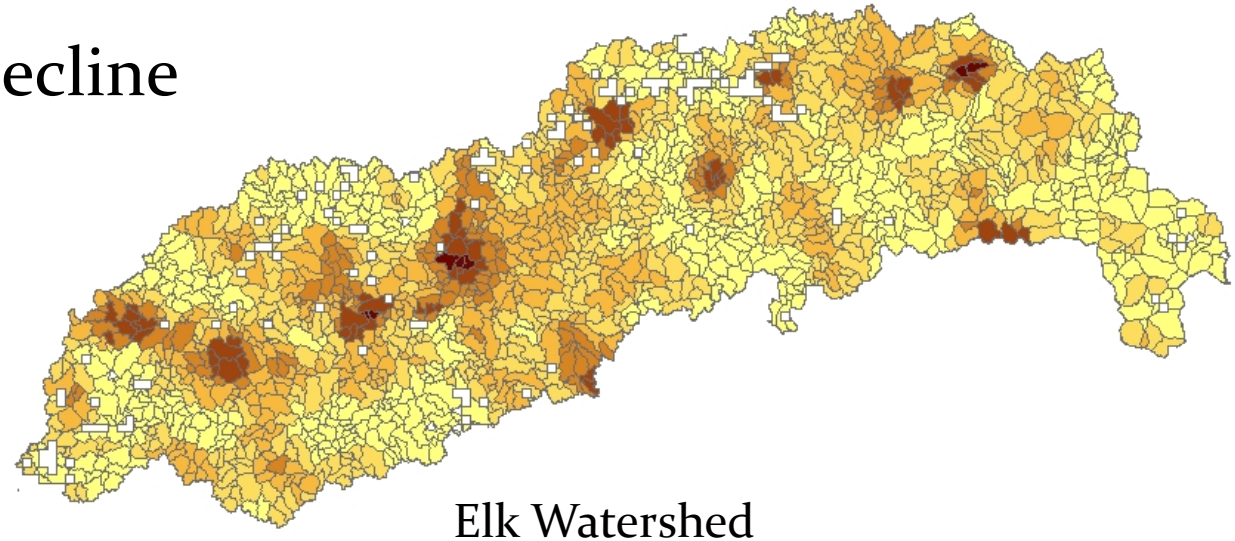
- Active surface mining (also in Habitat Connectivity)
- Legacy surface mines
- Vegetation unaltered from reference condition
- Percent karst
- Land use (% ag, grazed, developed, natural)
- Timber harvest (also in Habitat Connectivity)

Model: Uplands

Biodiversity

Metric: Pests & Pathogens

- Projected % basal area loss to pests over 15 years
- Specific pests modeled:
  - Gypsy Moth
  - Hardwood decline
  - Red oak decline



Elk Watershed

Biodiversity Metrics

- Rare and threatened species (includes DNR's SGNC species)
- Rare species index (calculated from # geology classes, elevation range, calcareous bedrock)
- Non-native invasive species
- Number of ecoregional subdivisions
- Calcareous bedrock

Model: Uplands

Protected Lands:

GAP 1 – 3 lands

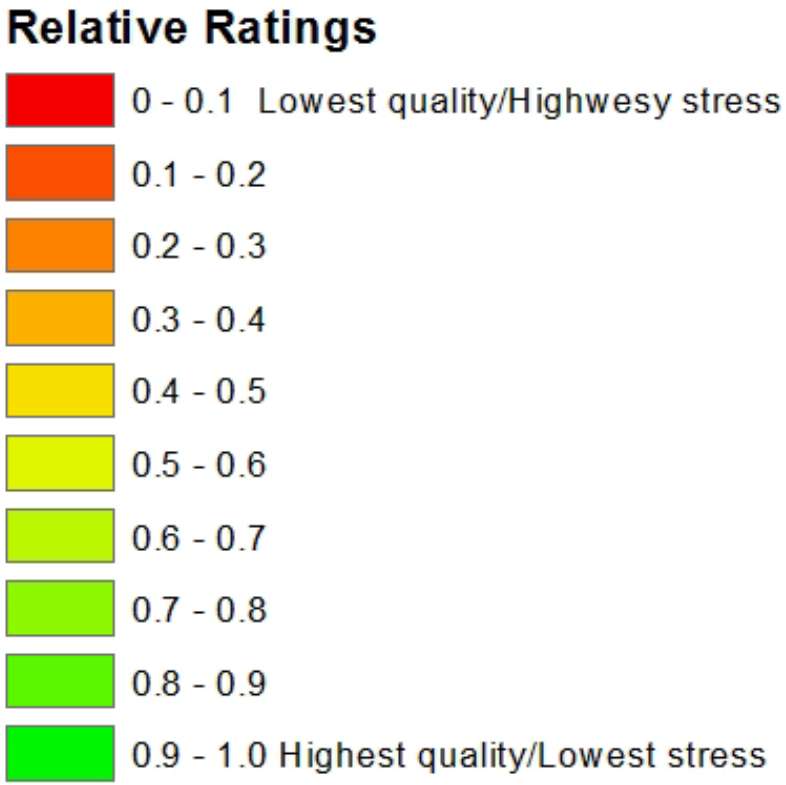

Elk River at Birch Run, WV ©www.over-land.com

FEEDBACK/QUESTIONS?

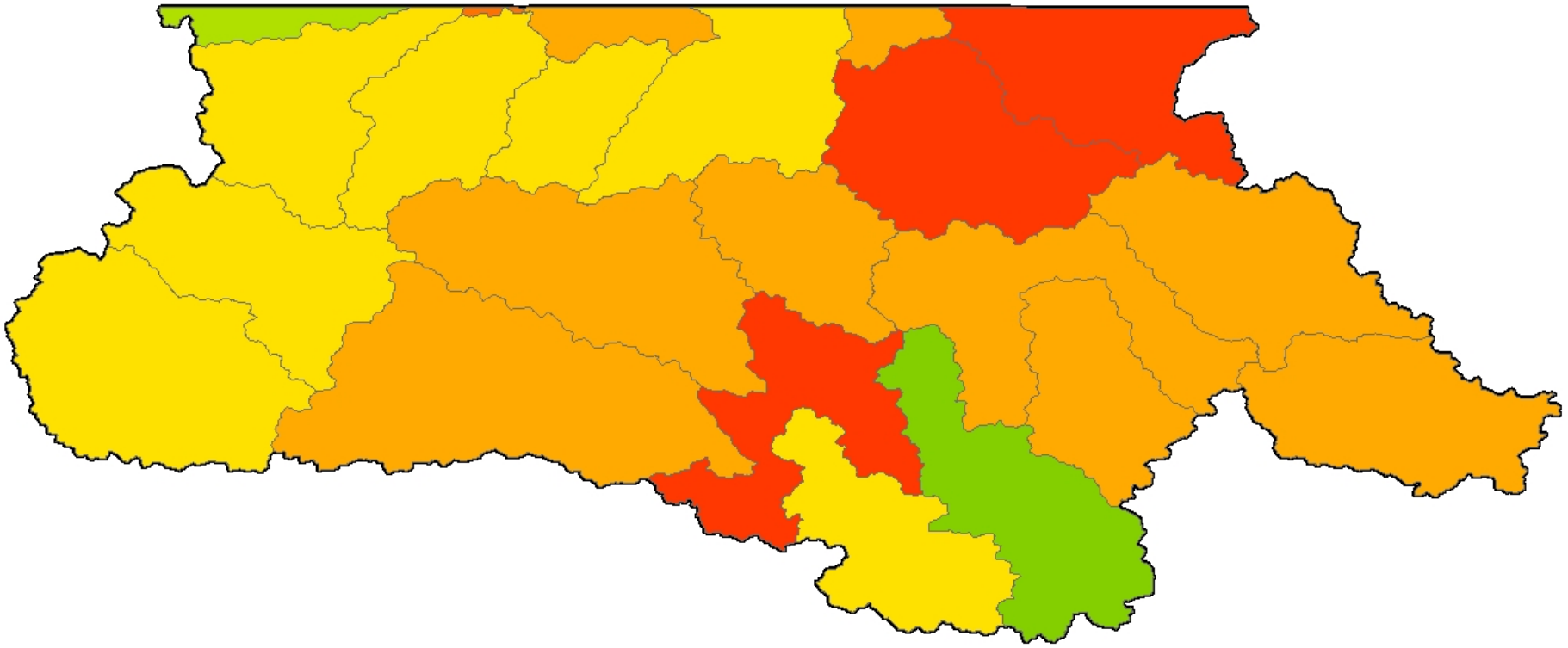
Monongahela Watershed

Results:
Relative Rankings

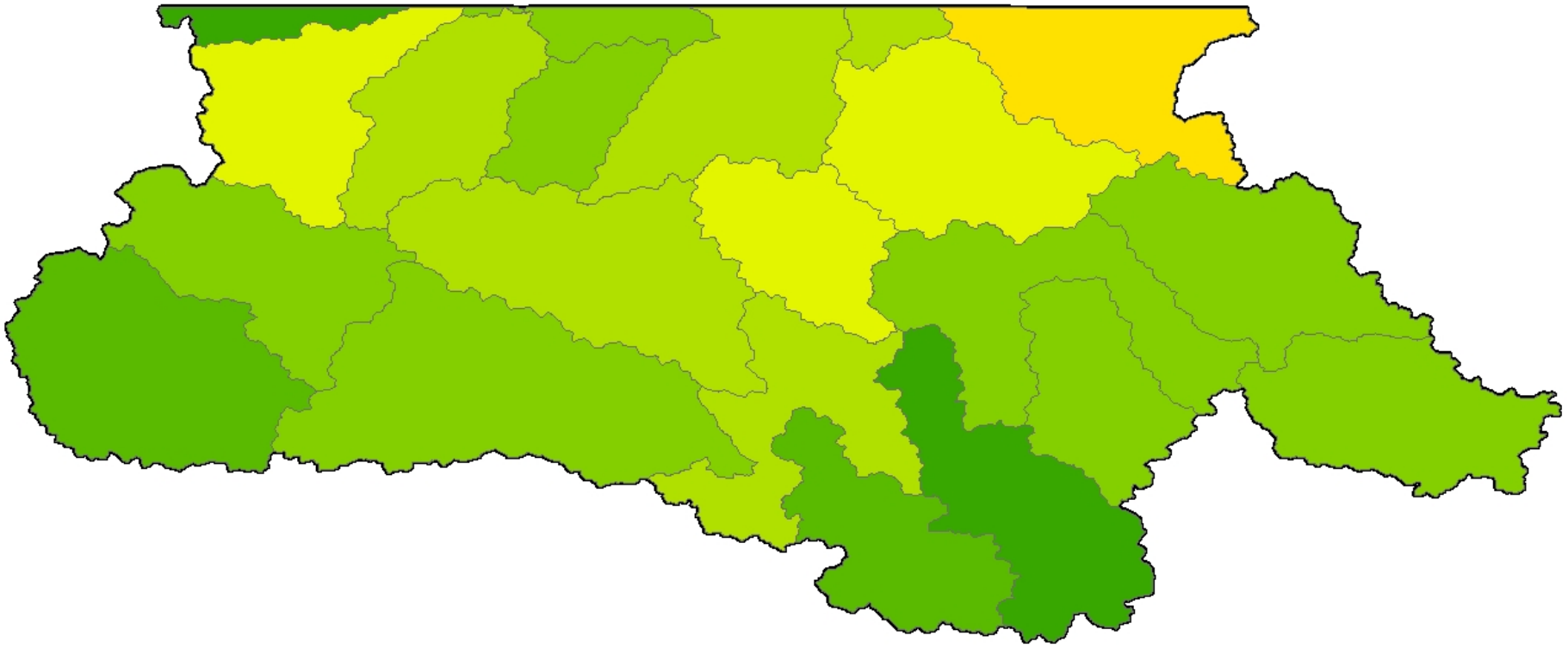
Standard Legend



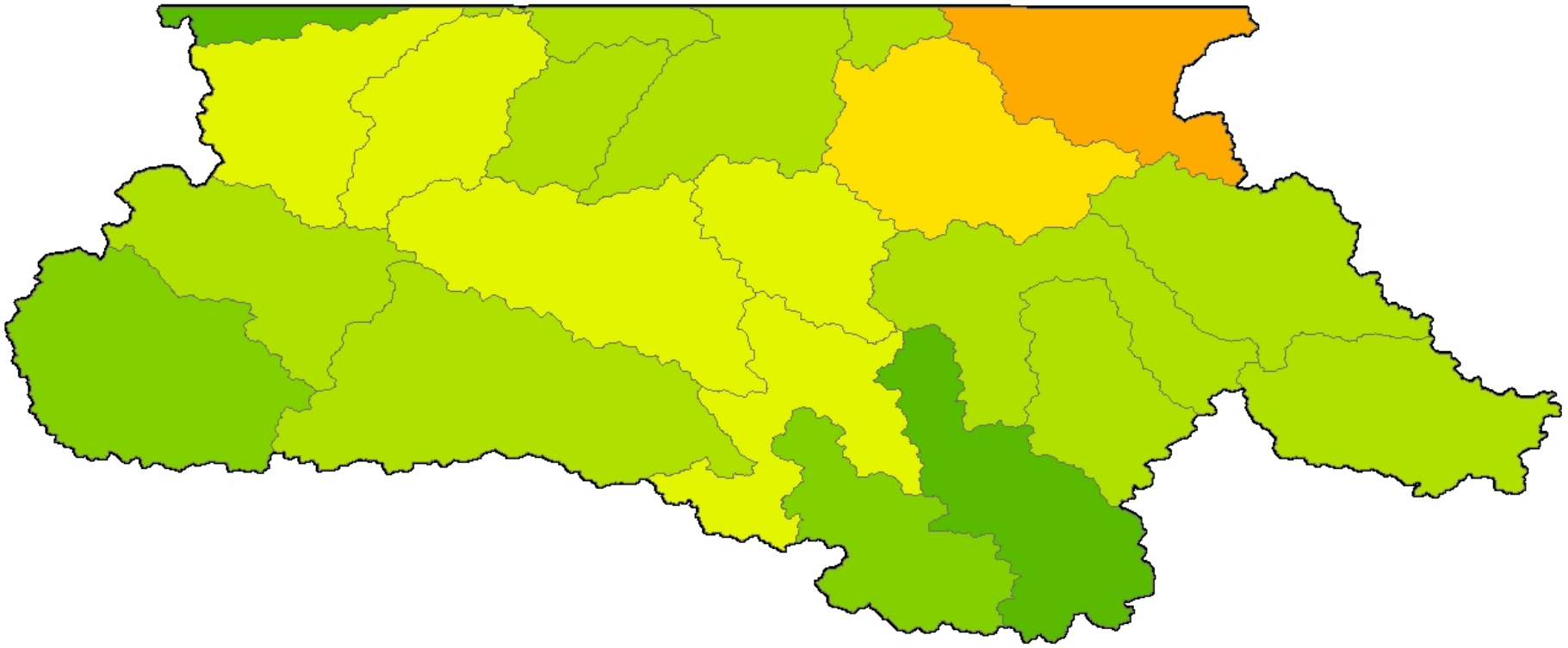
Streams
Water Quality
Quality Indicators



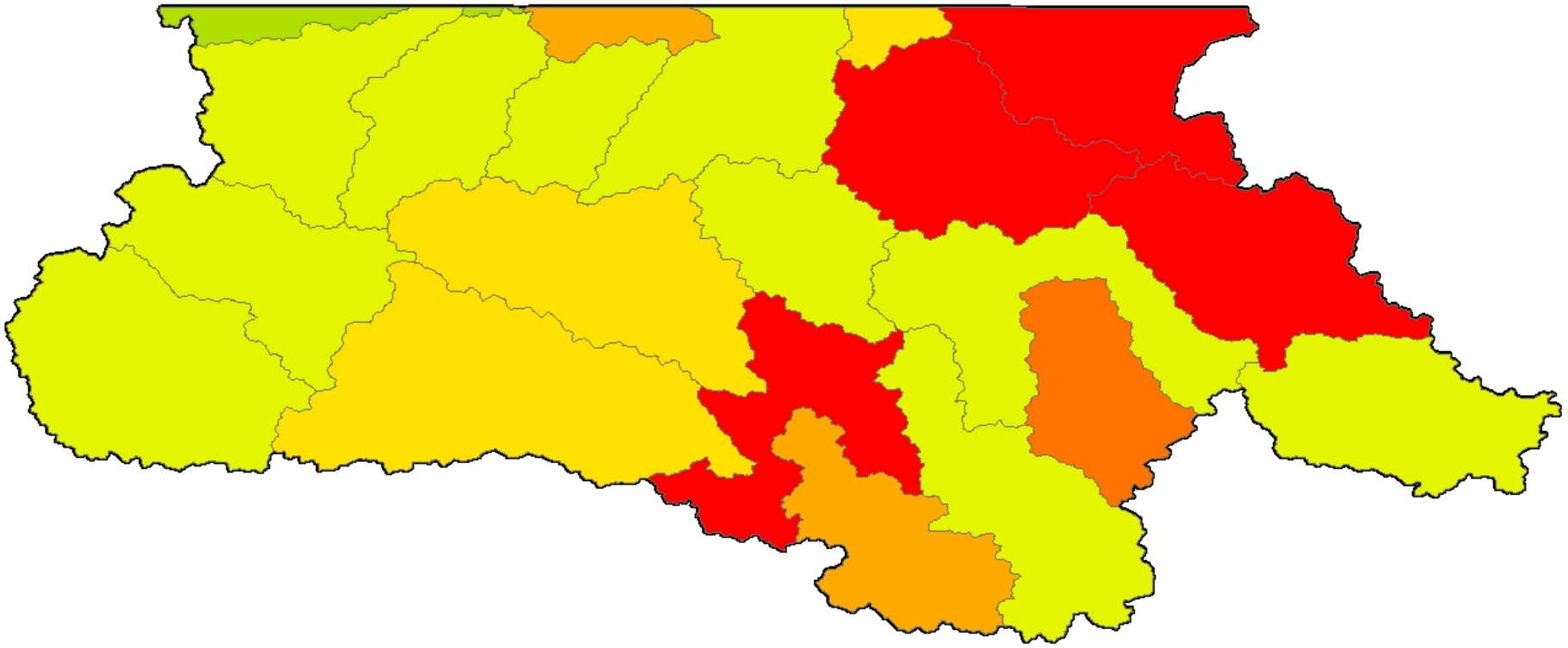
Streams
Water Quality
Stressors



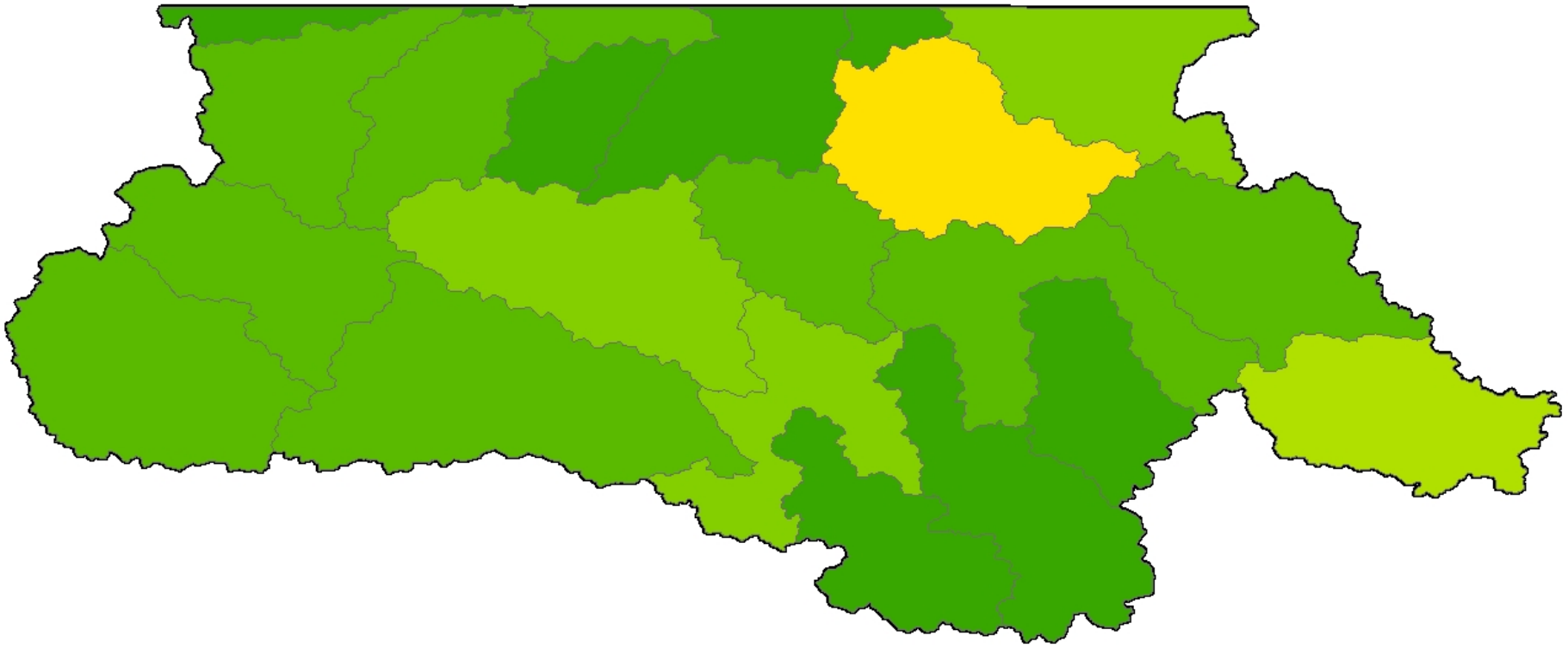
Streams
Water Quality
Overall



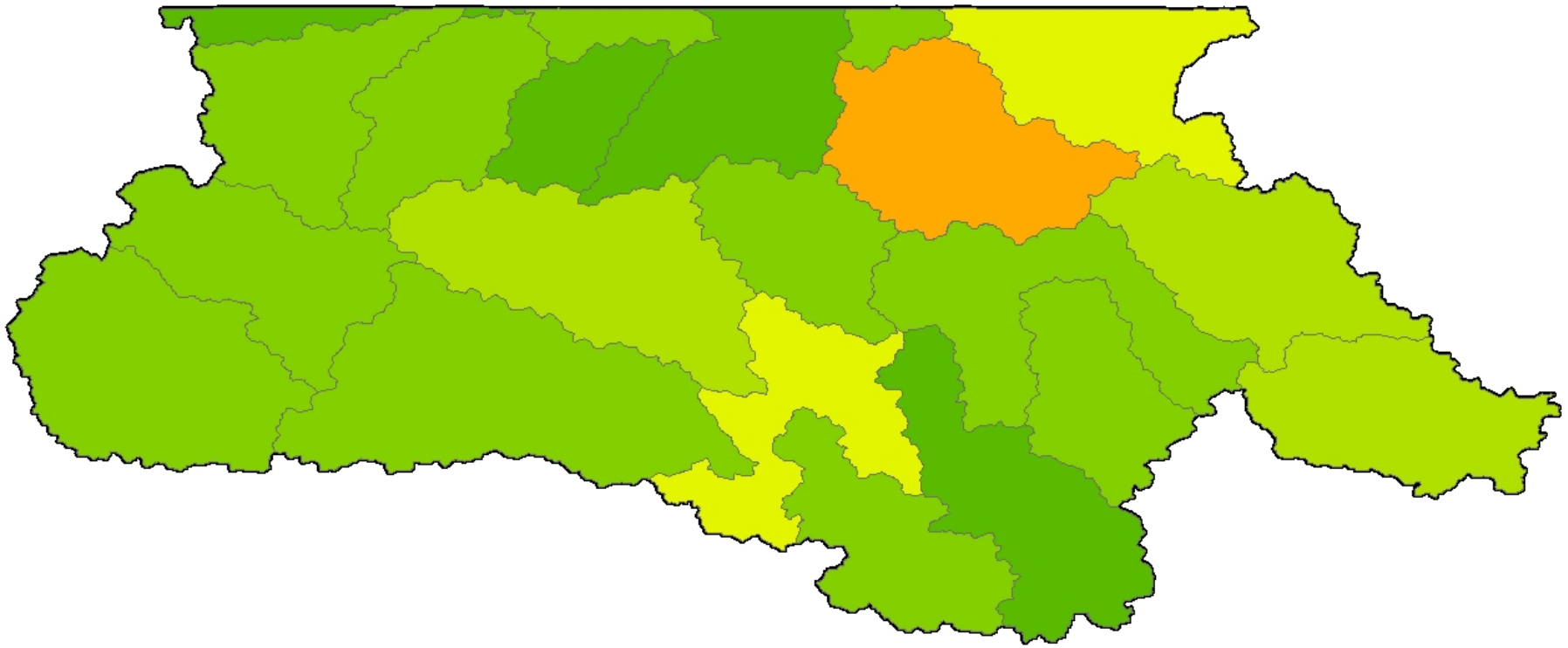
Streams
Water Quantity
Quality Indicators



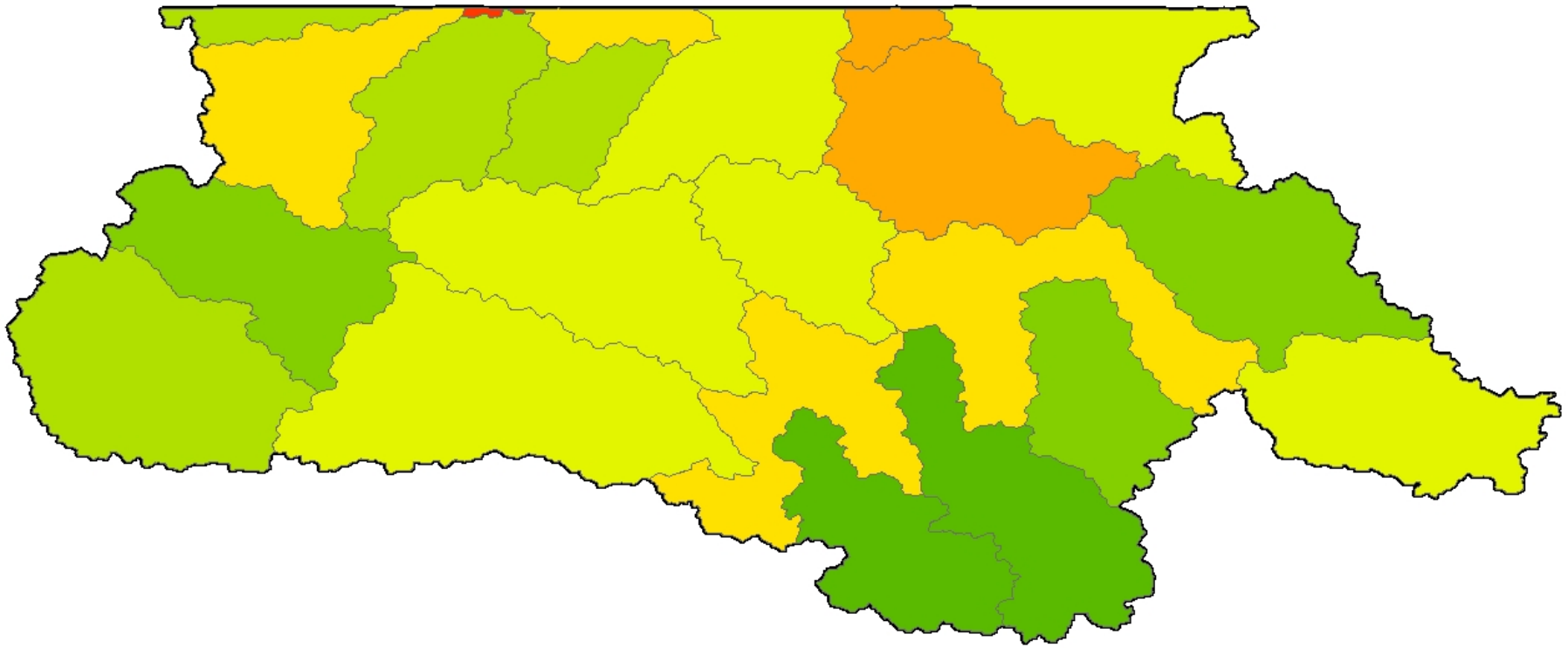
Streams
Water Quantity
Stressors



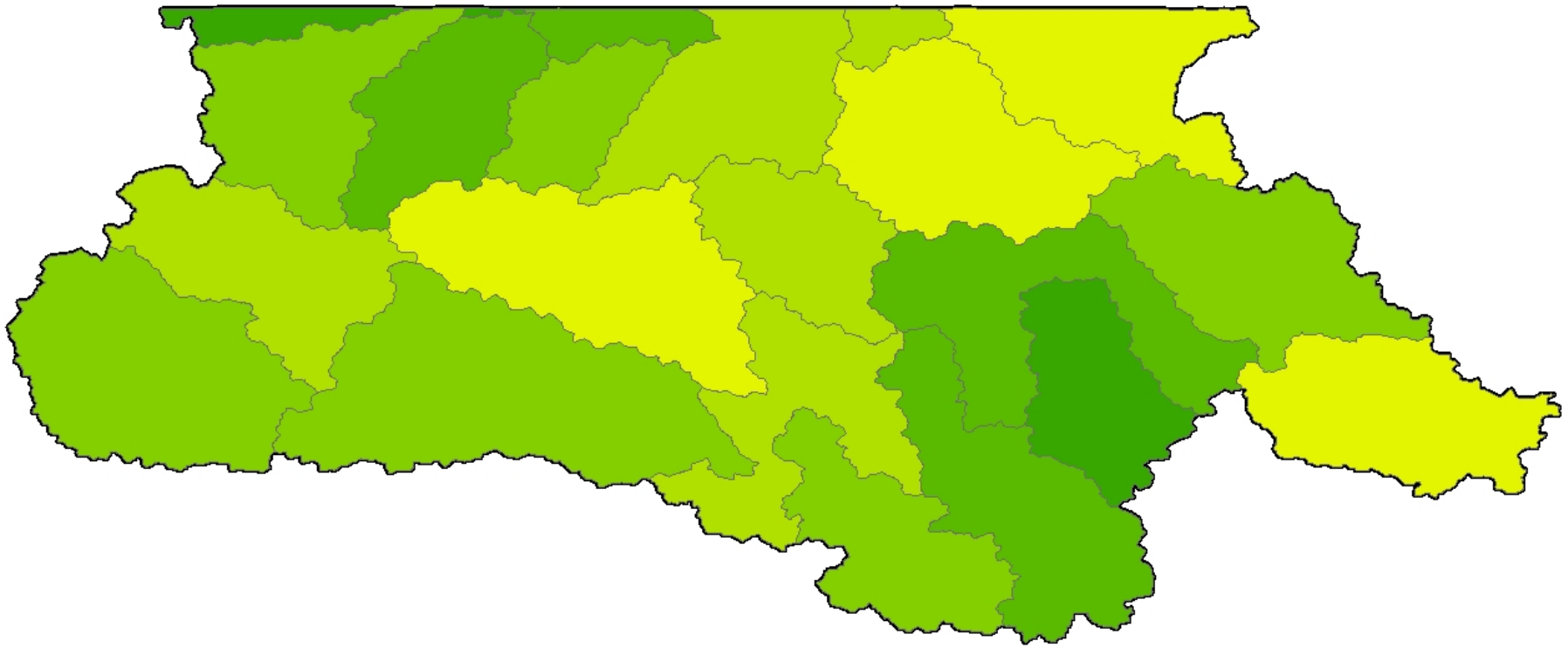
Streams
Water Quantity
Overall



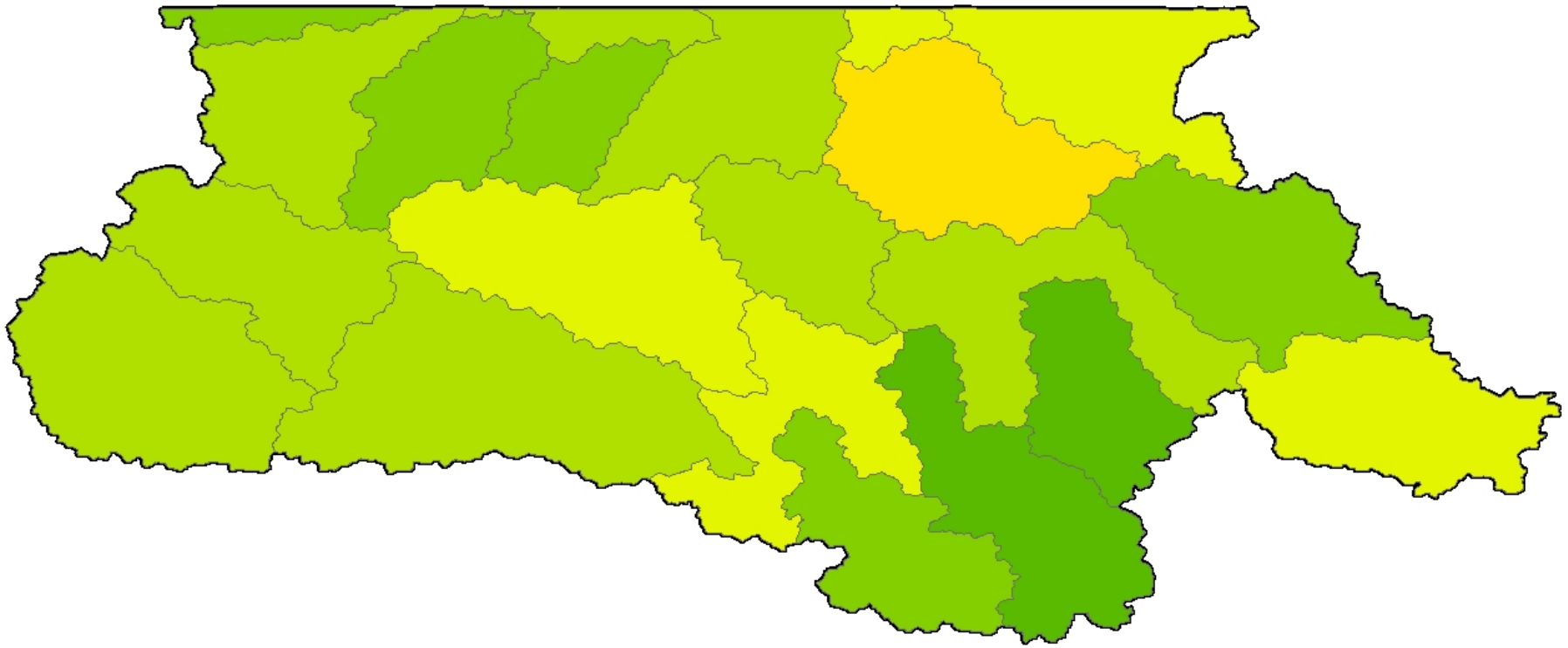
Streams
Hydrologic Connectivity
Quality Indicators



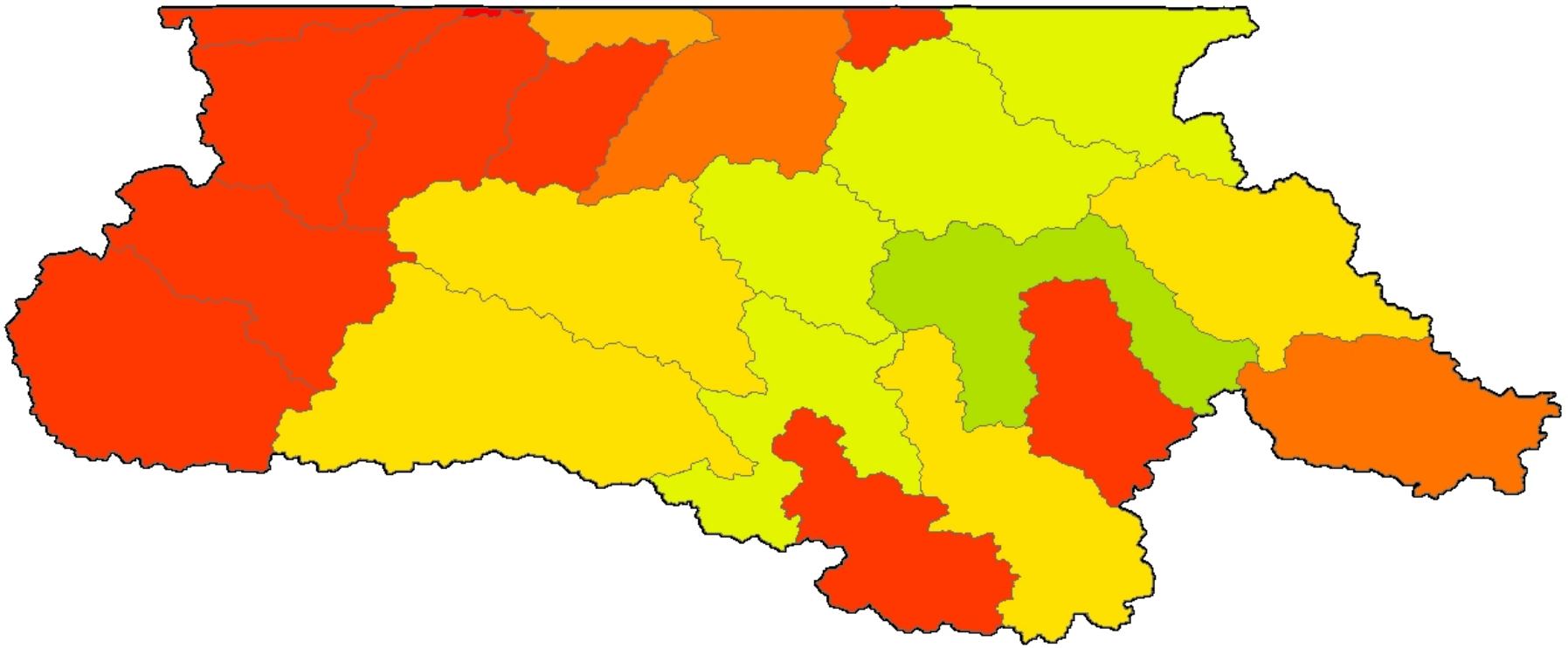
Streams
Hydrologic Connectivity
Stressors



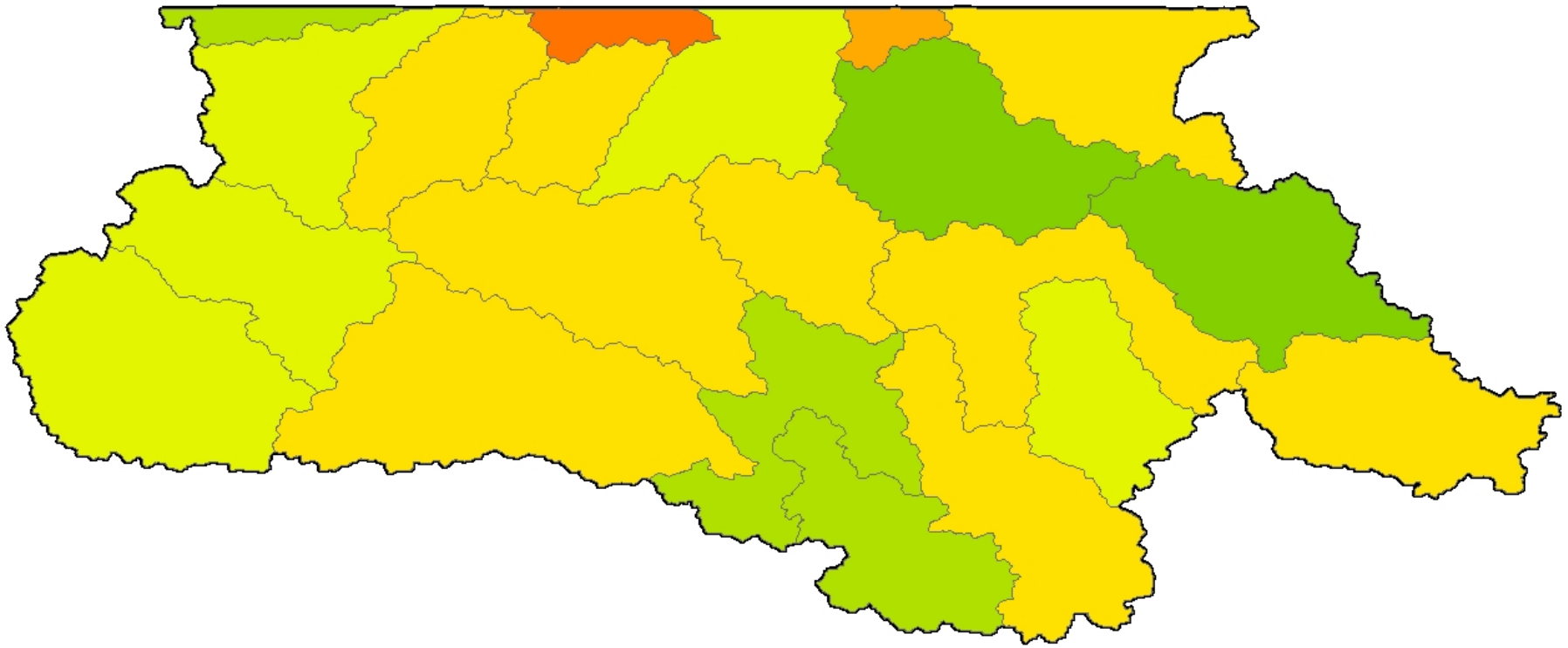
Streams
Hydrologic Connectivity
Overall



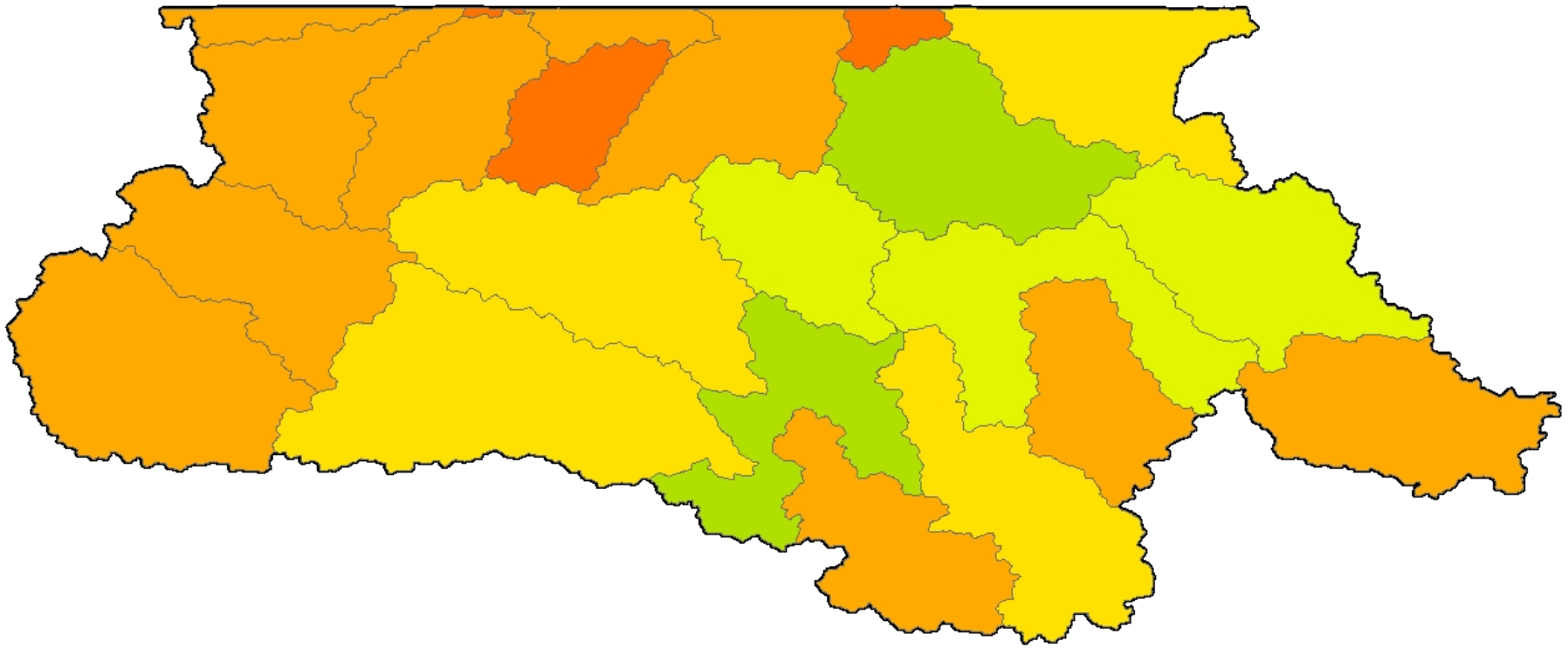
Streams
Biodiversity
Quality Indicators



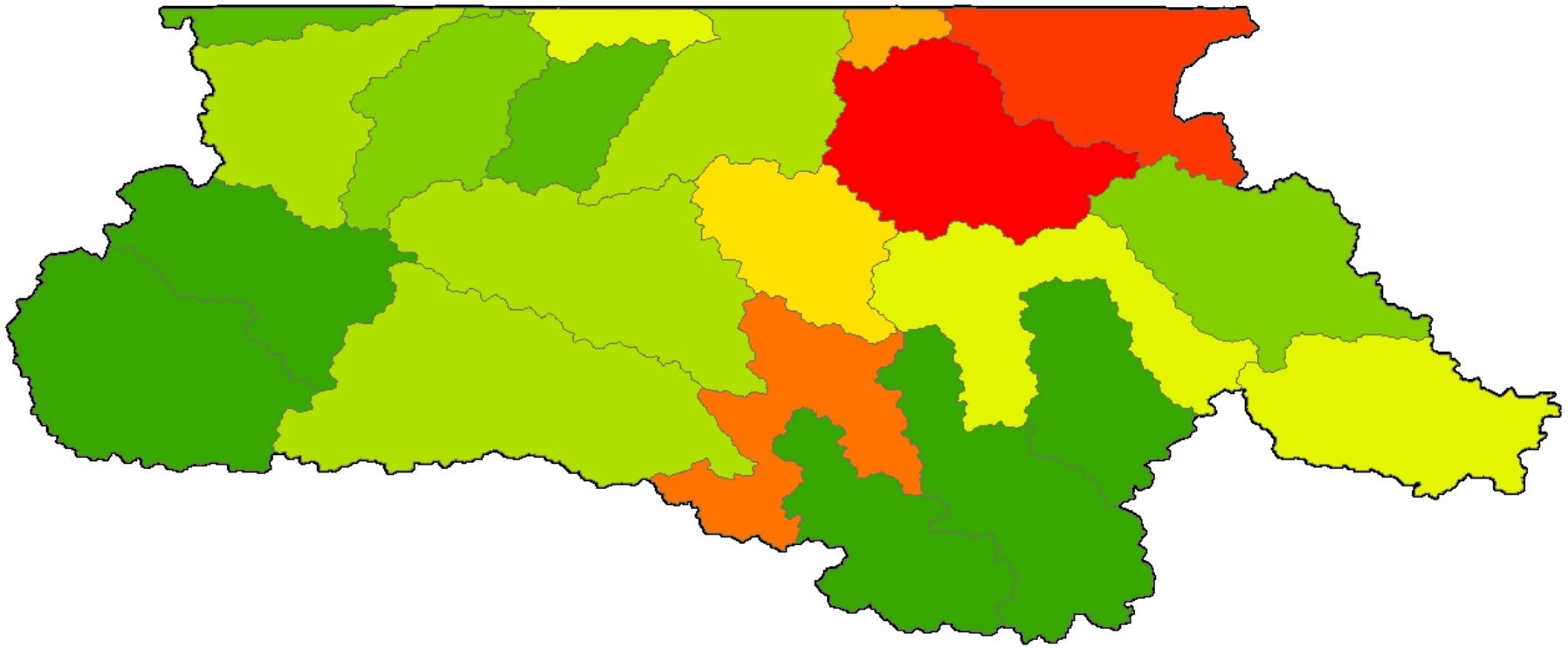
Streams
Biodiversity
Stressors



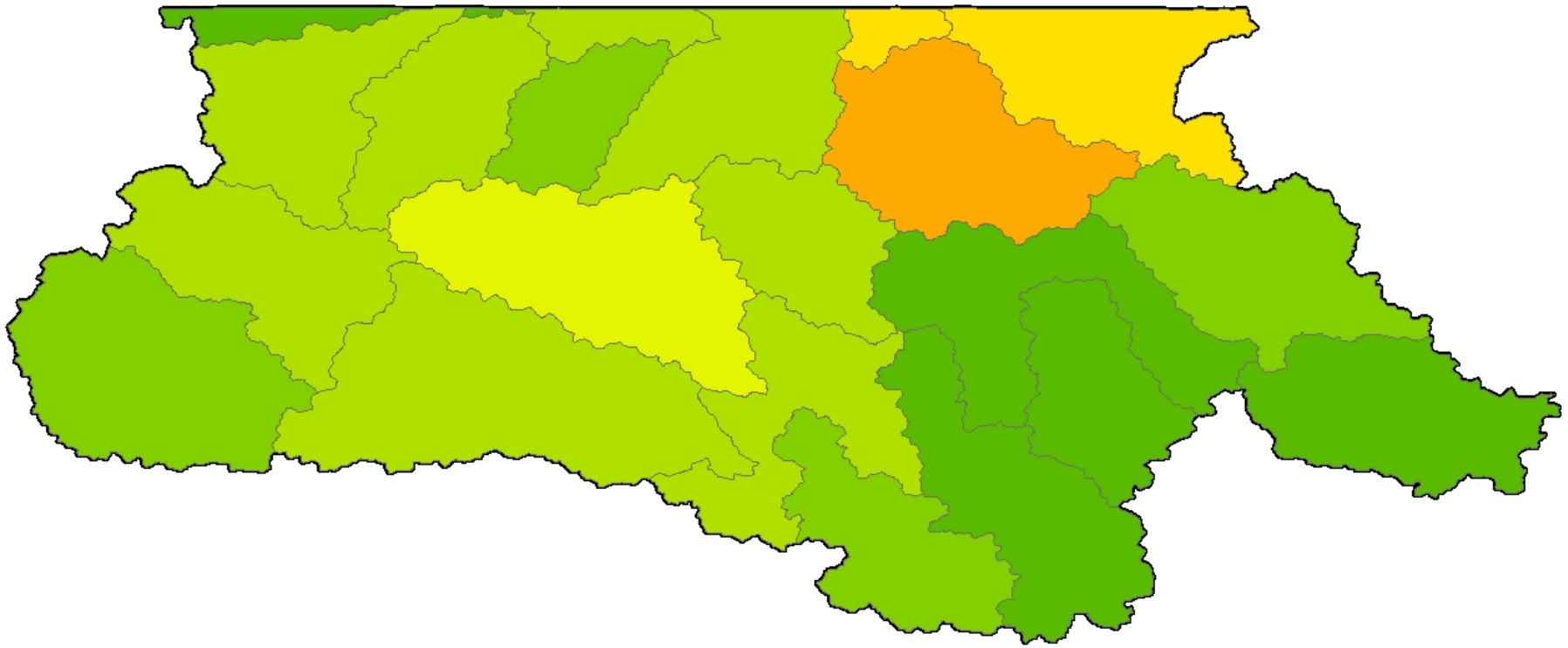
Streams
Biodiversity
Overall



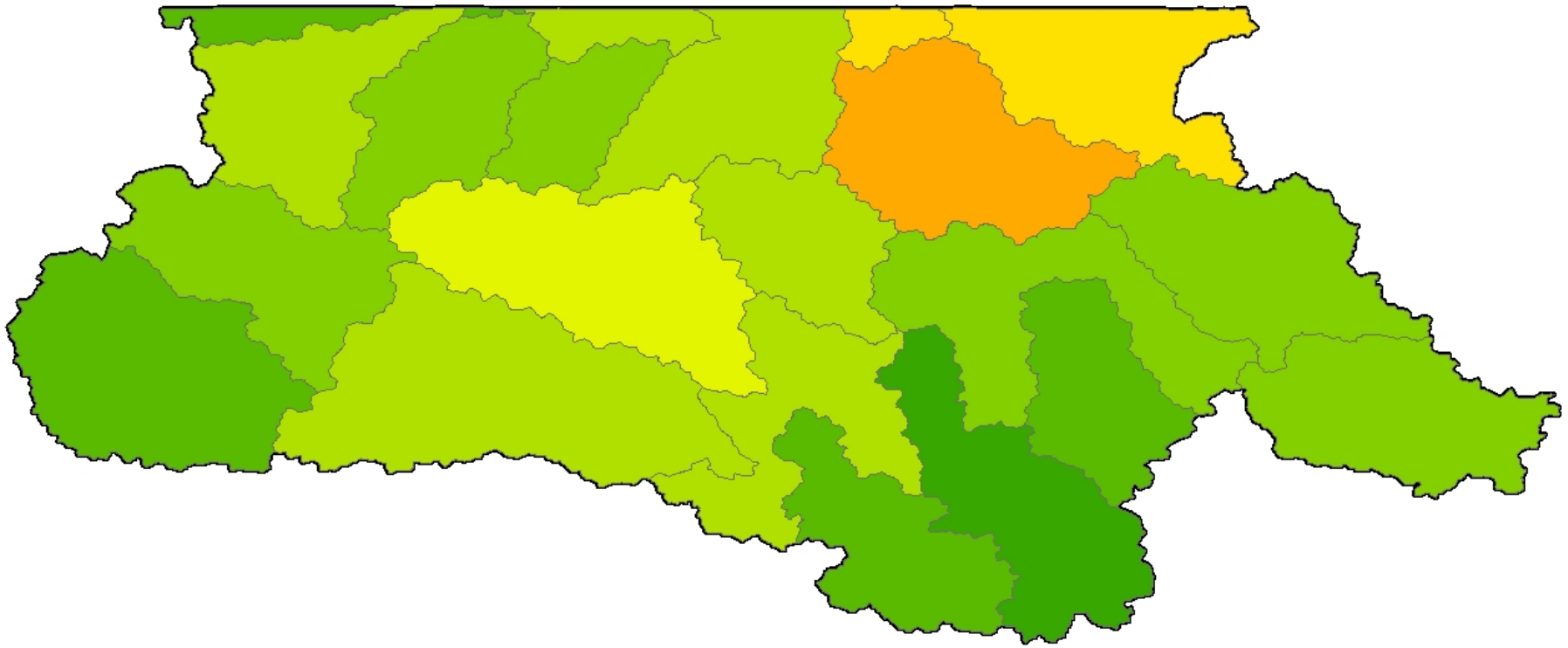
Streams
Riparian Habitat
Quality Indicators



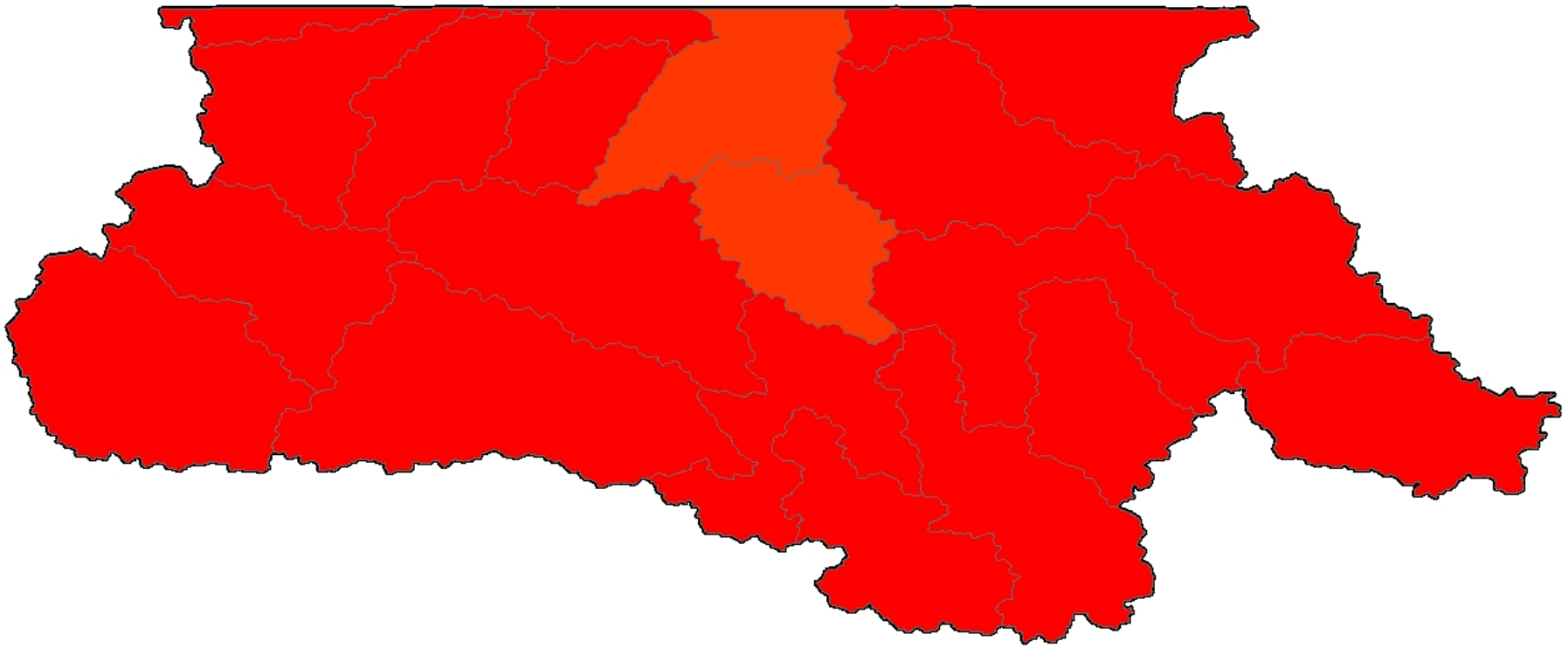
Streams
Riparian Habitat
Stressors



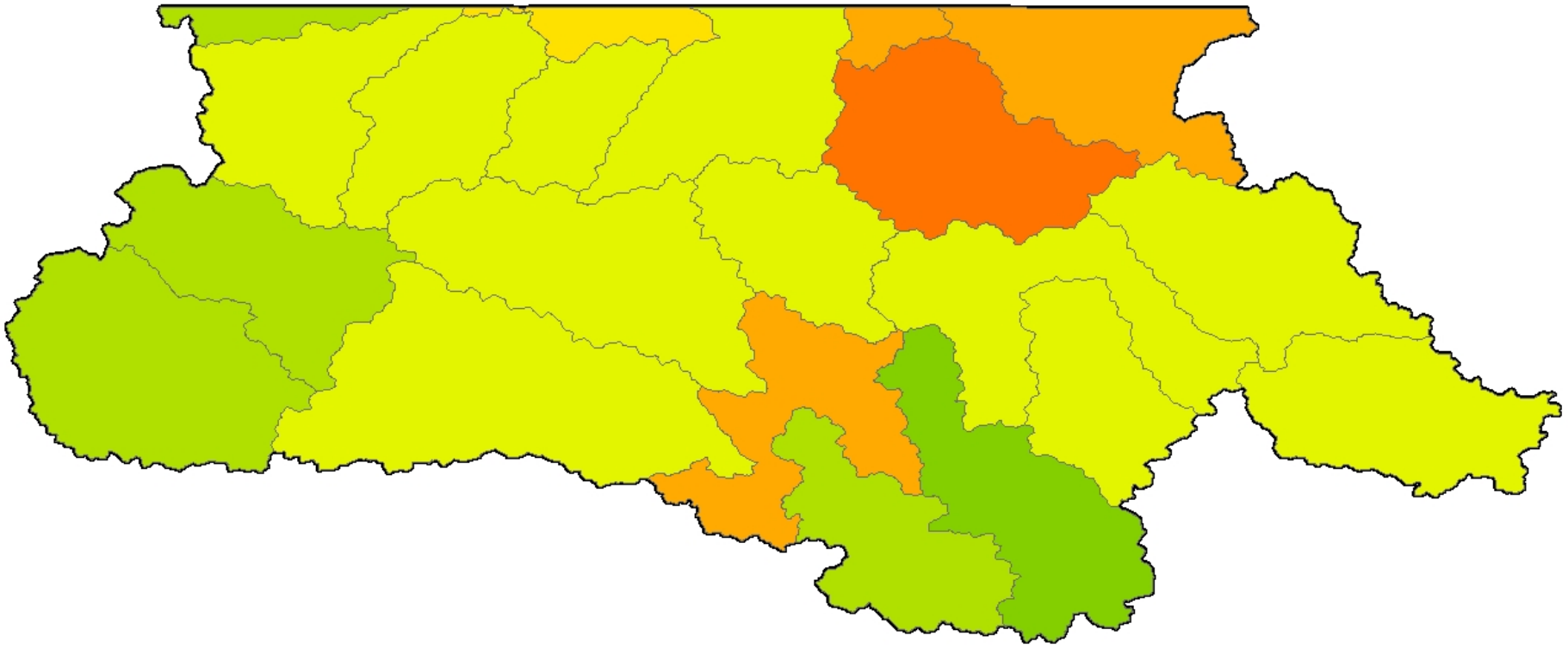
Streams
Riparian Habitat
Overall



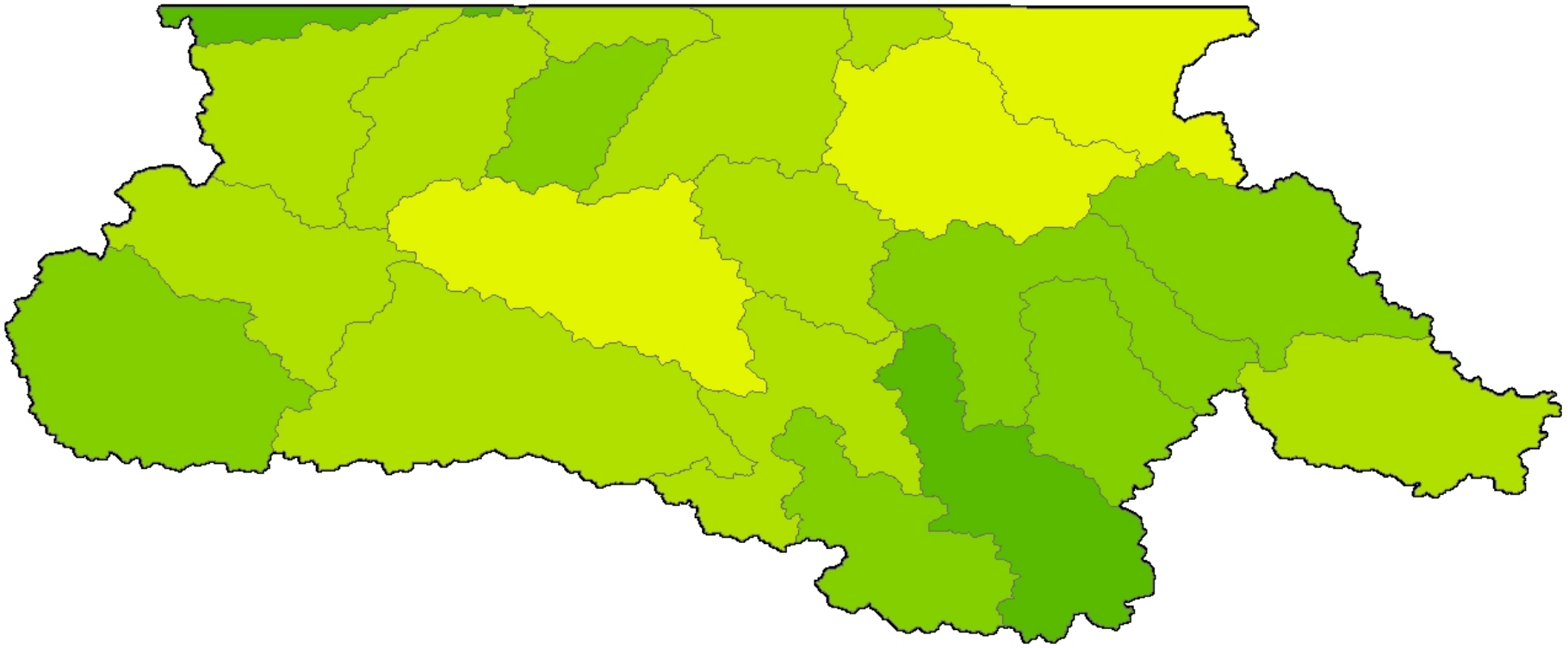
Streams
Protected Lands
Overall



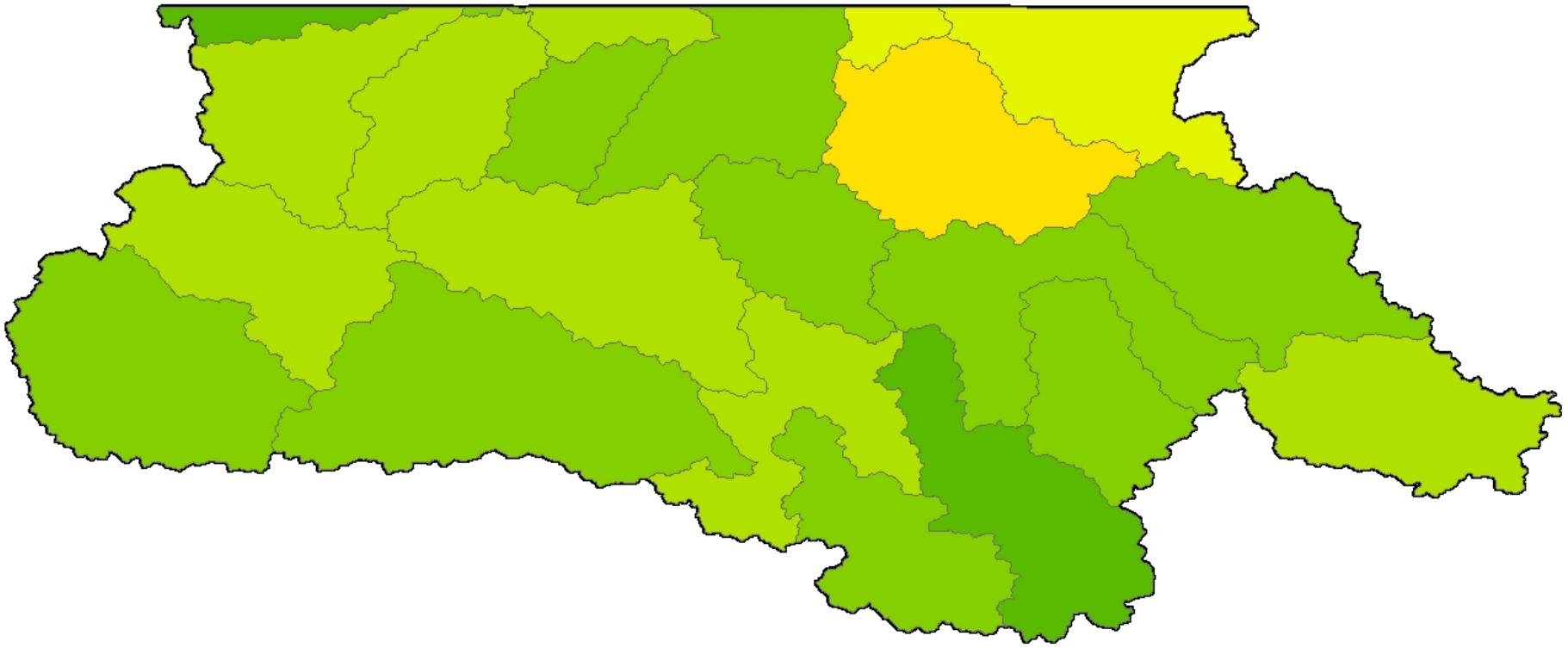
Streams
Quality Indicators
Overall



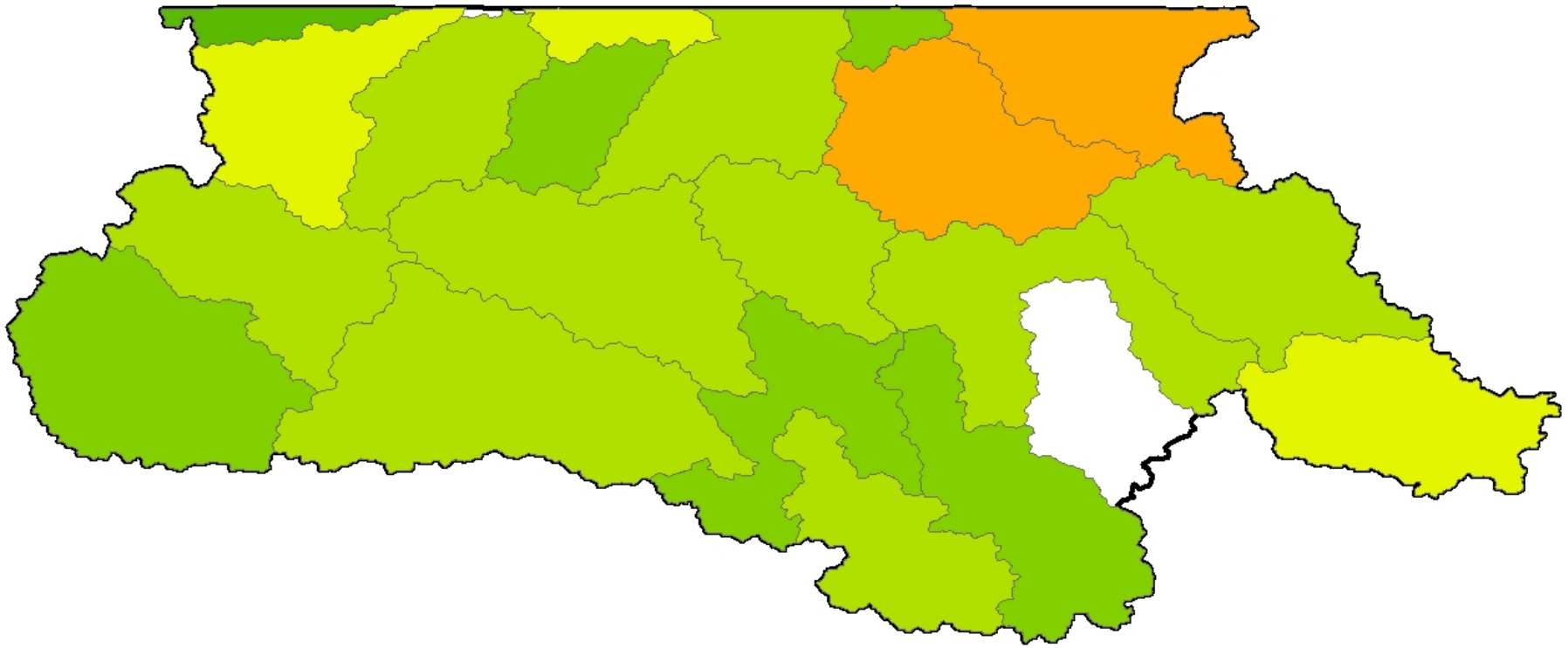
Streams
Stressors
Overall



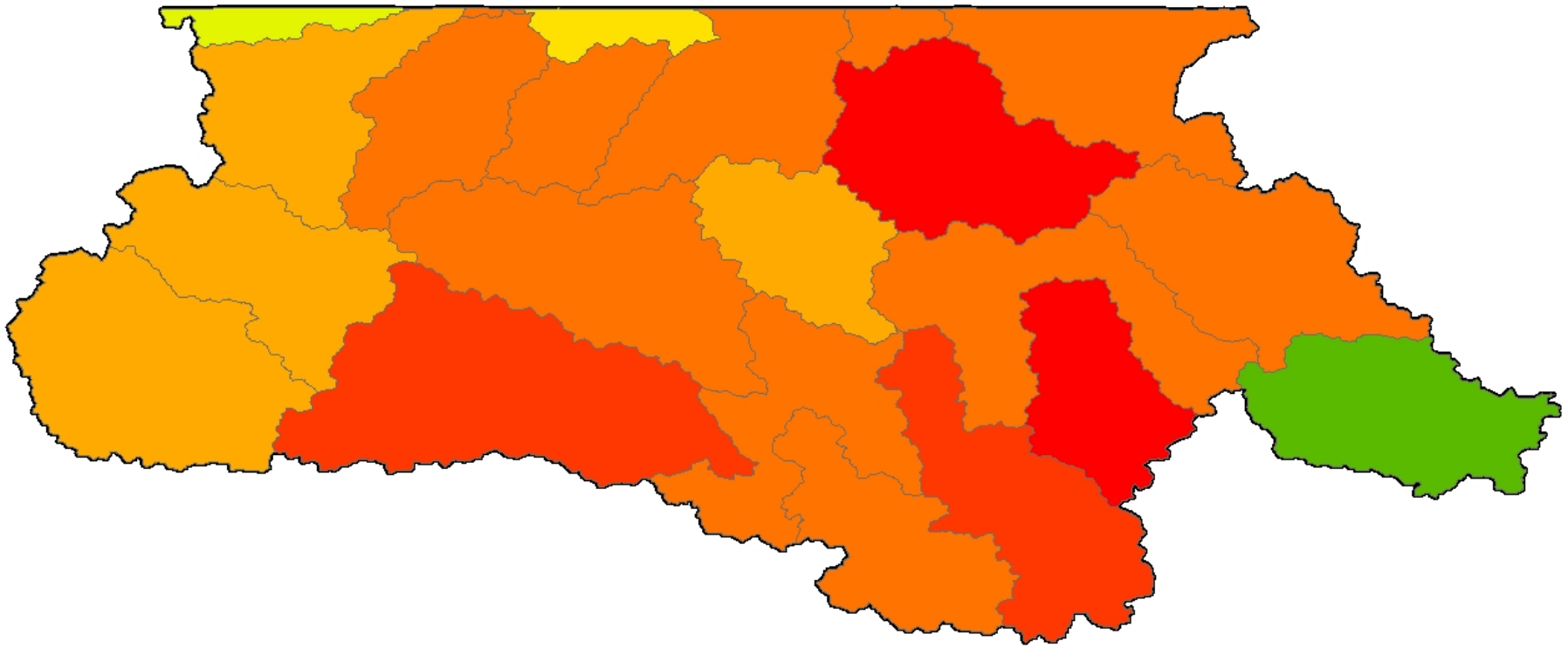
Streams
Overall



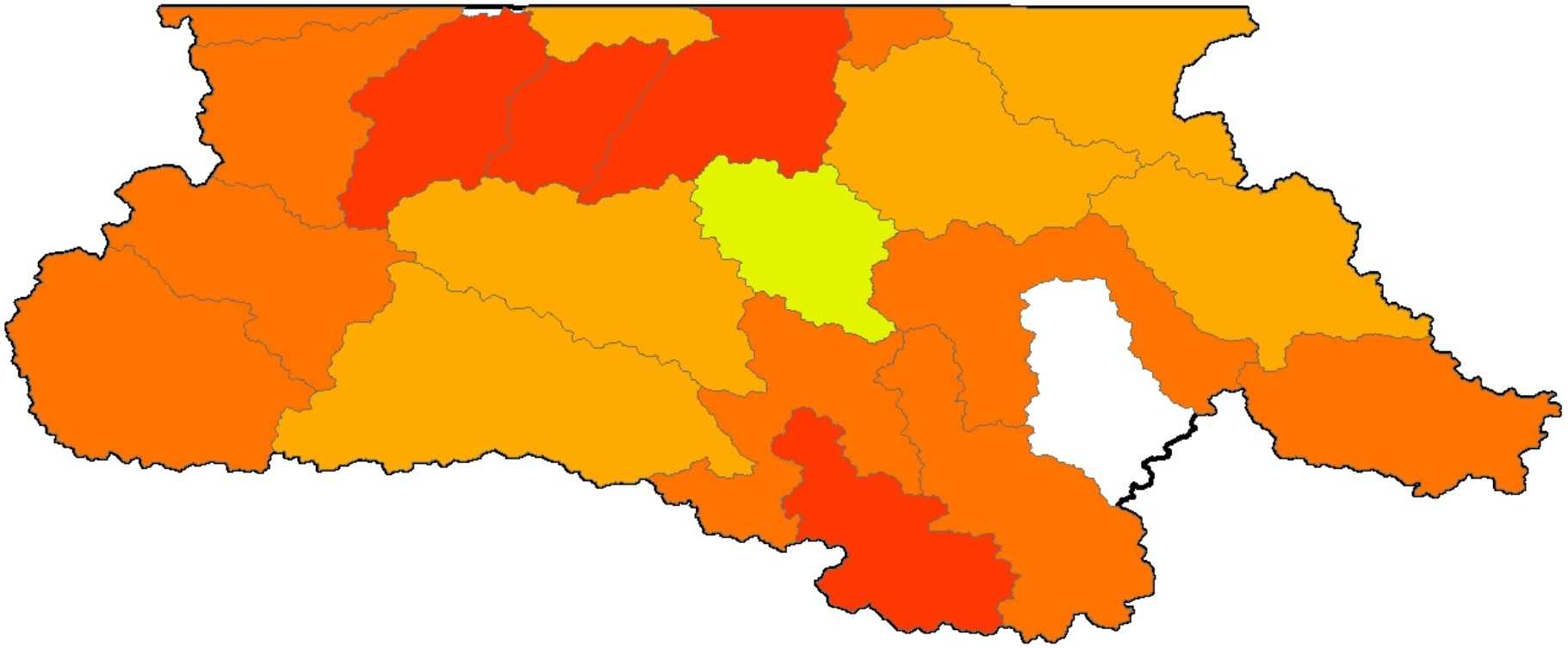
Wetlands
Water Quality
Overall



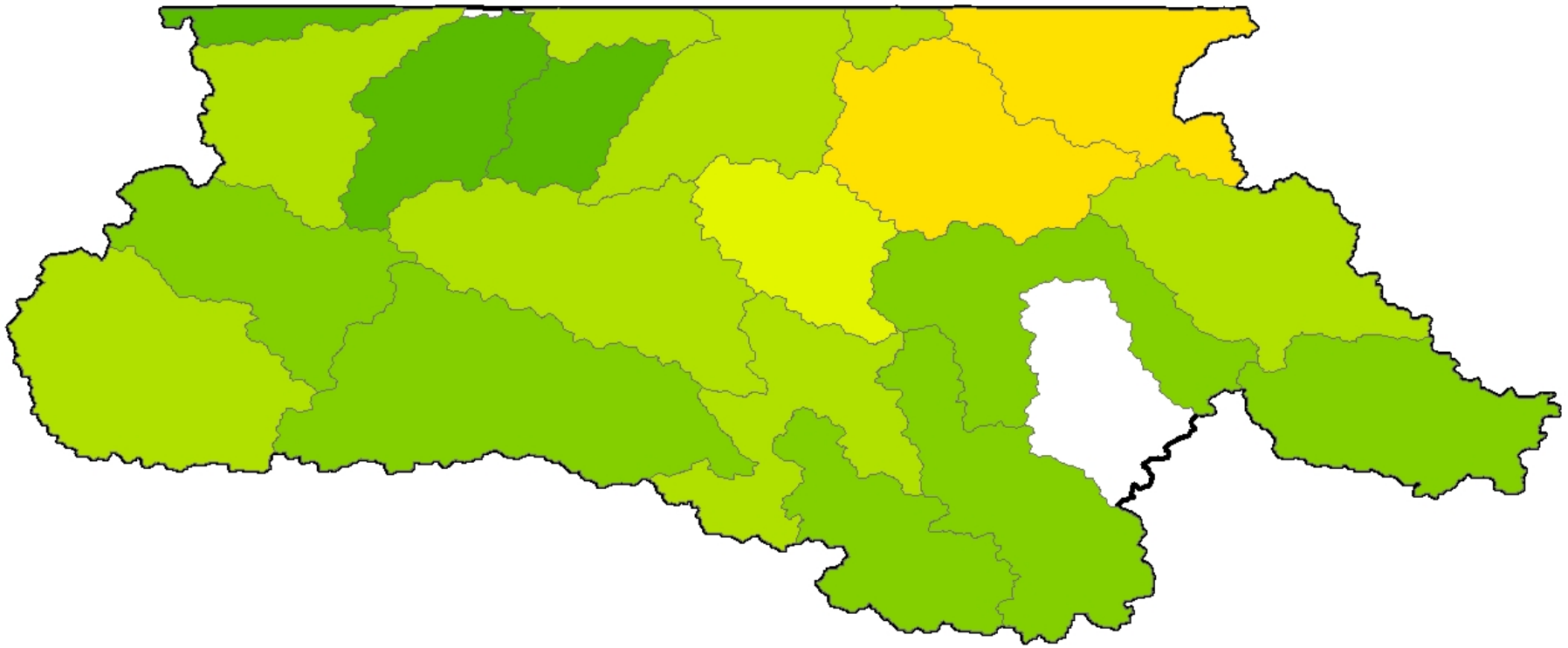
Wetlands
Hydrology
Overall



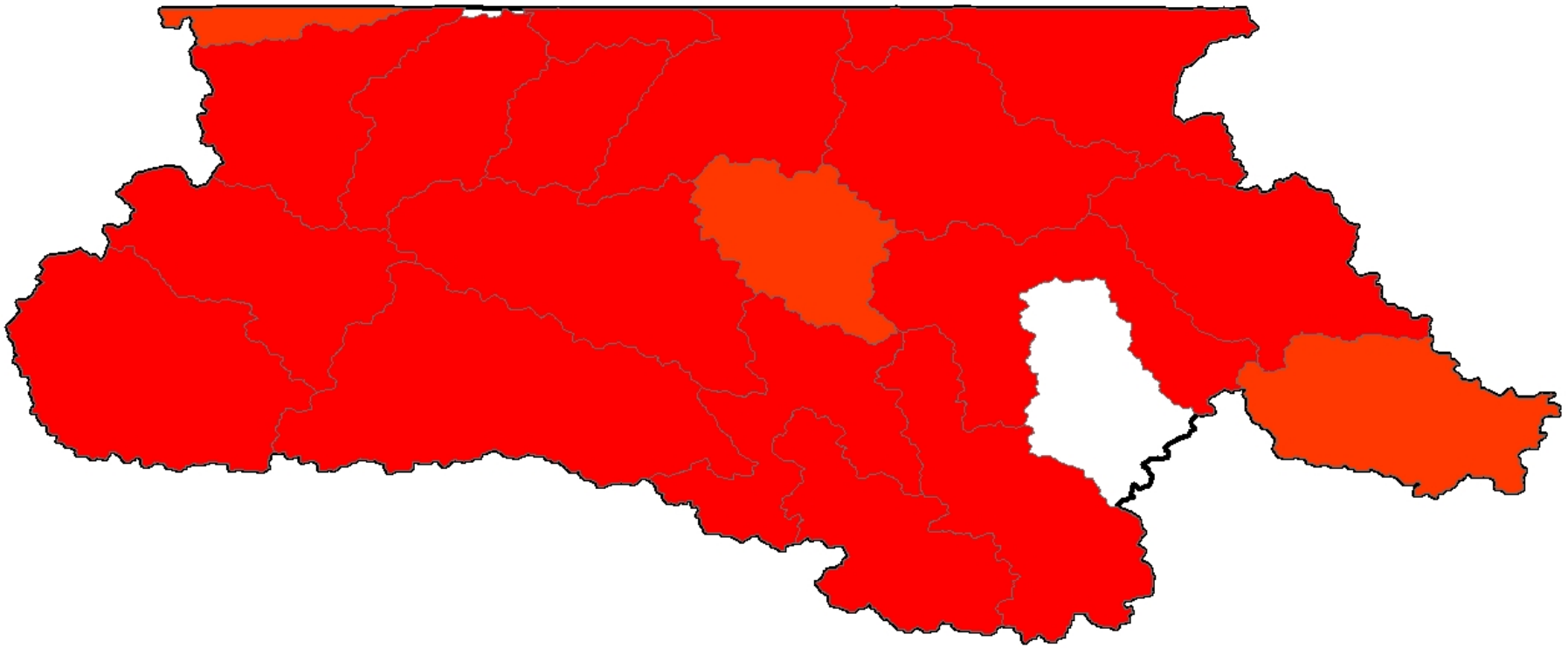
Wetlands
Biodiversity
Overall



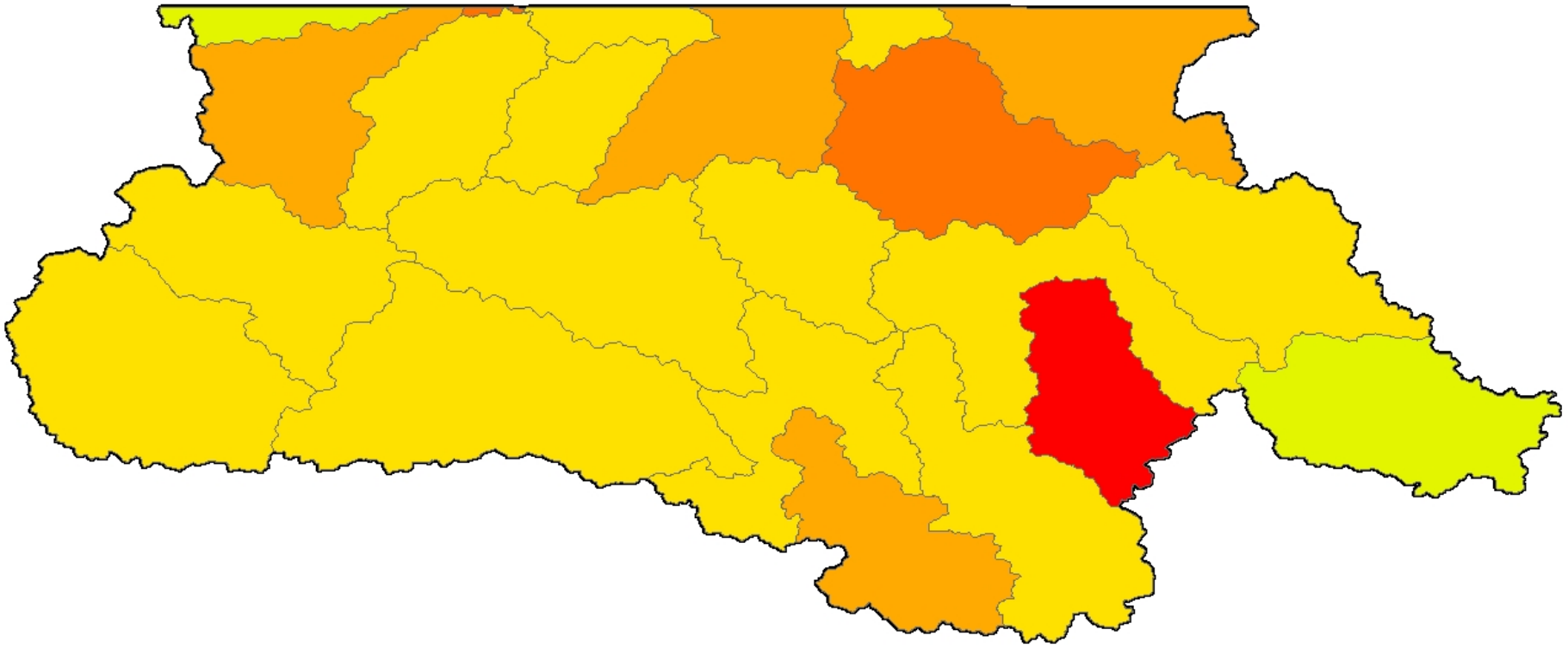
Wetlands
Wetland Habitat
Overall



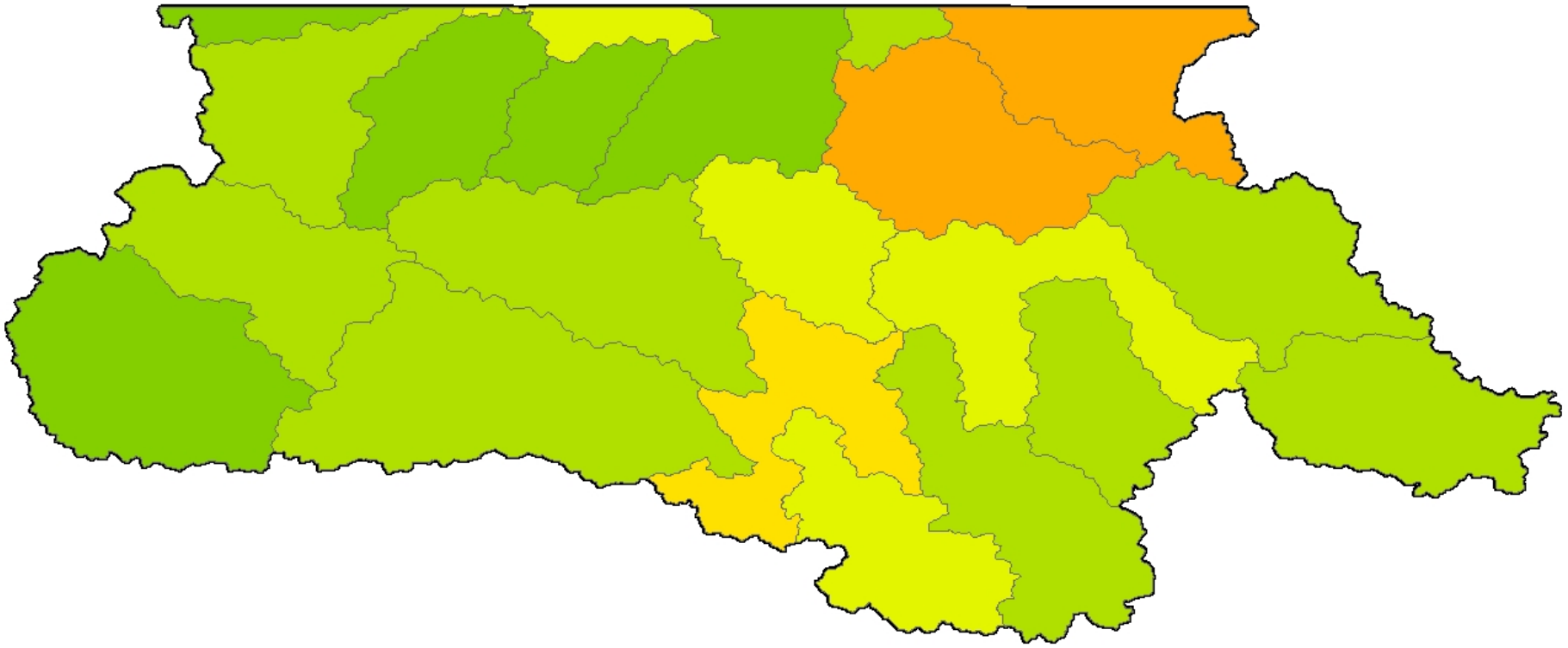
Wetlands
Protected Lands
Overall



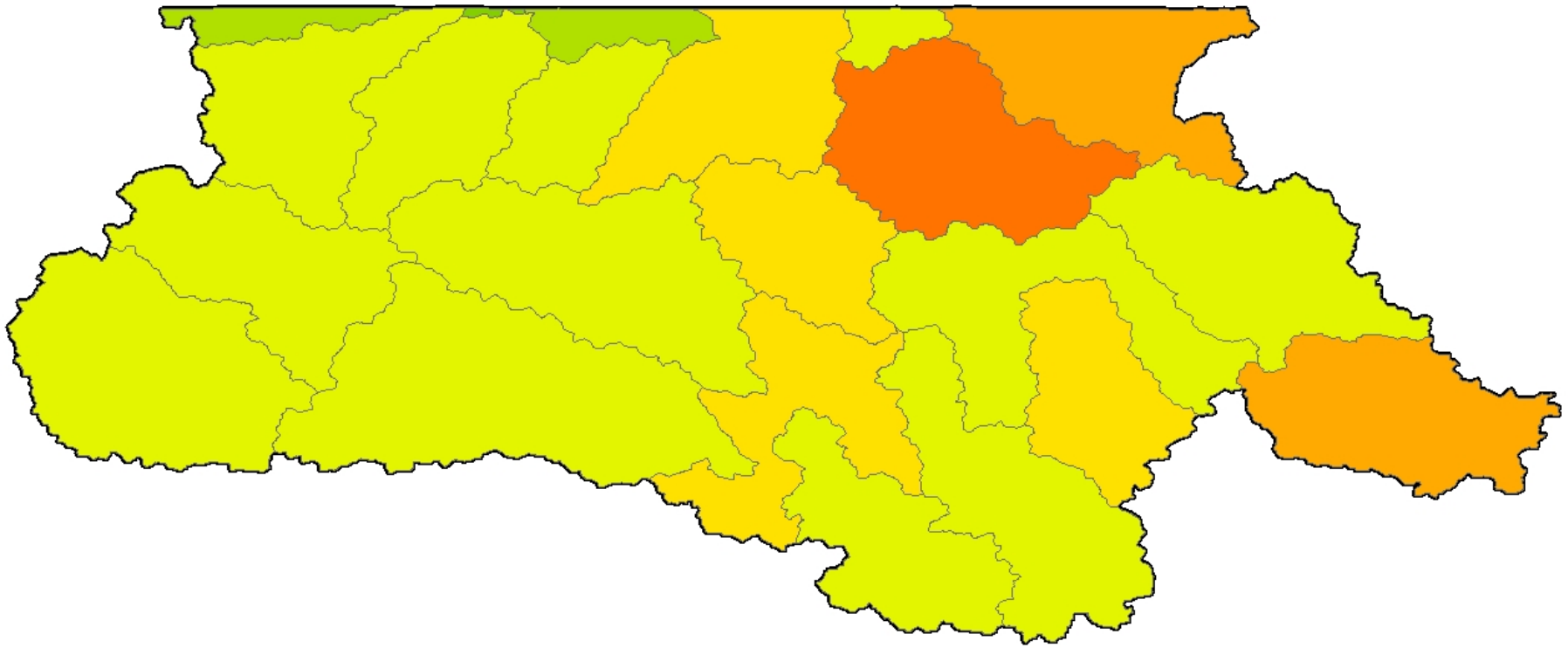
Wetlands
Overall



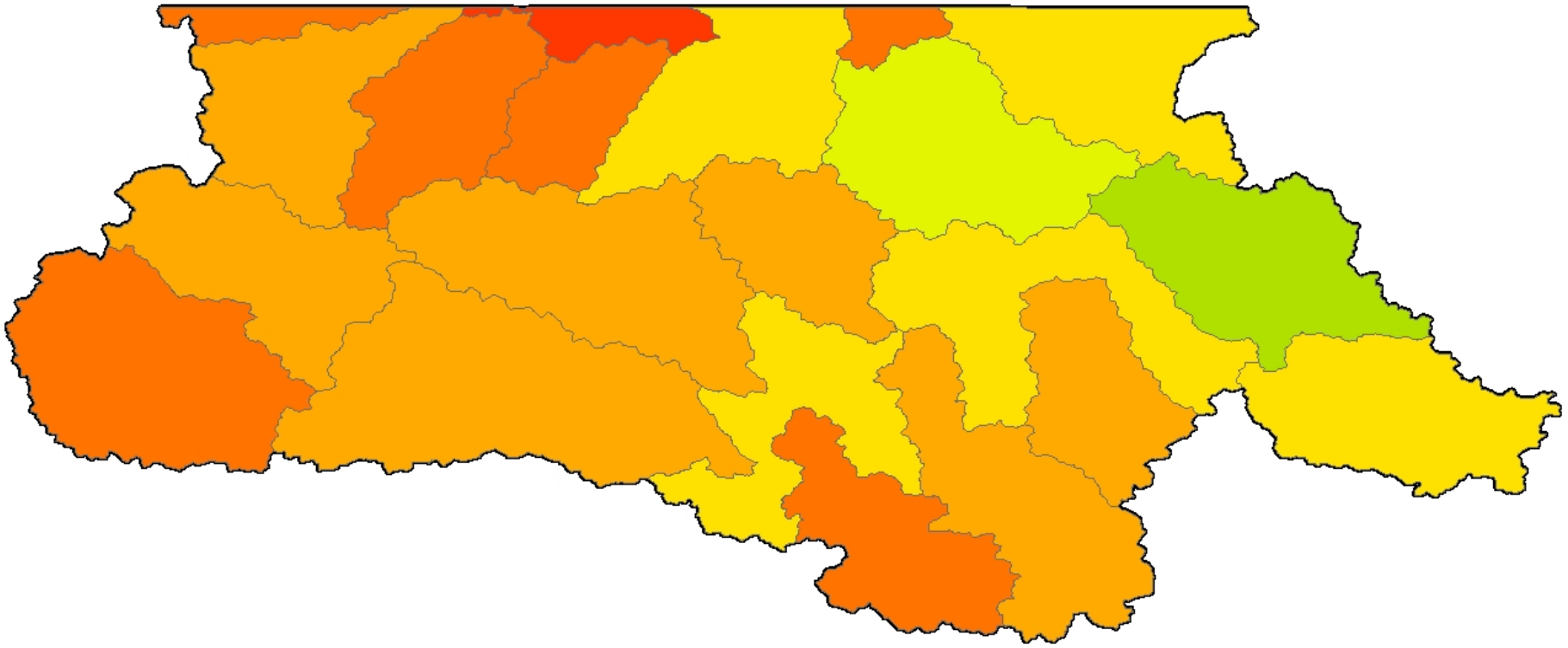
Uplands
Habitat Connectivity
Overall



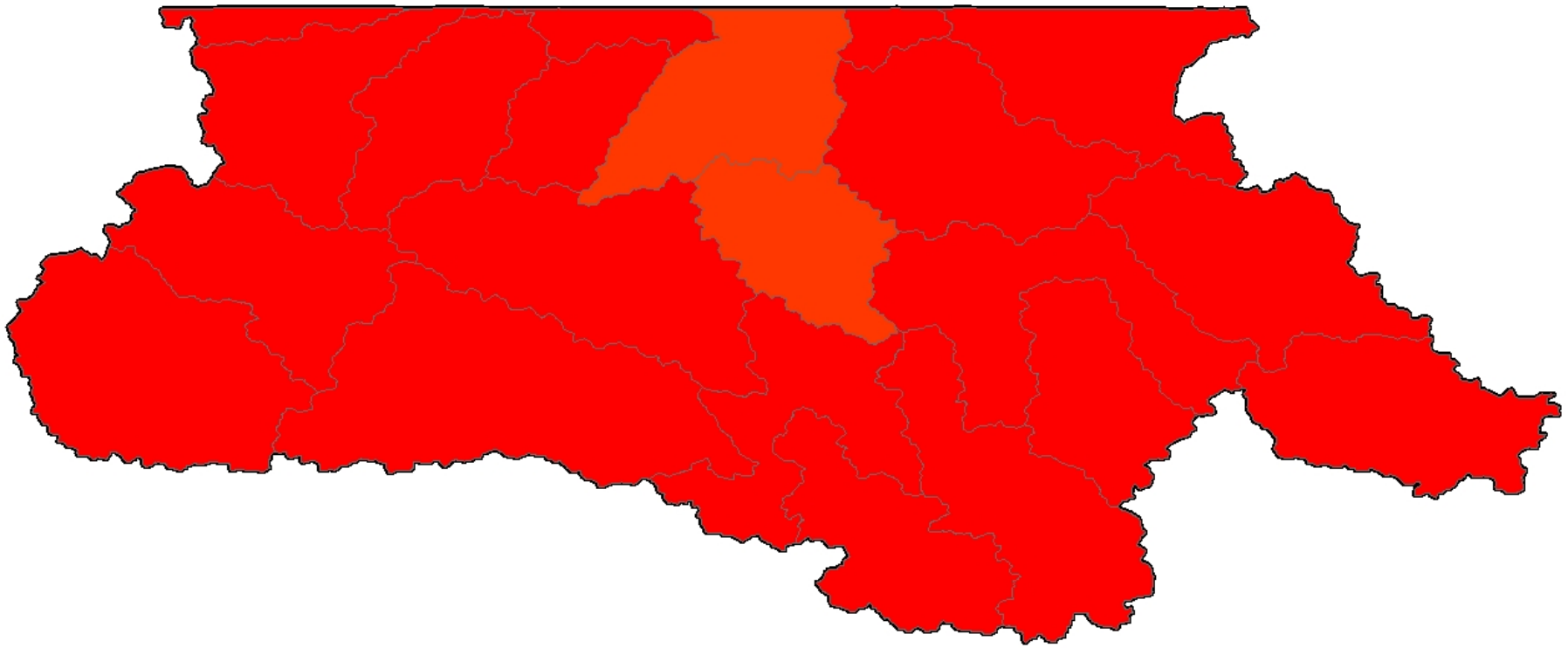
Uplands
Habitat Quality
Overall



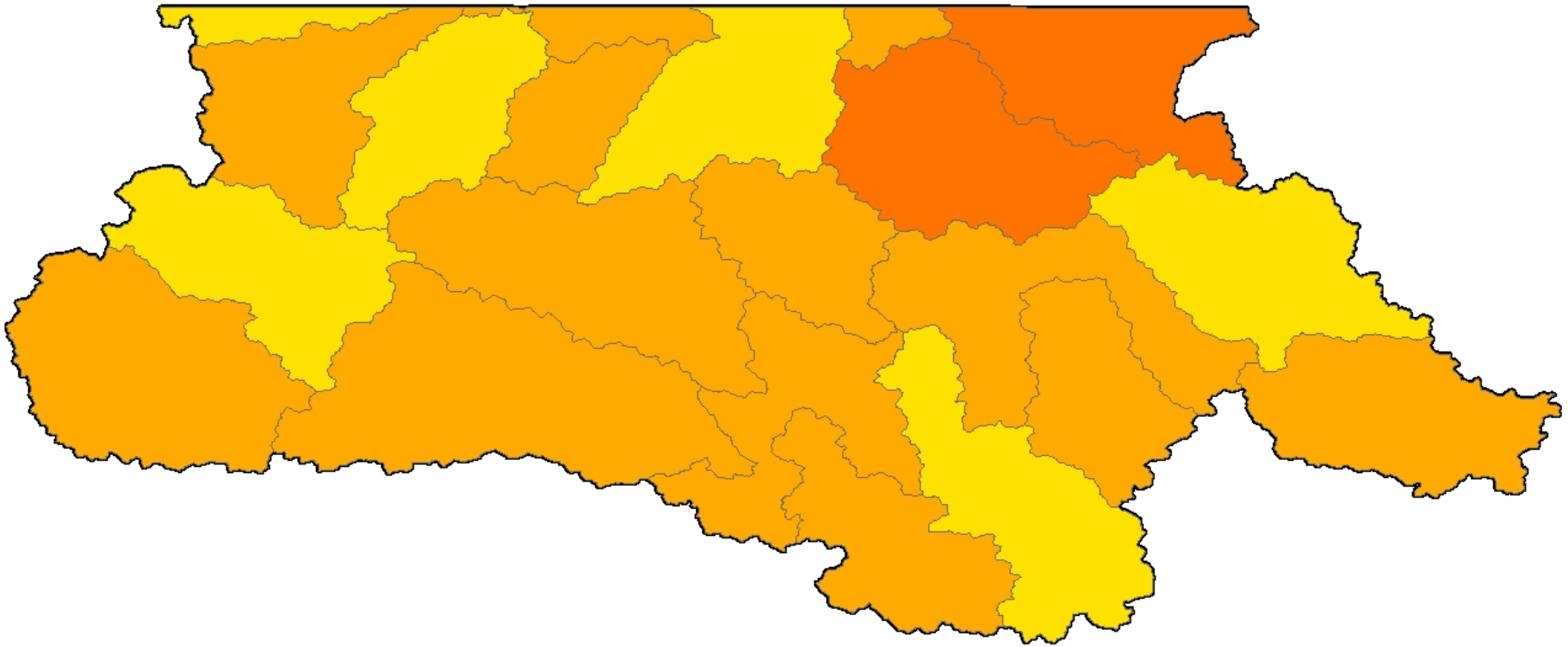
Uplands Biodiversity Overall



Uplands
Protected Lands
Overall



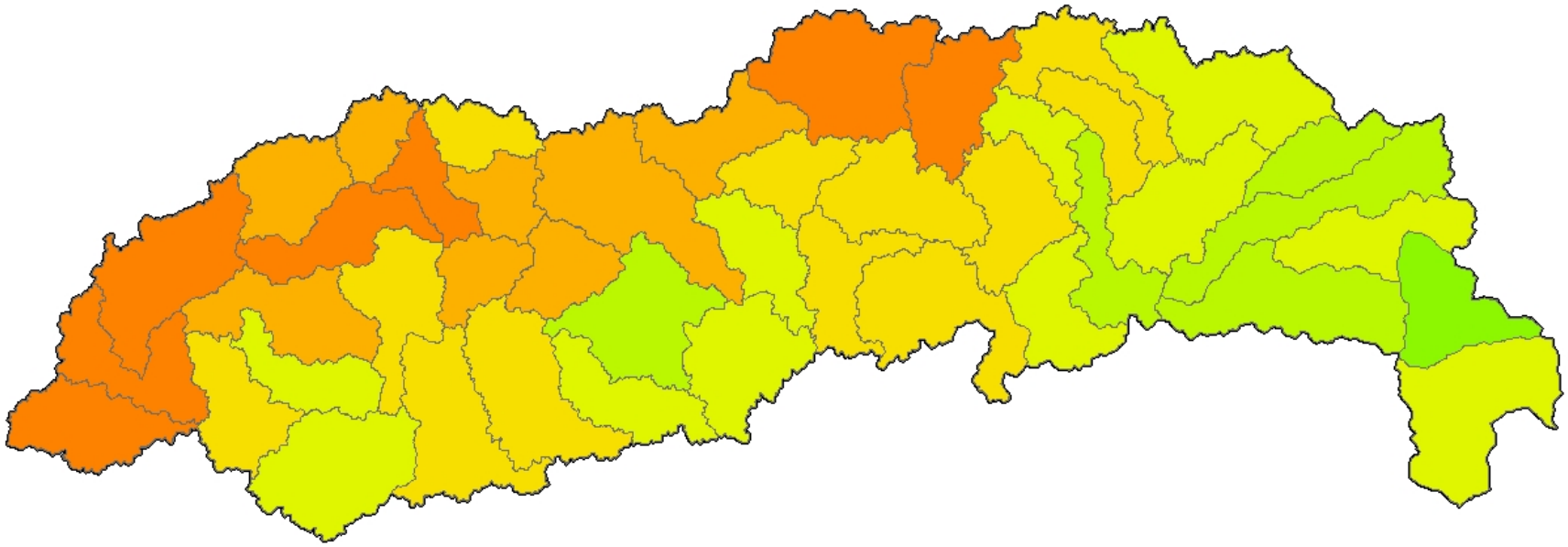
Uplands
Overall



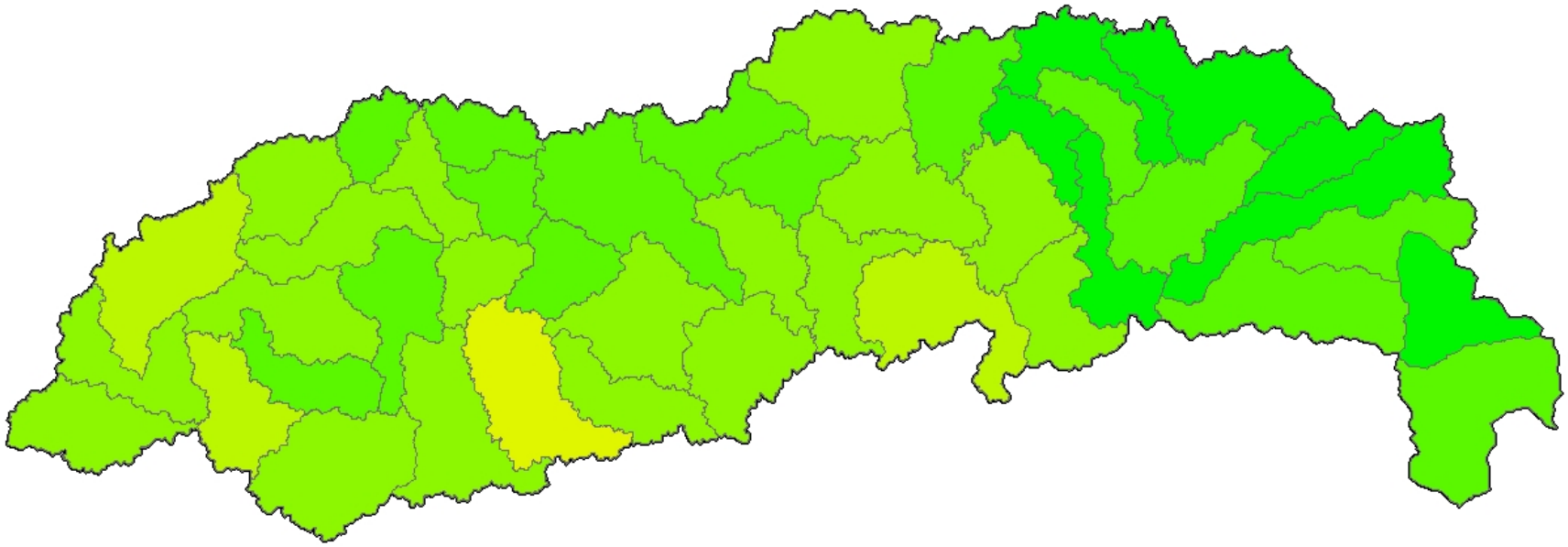
Elk Watershed

Results:
Relative Rankings

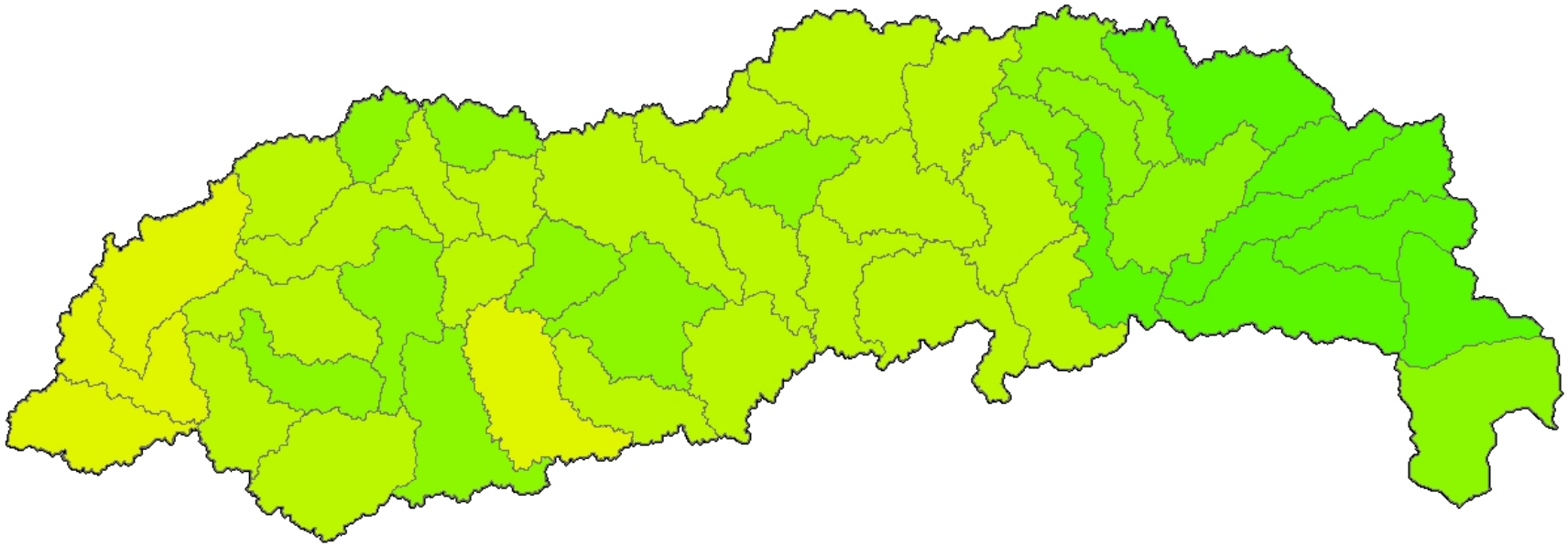
Streams
Water Quality
Quality Indicators



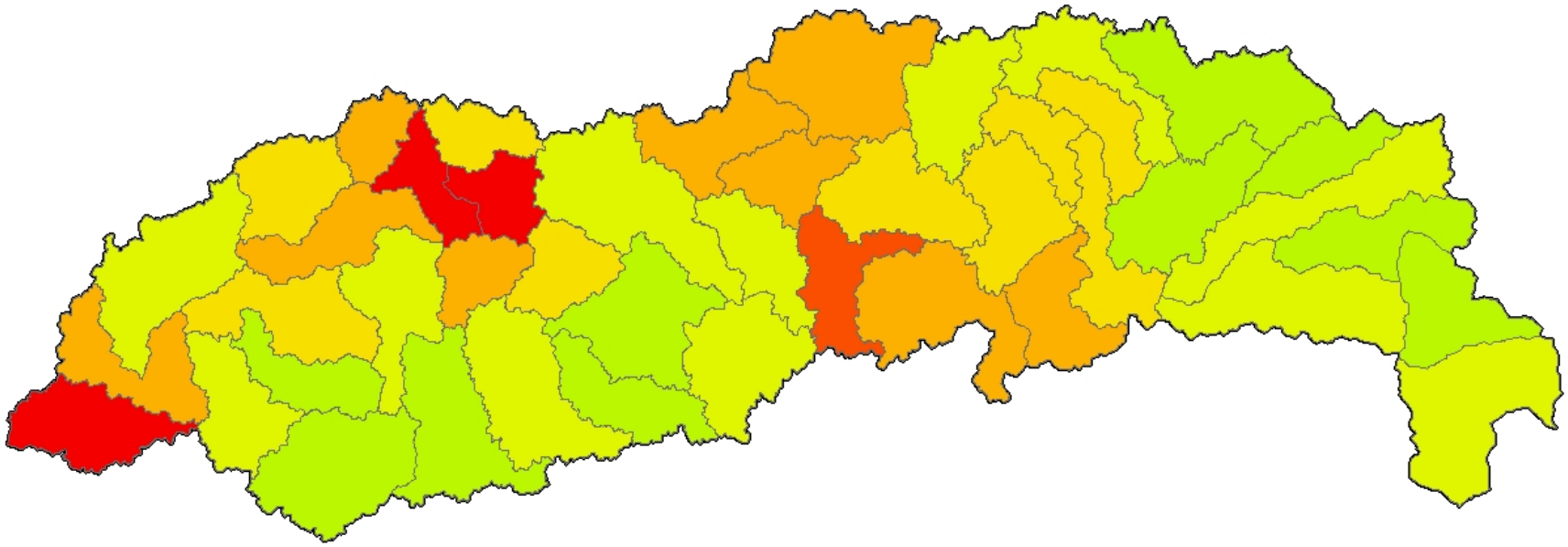
Streams
Water Quality
Stressors



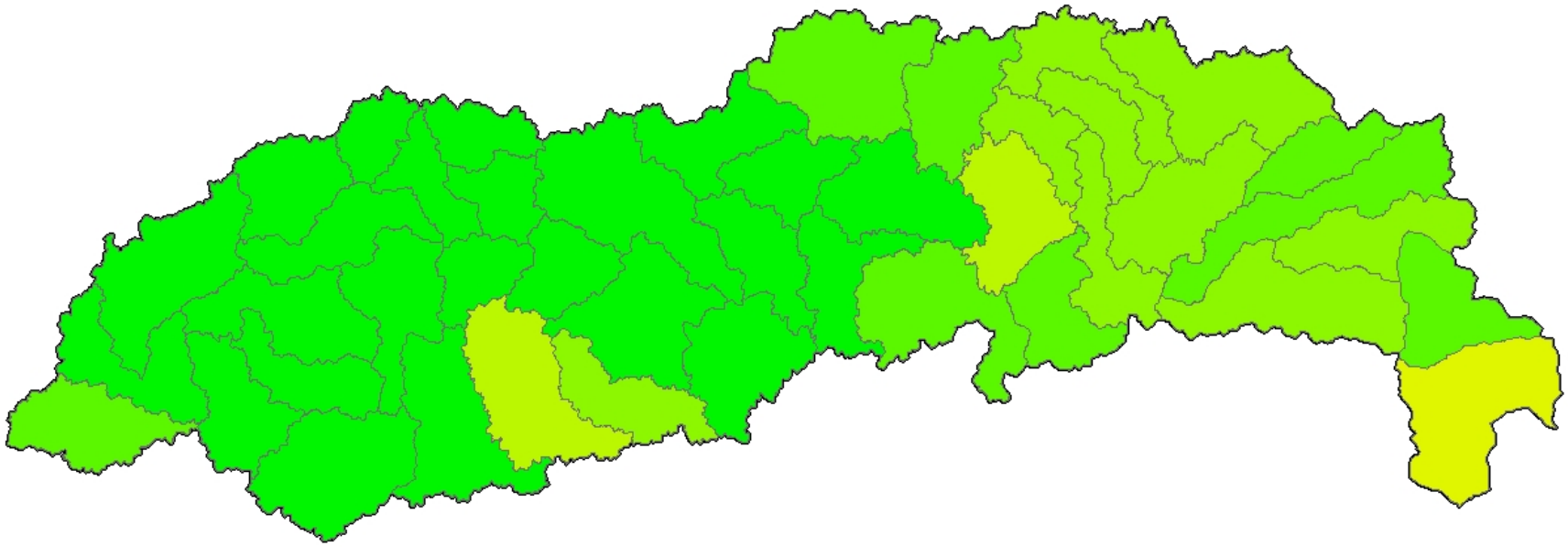
Streams
Water Quality
Overall



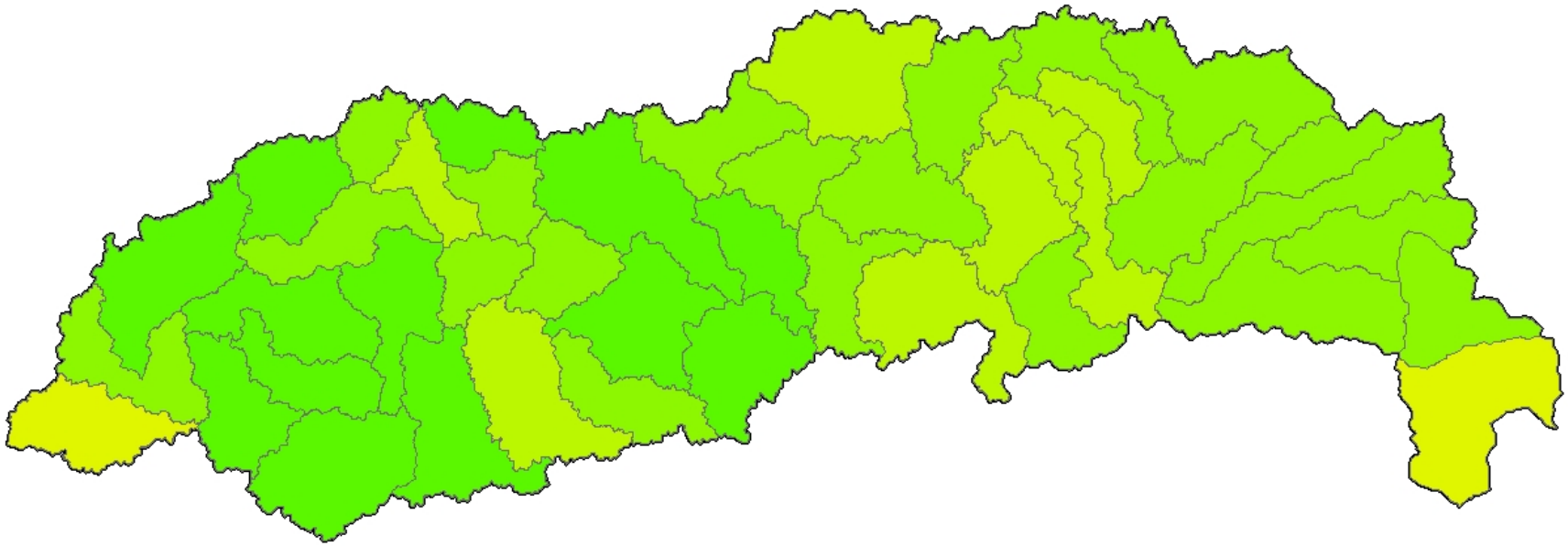
Streams
Water Quantity
Quality Indicators



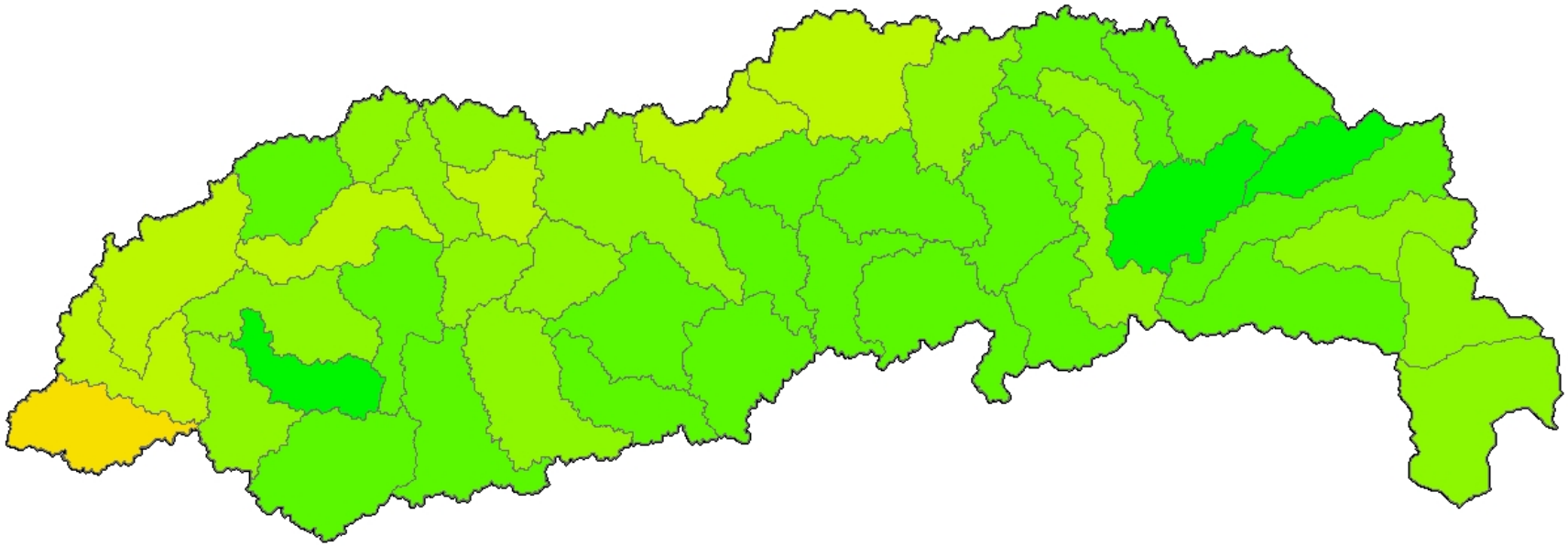
Streams
Water Quantity
Stressors



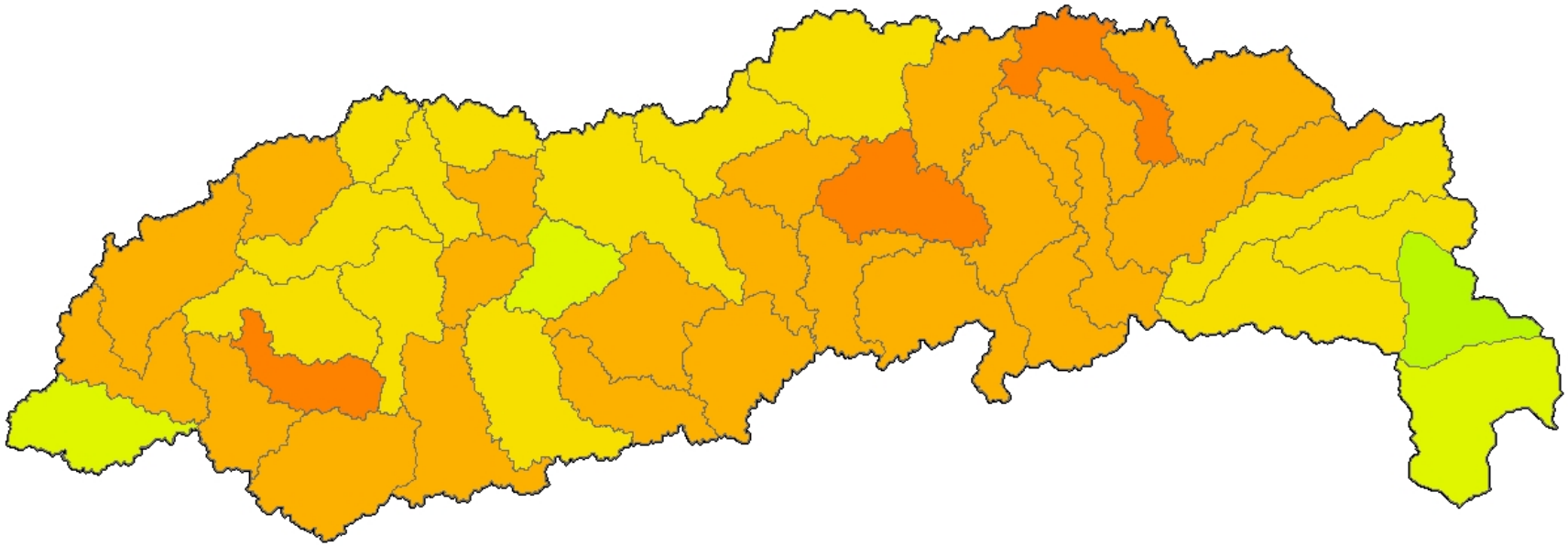
Streams
Water Quantity
Overall



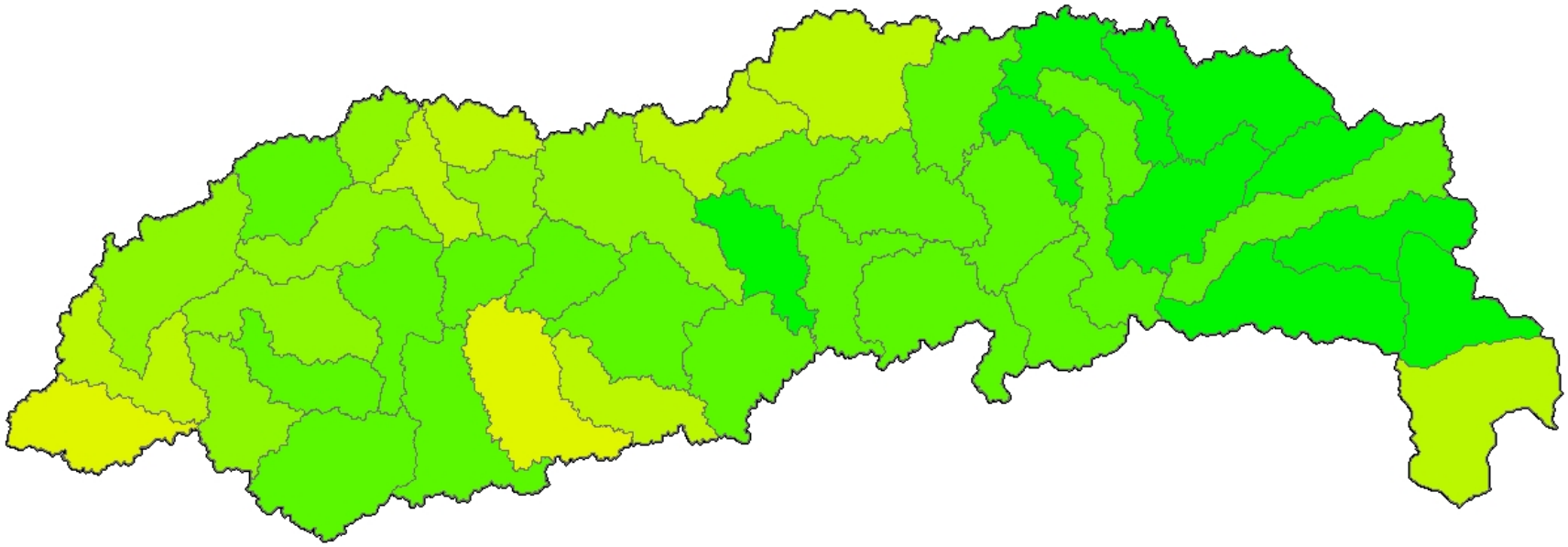
Streams
Hydrologic Connectivity
Overall



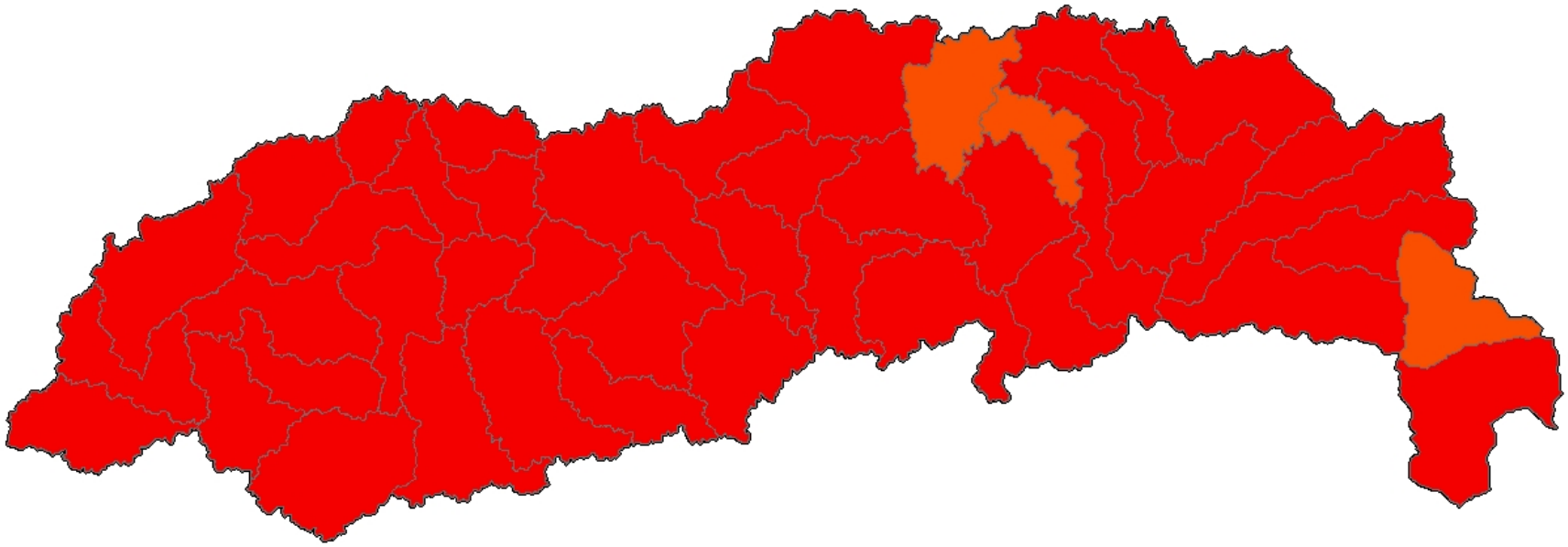
Streams
Biodiversity
Overall



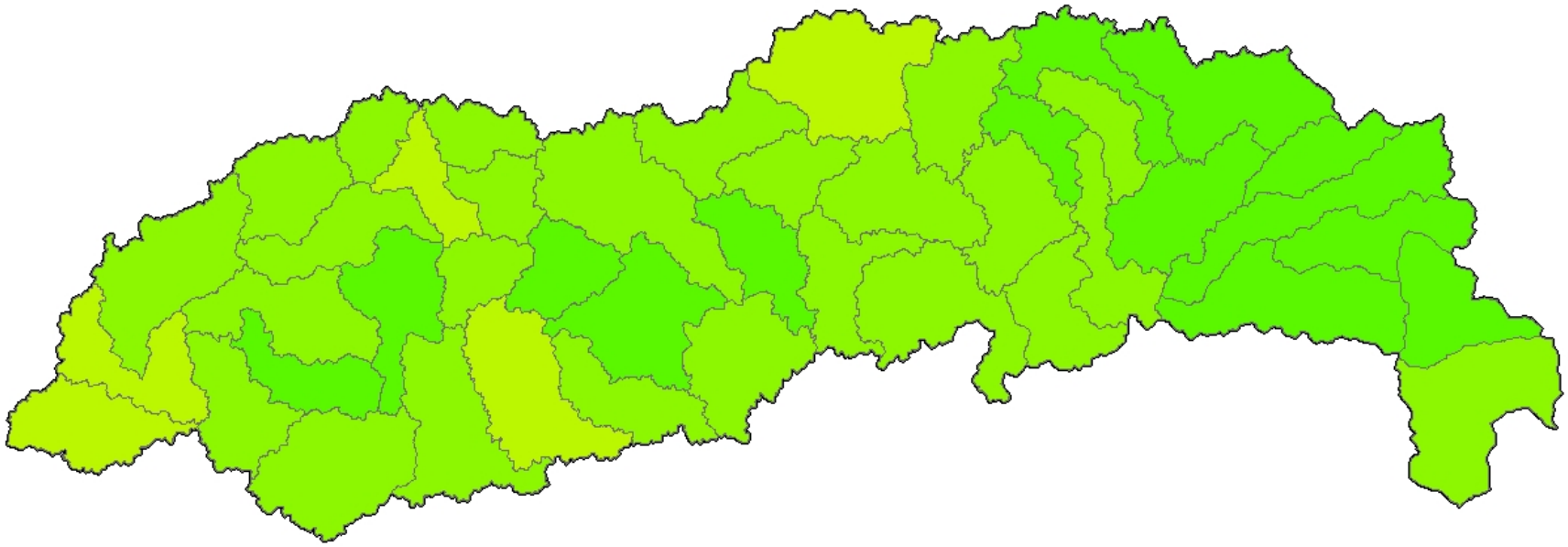
Streams
Riparian Habitat
Overall



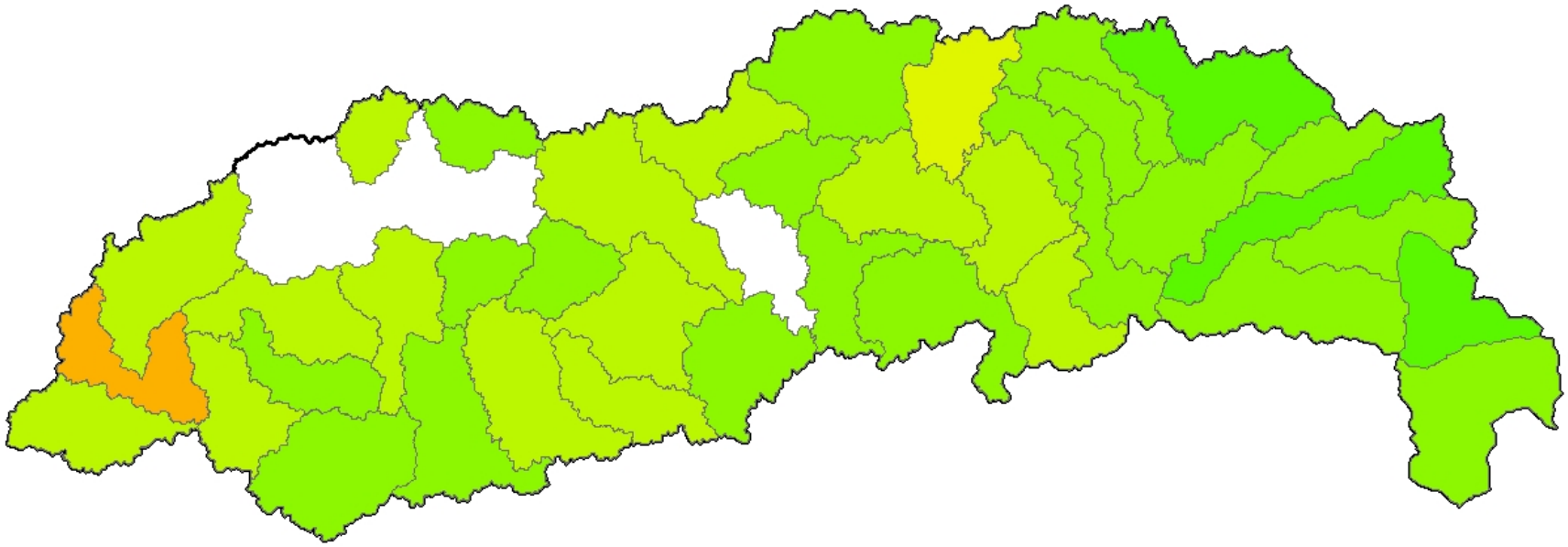
Streams
Protected Lands
Overall



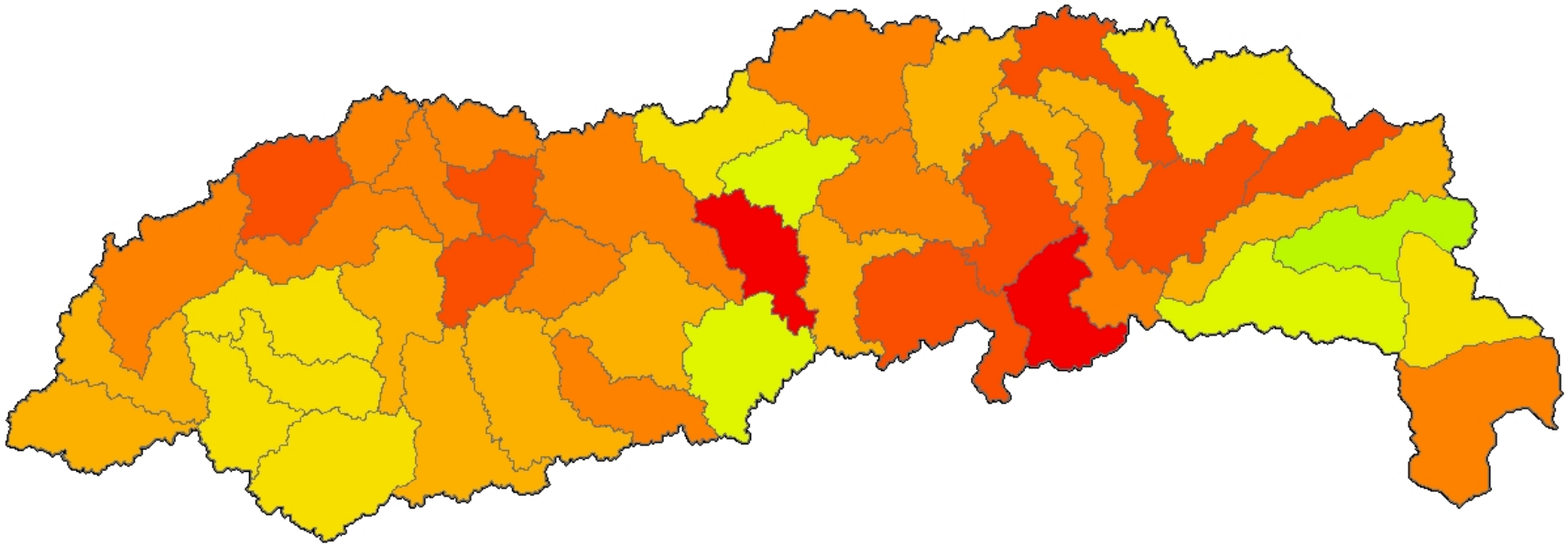
Streams
Overall



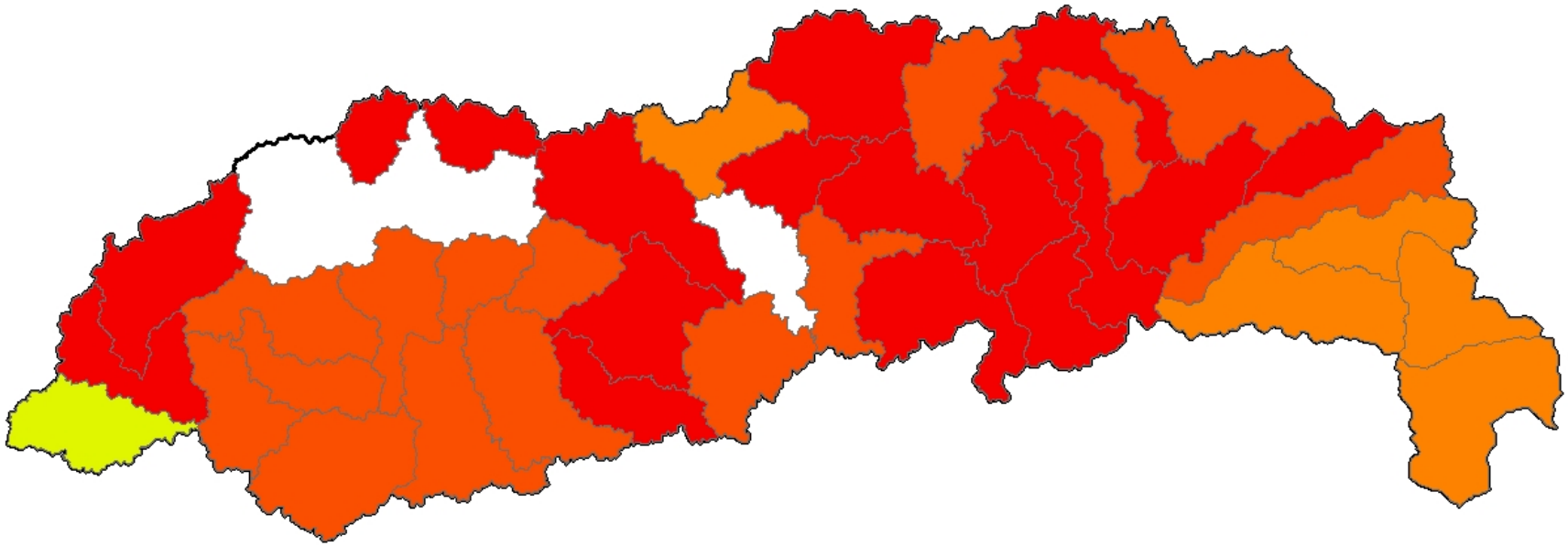
Wetlands
Water Quality
Overall



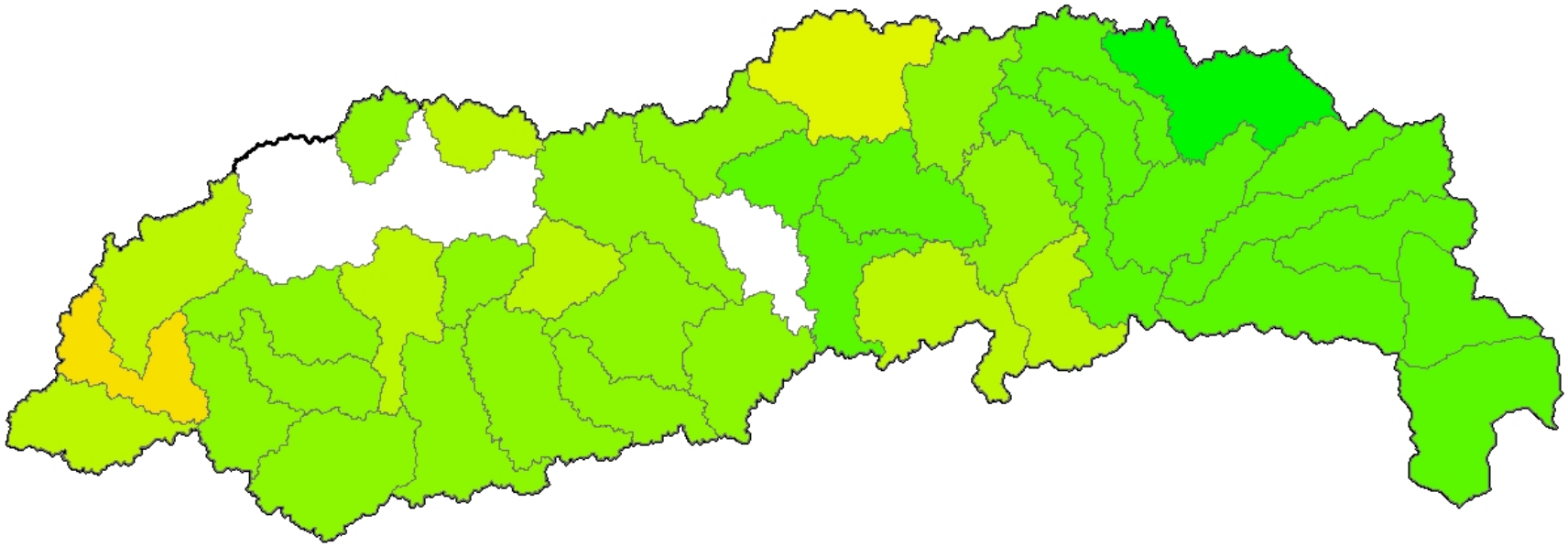
Wetlands
Hydrology
Overall



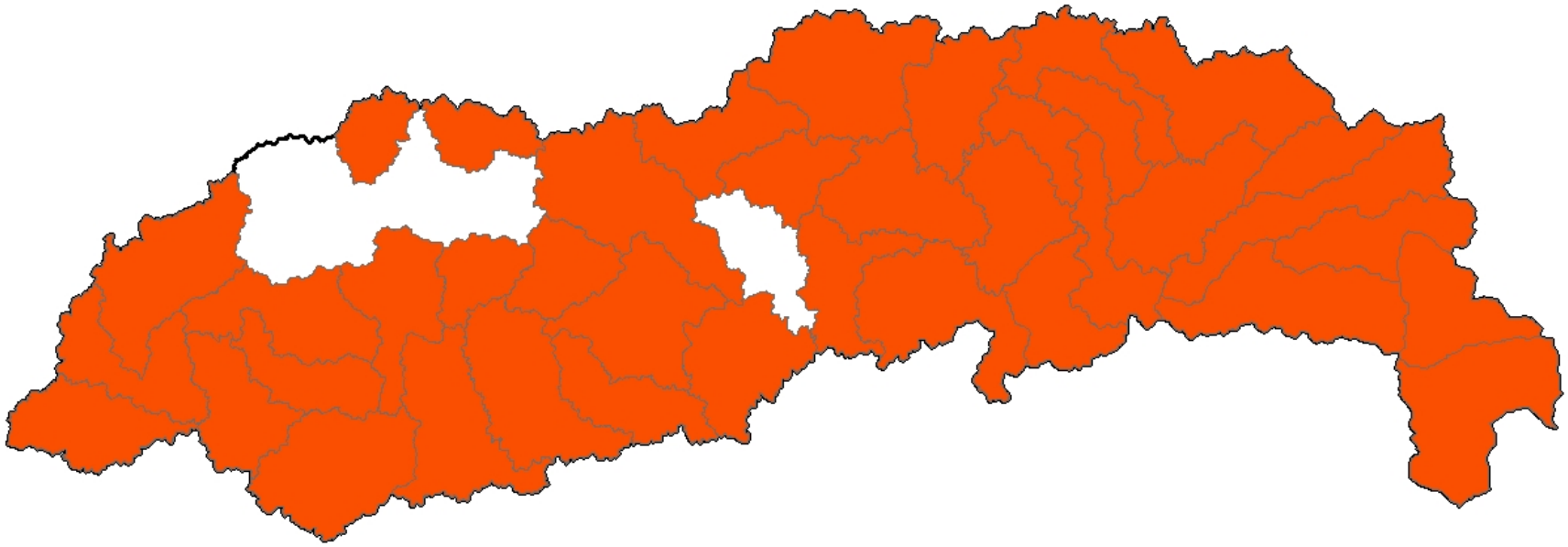
Wetlands
Biodiversity
Overall



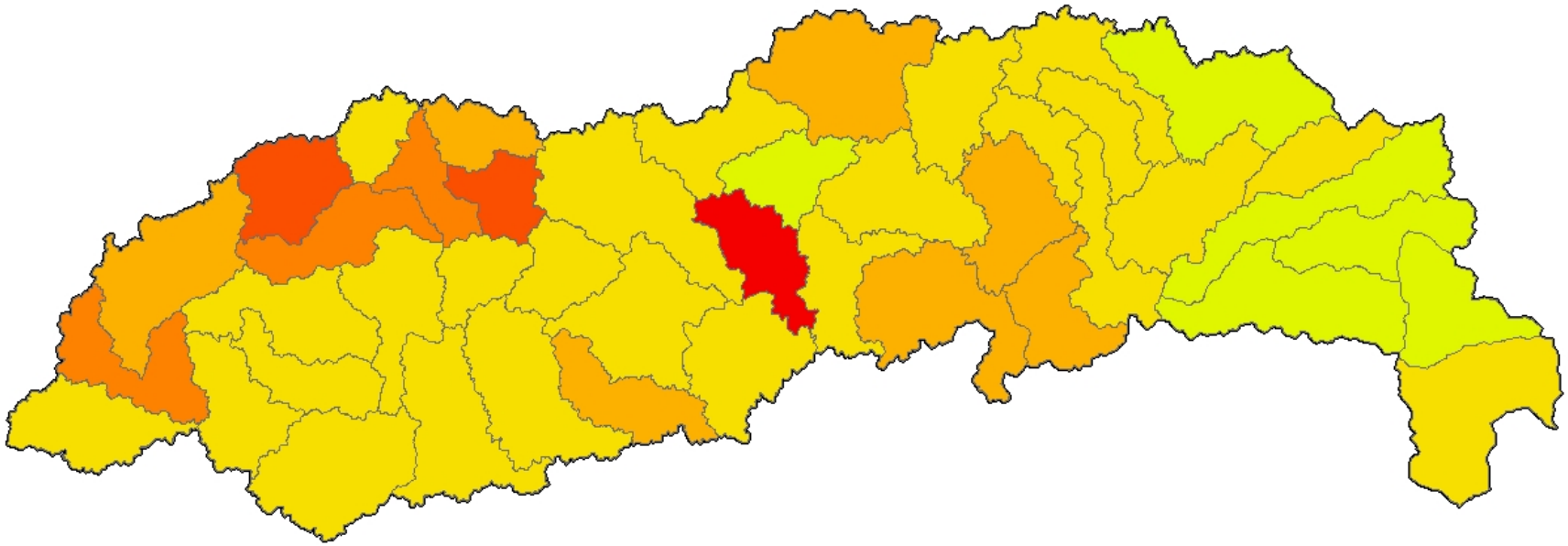
Wetlands
Wetland Habitat
Overall



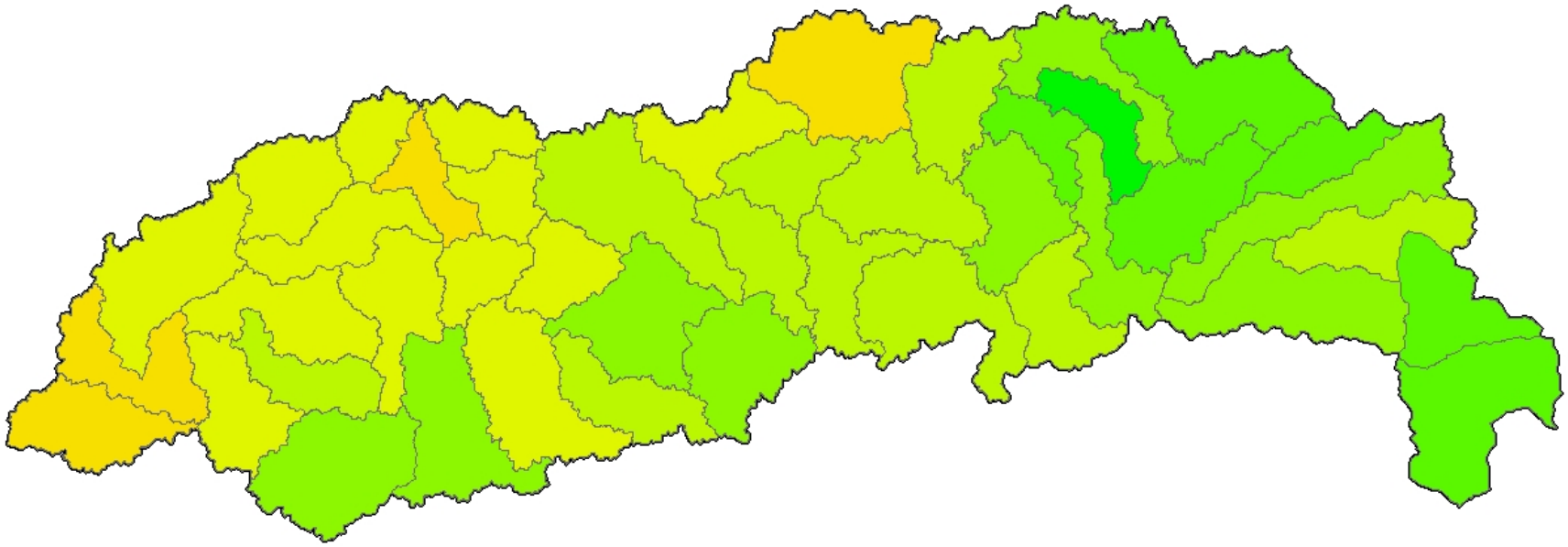
Wetlands
Protected Lands
Overall



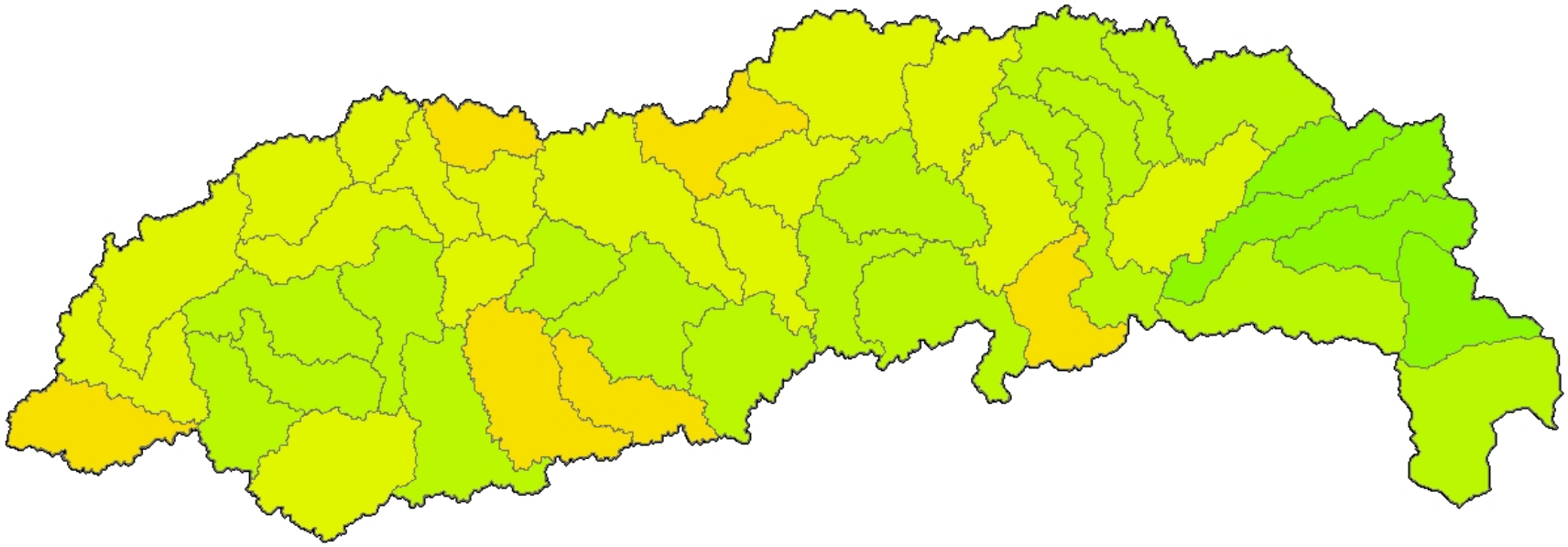
Wetlands
Overall



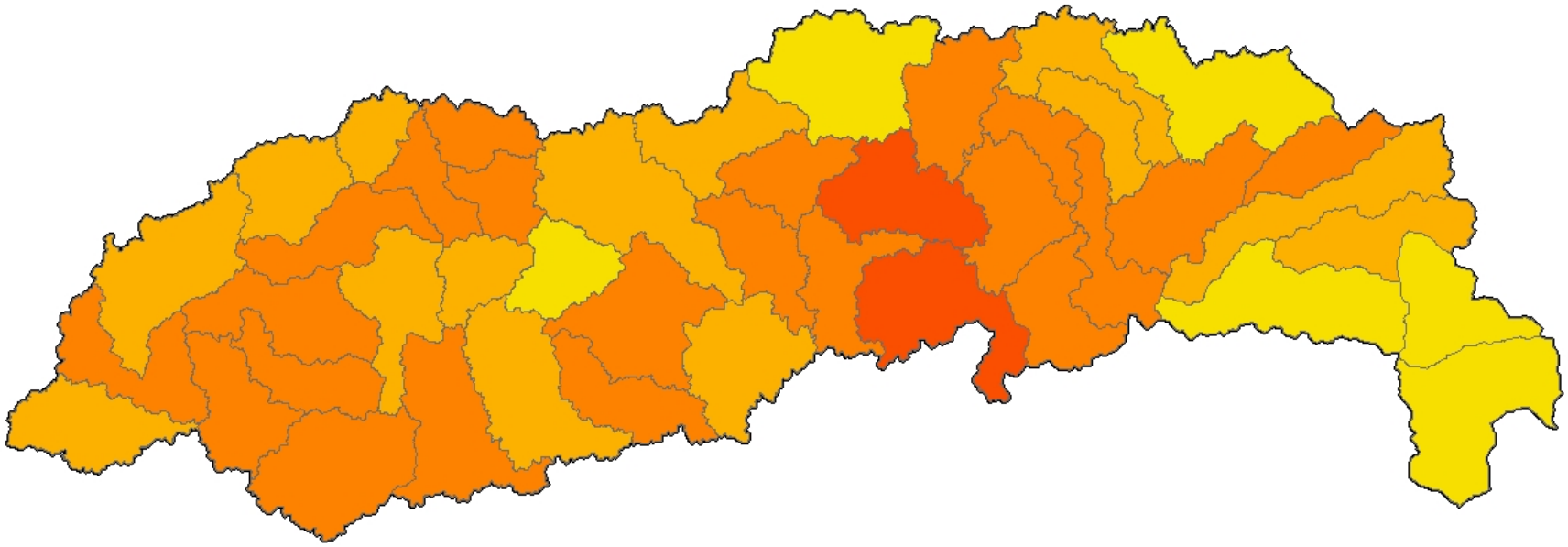
Uplands
Habitat Connectivity
Overall



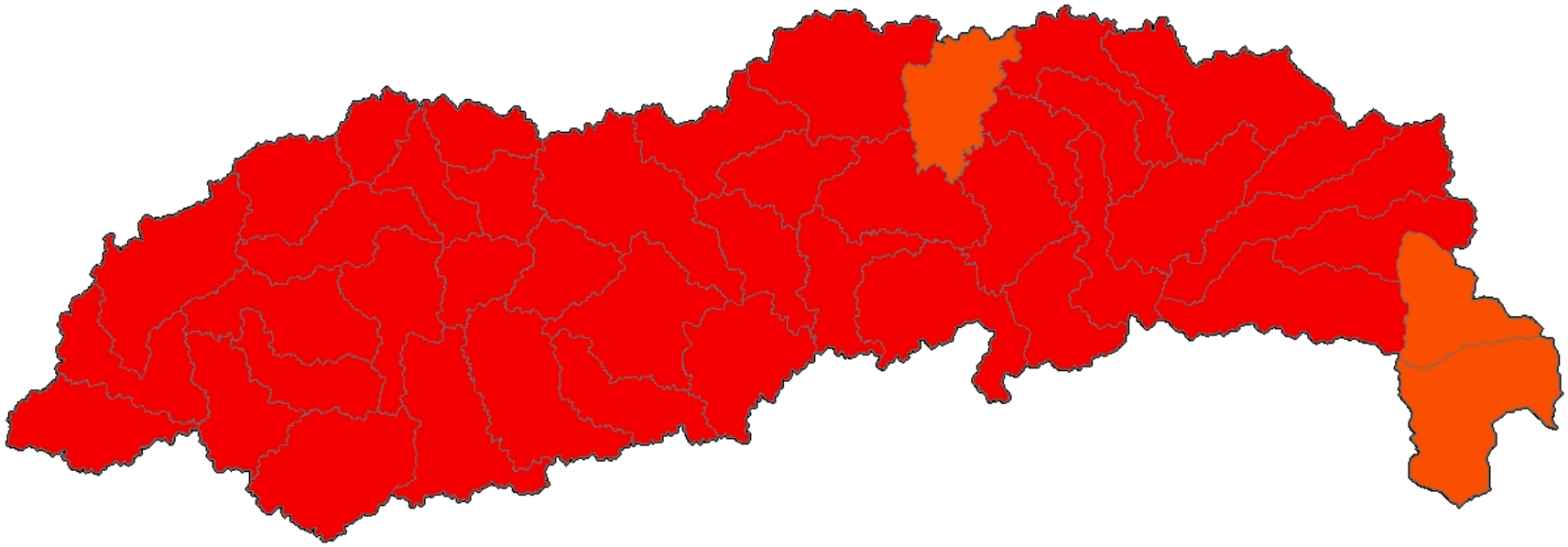
Uplands
Habitat Quality
Overall



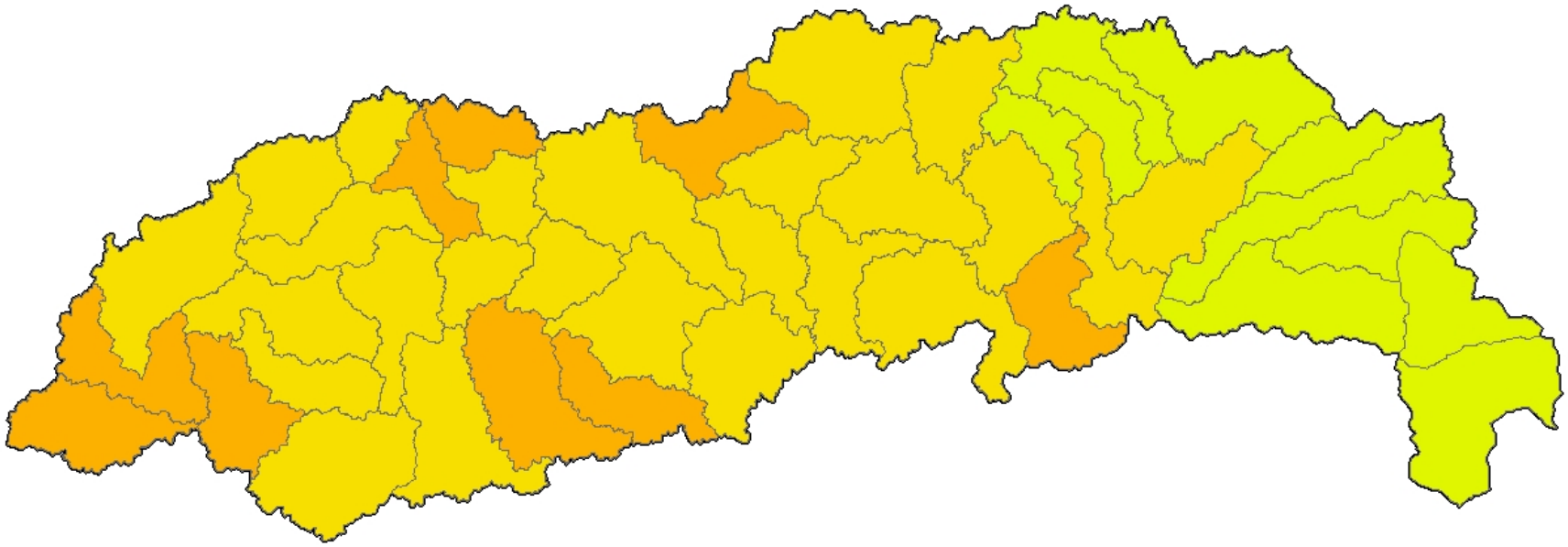
Uplands Biodiversity Overall



Uplands
Protected Lands
Overall



Uplands
Overall



GROUP DISCUSSION 1

Please split up into assigned Groups to discuss the revised structure and metrics.

Questions to consider:

- Do the new Indices describe the Condition/Function adequately?
- Do the metrics describe the condition of the indices?
- Are we missing important metrics?
- Which metrics are most important in describing each index?
- How should they be weighted?
- Is it ok to have the same metric in more than one index?
- Does the rollup procedure capture the overall condition/function appropriately?

Objective/Categorized Rankings

Project Objectives

- Design and test a watershed assessment process, which includes analysis of cumulative watershed effects.
- **Establish priorities for protection and restoration of aquatic resources and evaluate/rank areas within watersheds accordingly.**
- Provide relevant information, strategies/actions, and a decision support tool to assist partners, stakeholders and regulatory staff with decisions affecting aquatic resources.

Relative vs. Objective Classification

- Relative ranking of HUC12s is completed
- Compares planning units, but gives no information on which are good quality and which need to be restored
- 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 Equal Intervals to define thresholds for preliminary results

Establish Priorities

- Need to define priorities for Protection and Restoration
- Highest Quality Areas highest priorities for Protection Activities?
- Lower Quality Areas priority for Restoration Activities?
- Having appropriate thresholds defined for each metric would help inform priorities

Threshold Categories

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

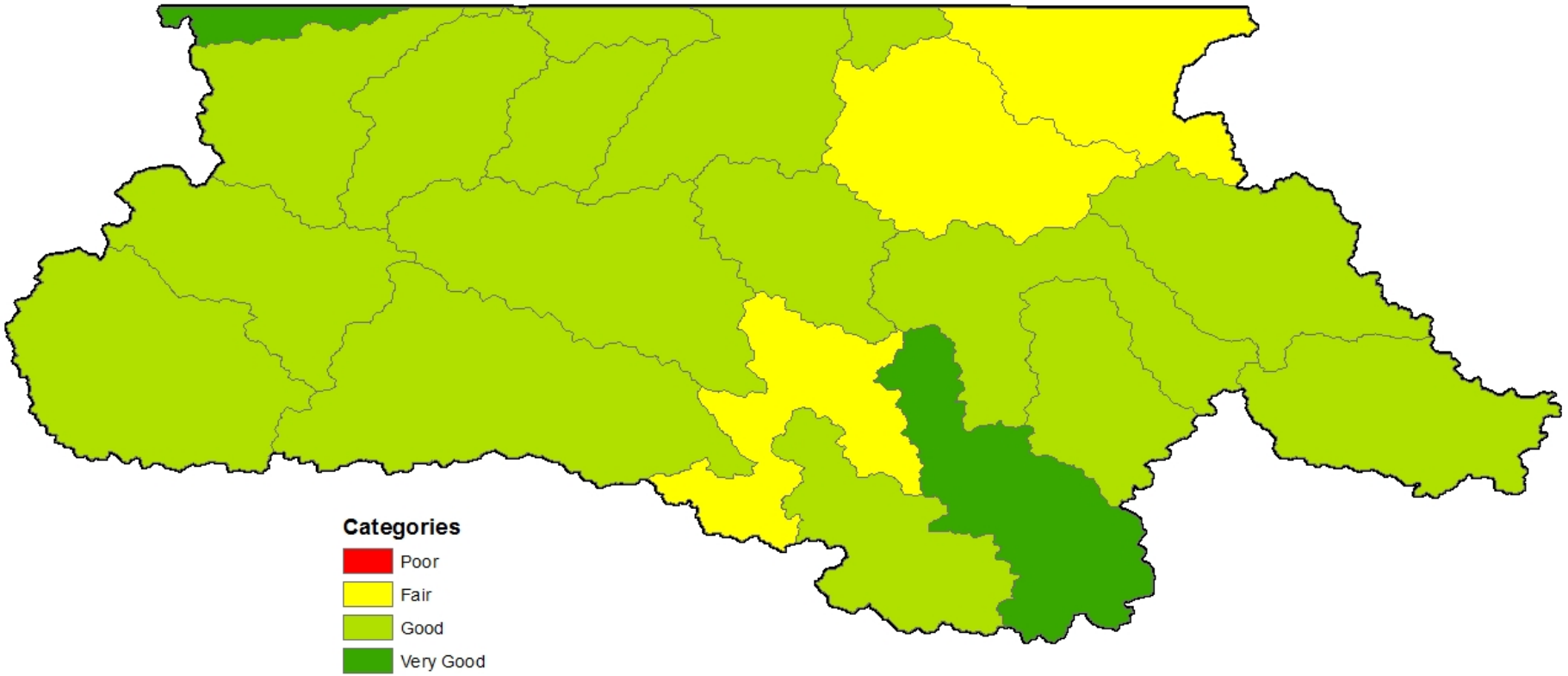
Restoration Threshold

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

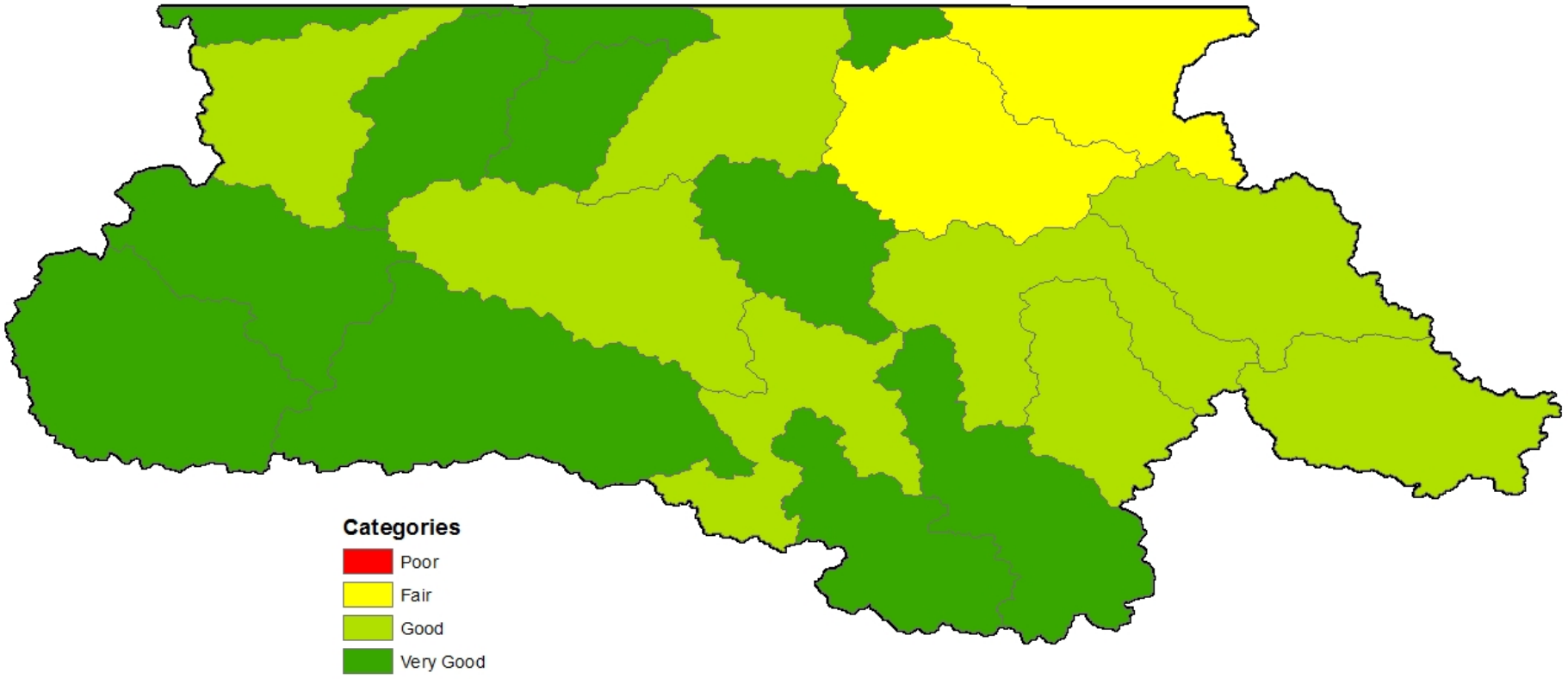
Monongahela Watershed

Results:
Objective Classification

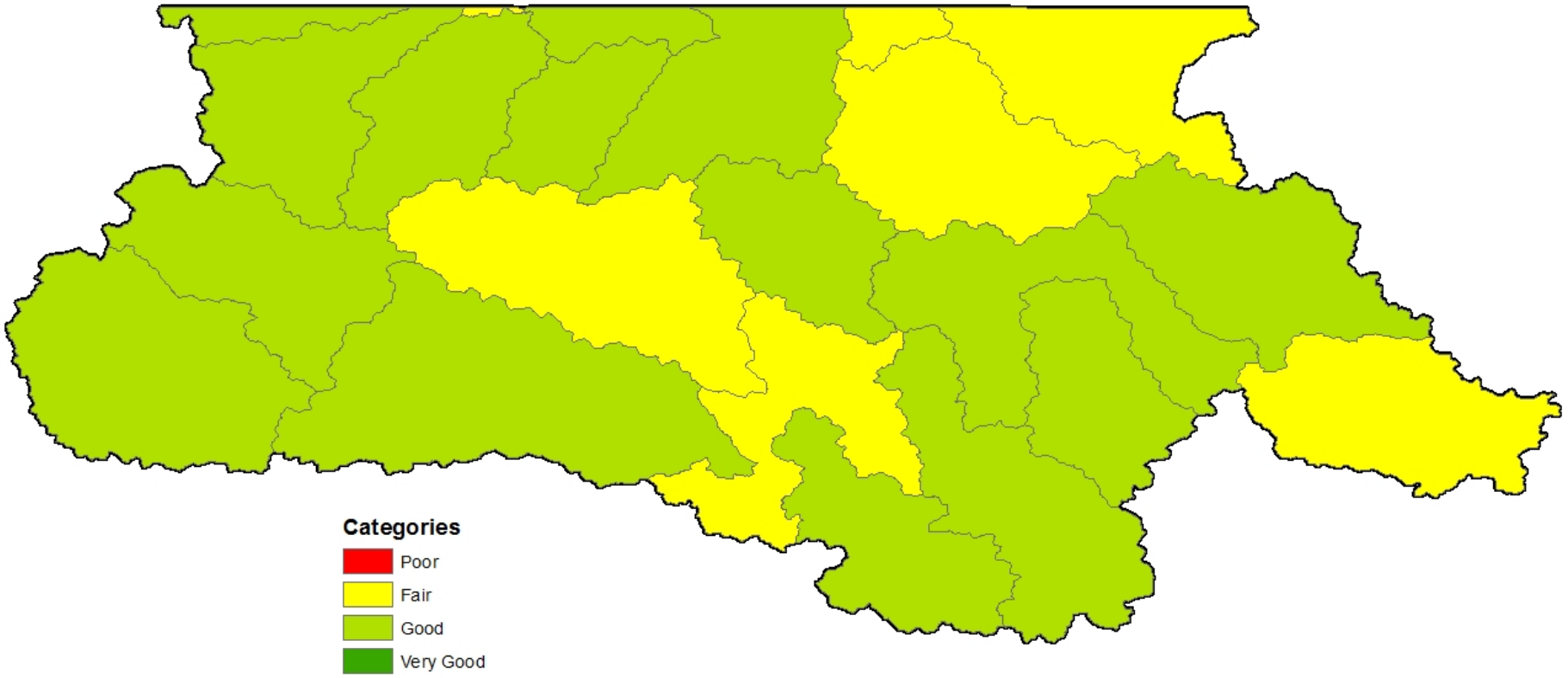
Streams
Water Quality



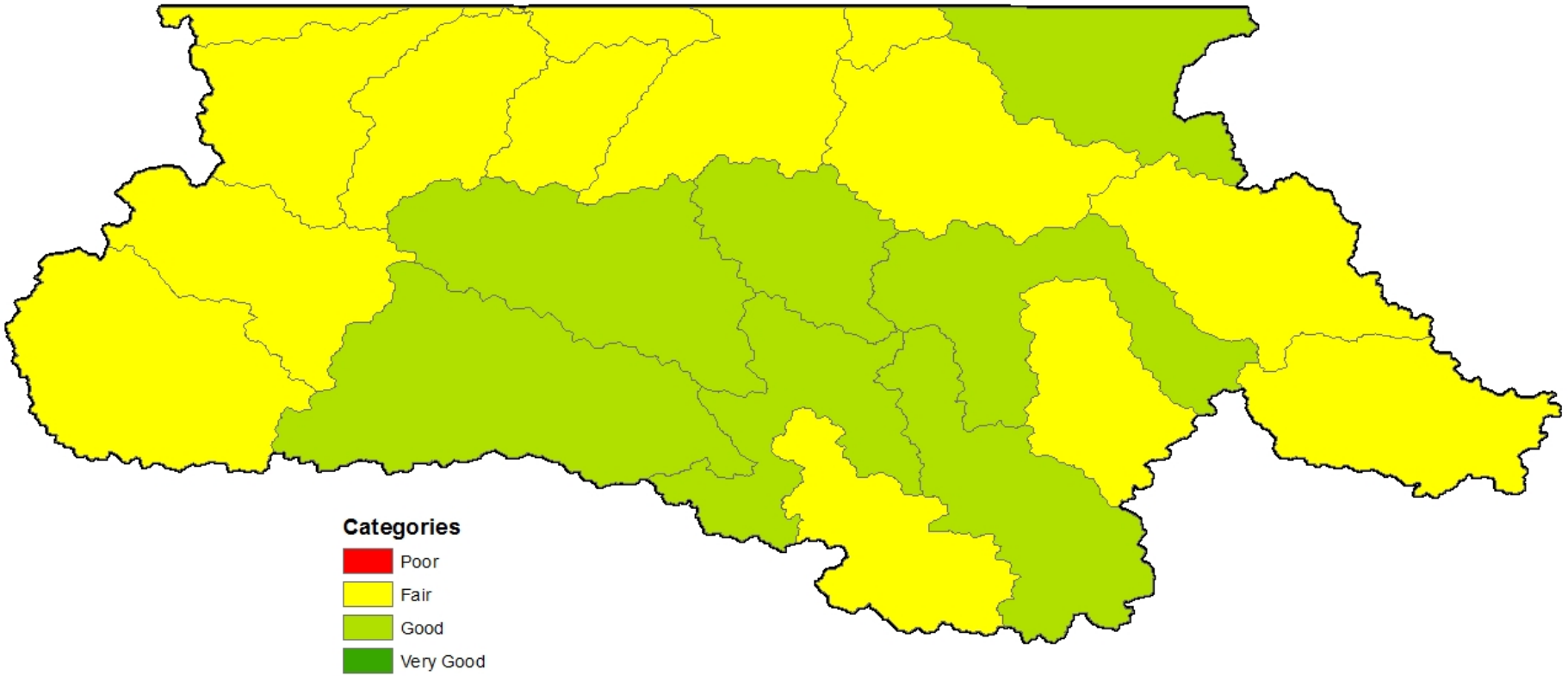
Streams
Water Quantity



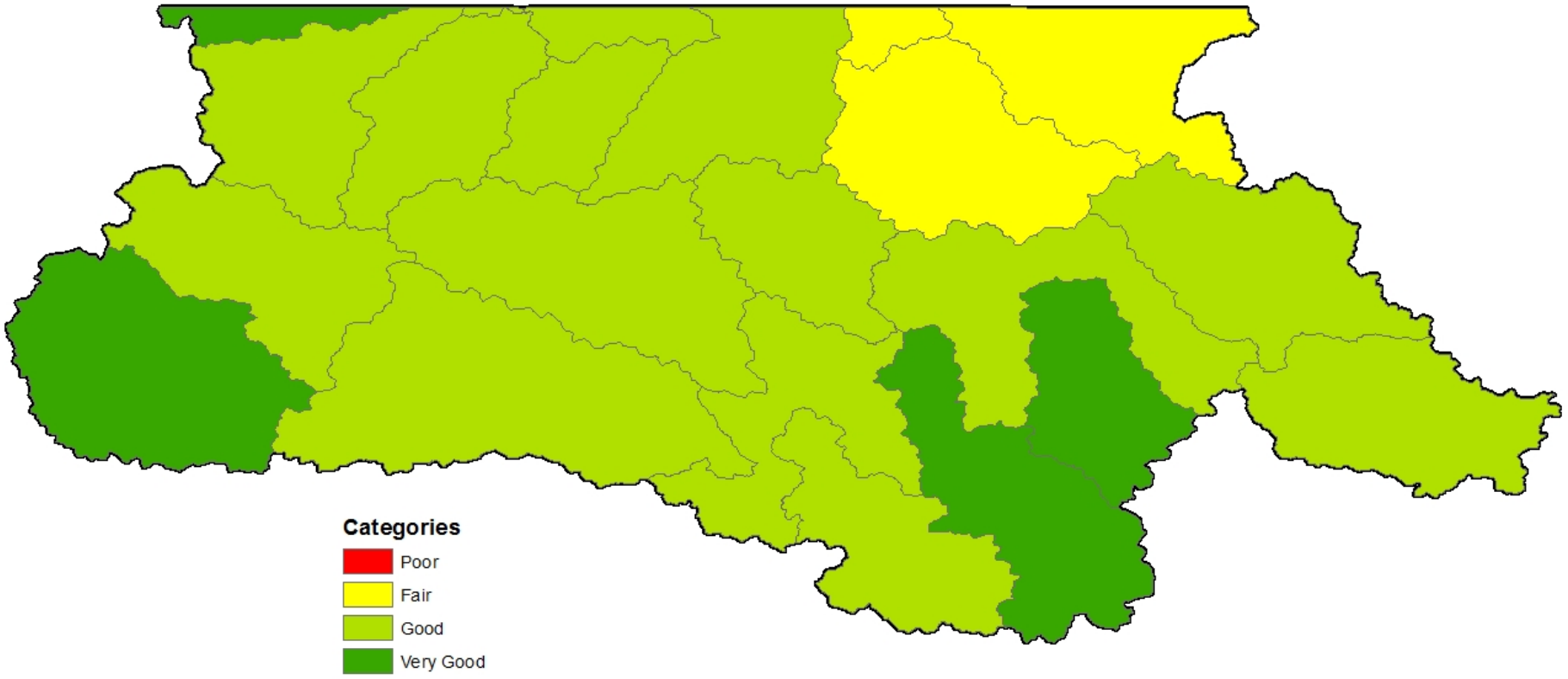
Streams
Hydrologic Connectivity



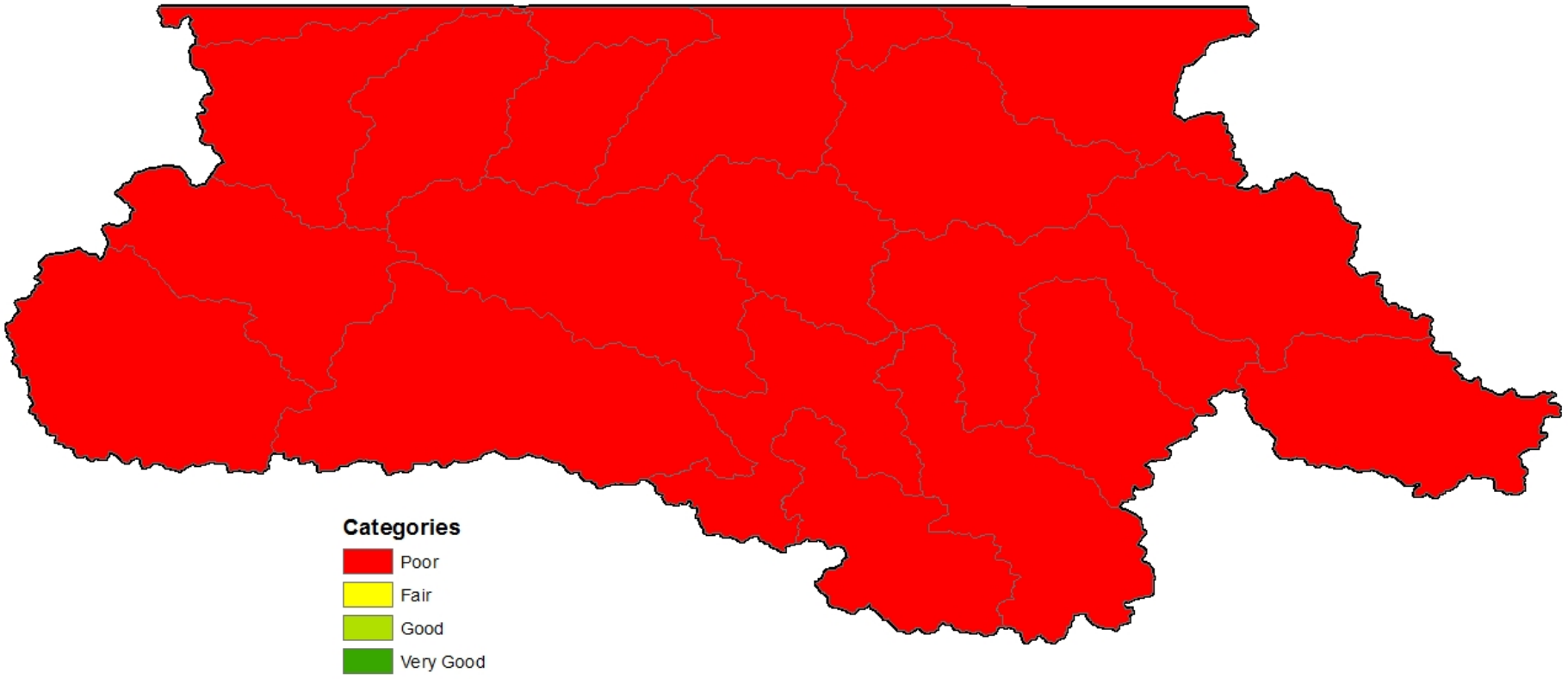
Streams
Biodiversity



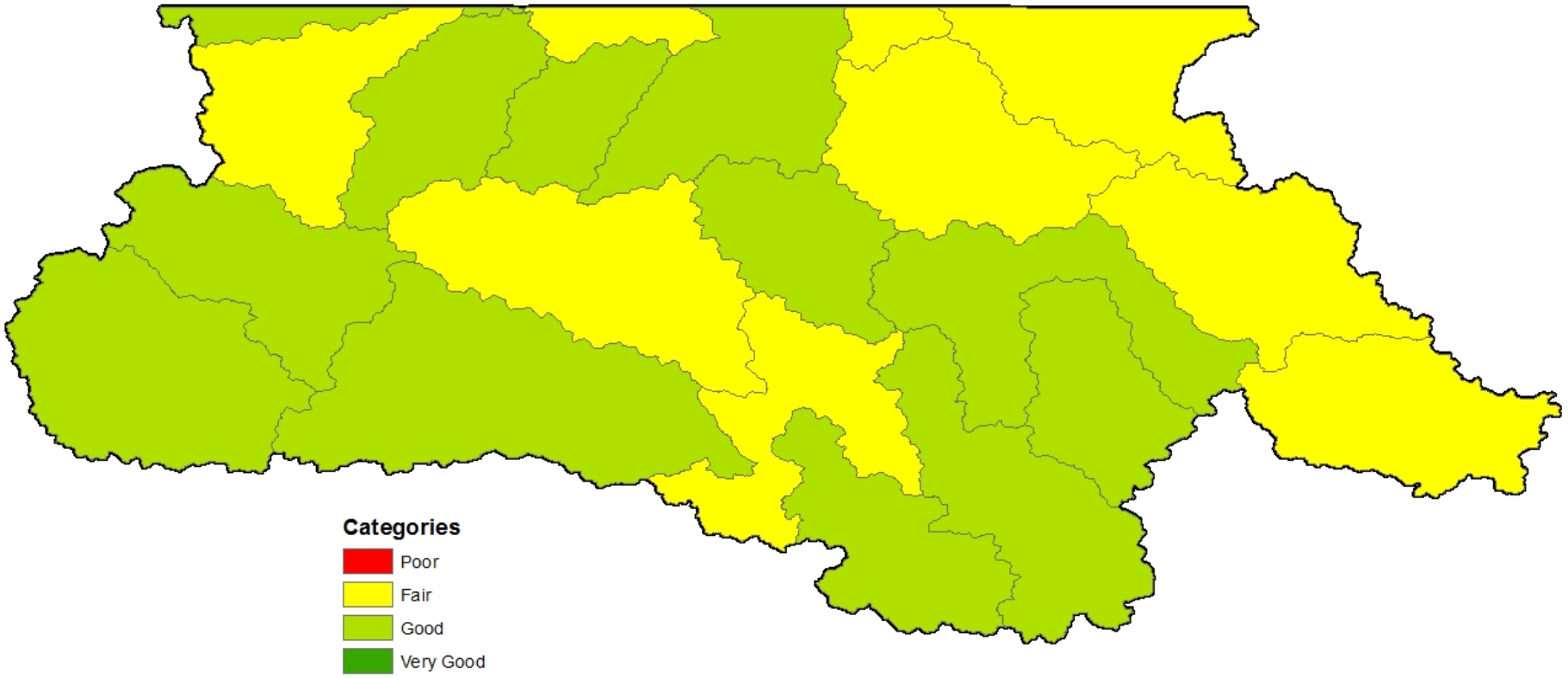
Streams
Riparian Habitat



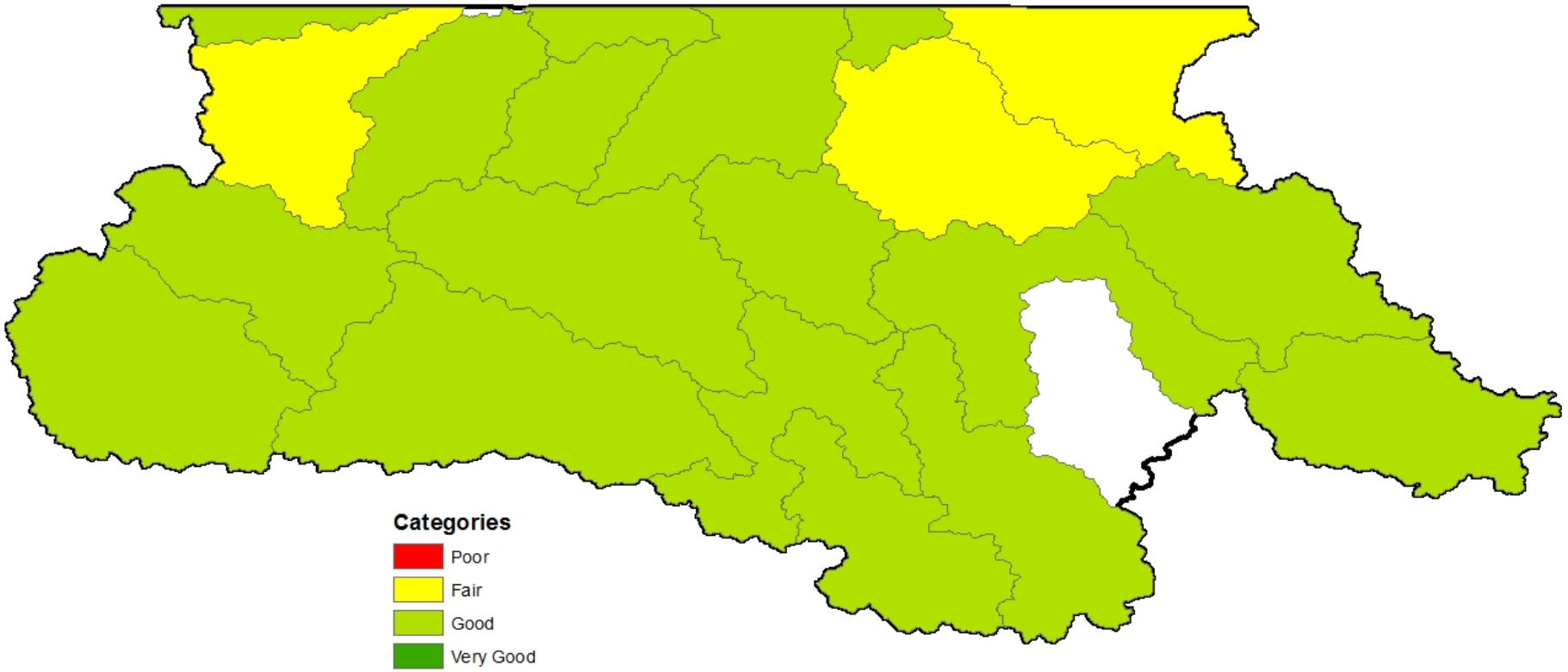
Streams
Protected Lands



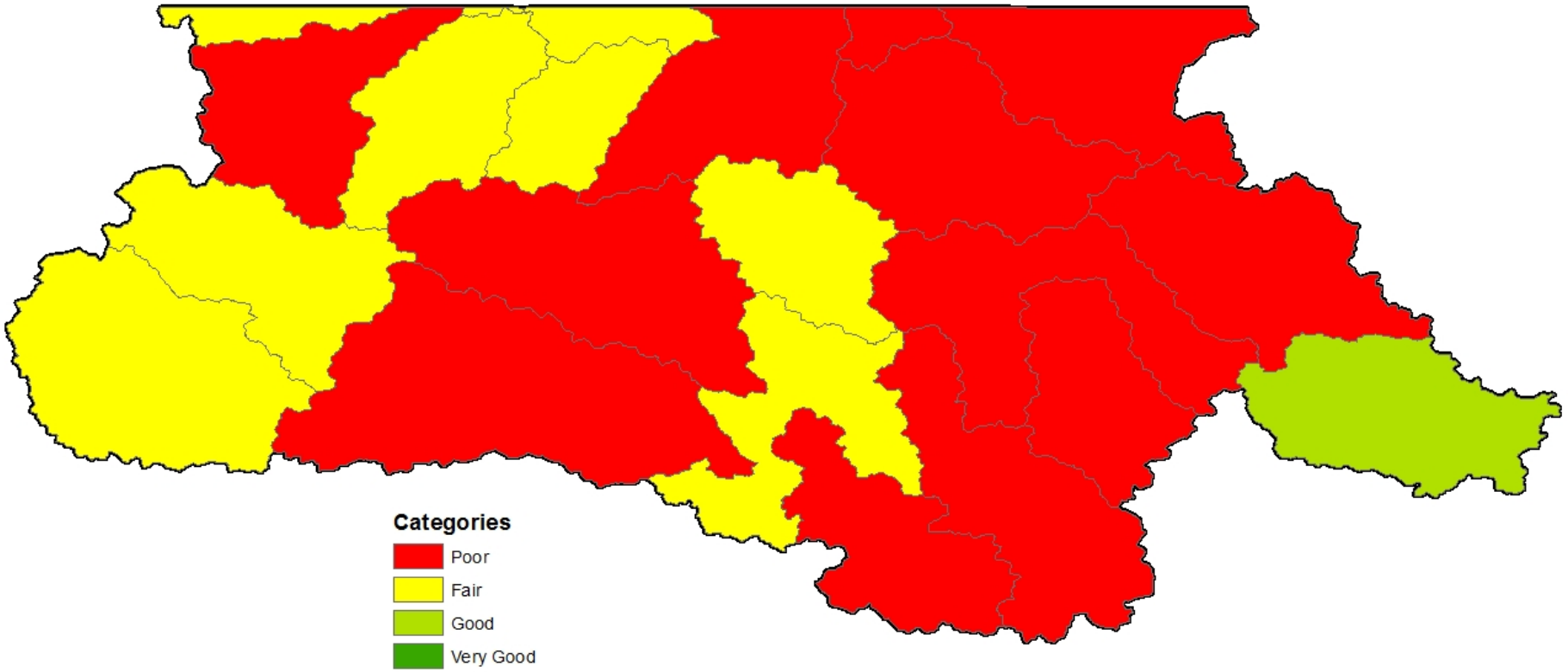
Streams
Overall



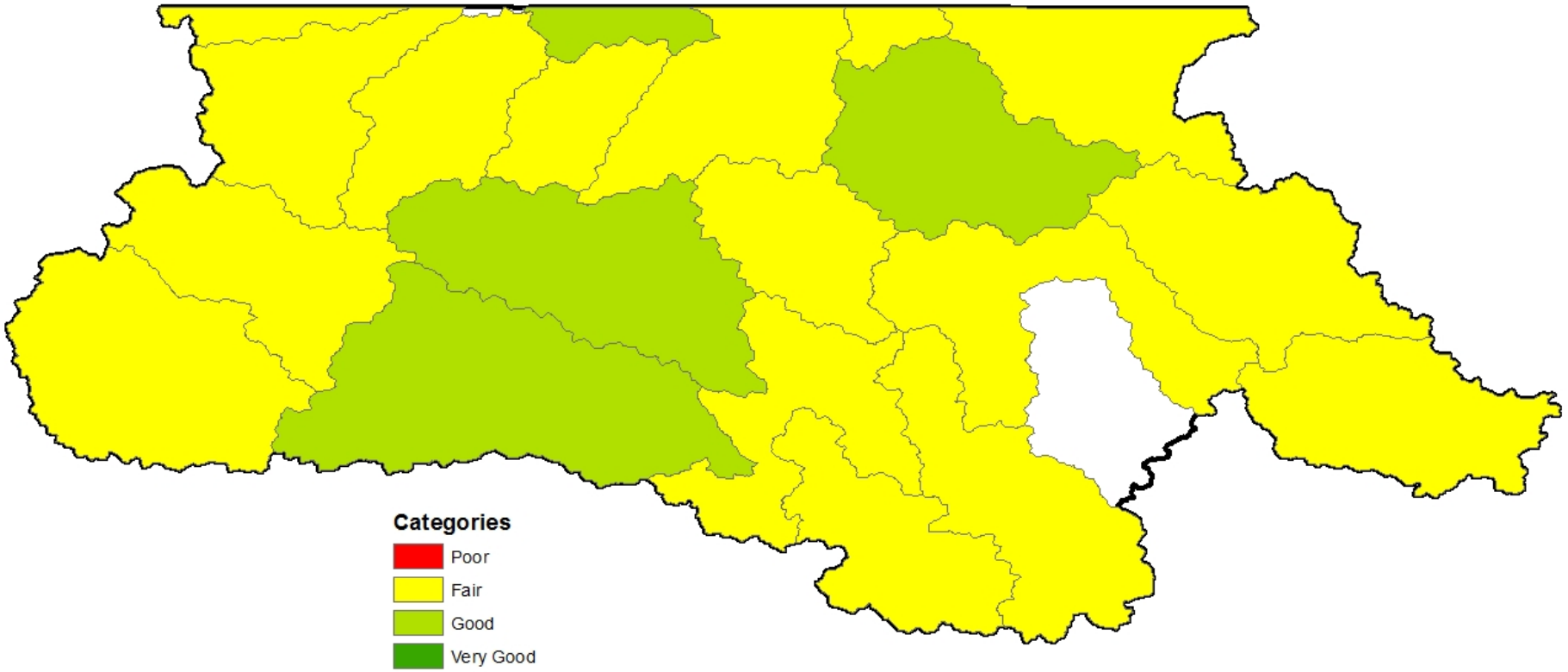
Wetlands
Water Quality



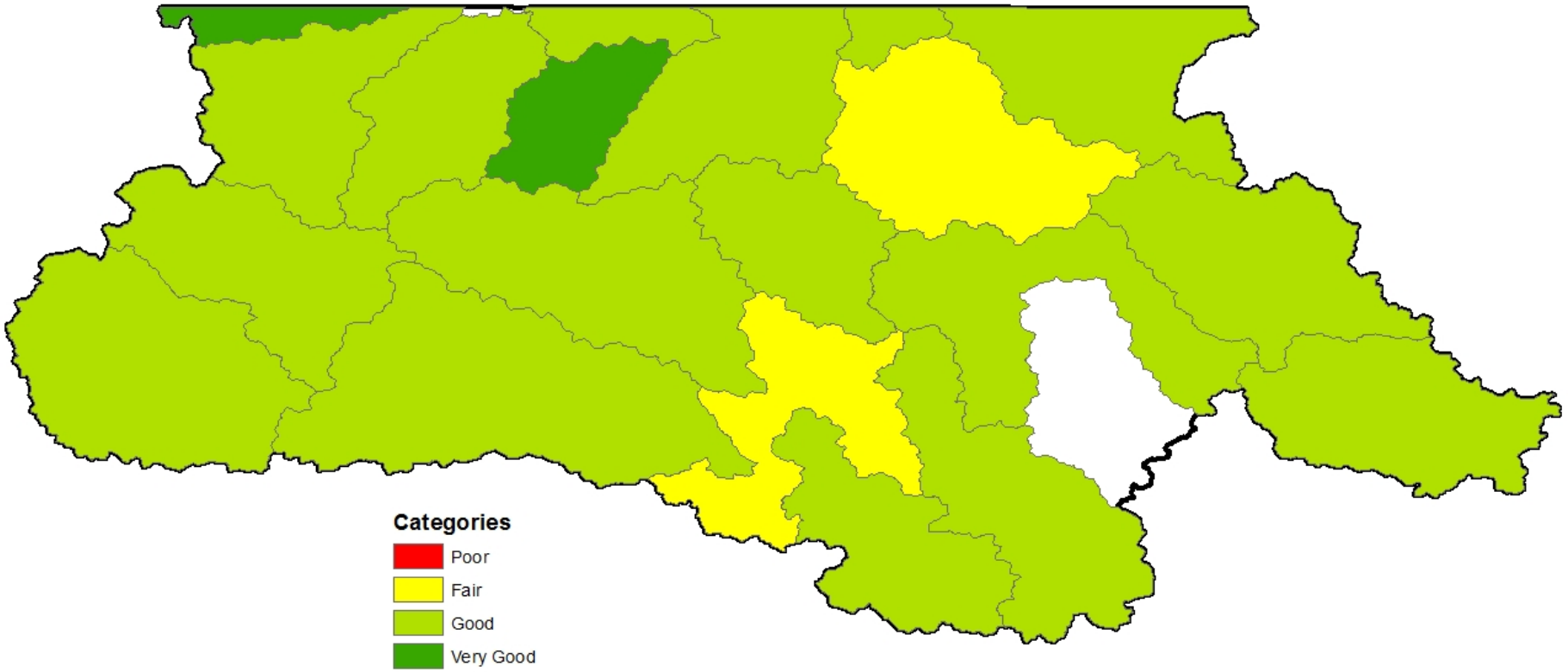
Wetlands
Hydrology



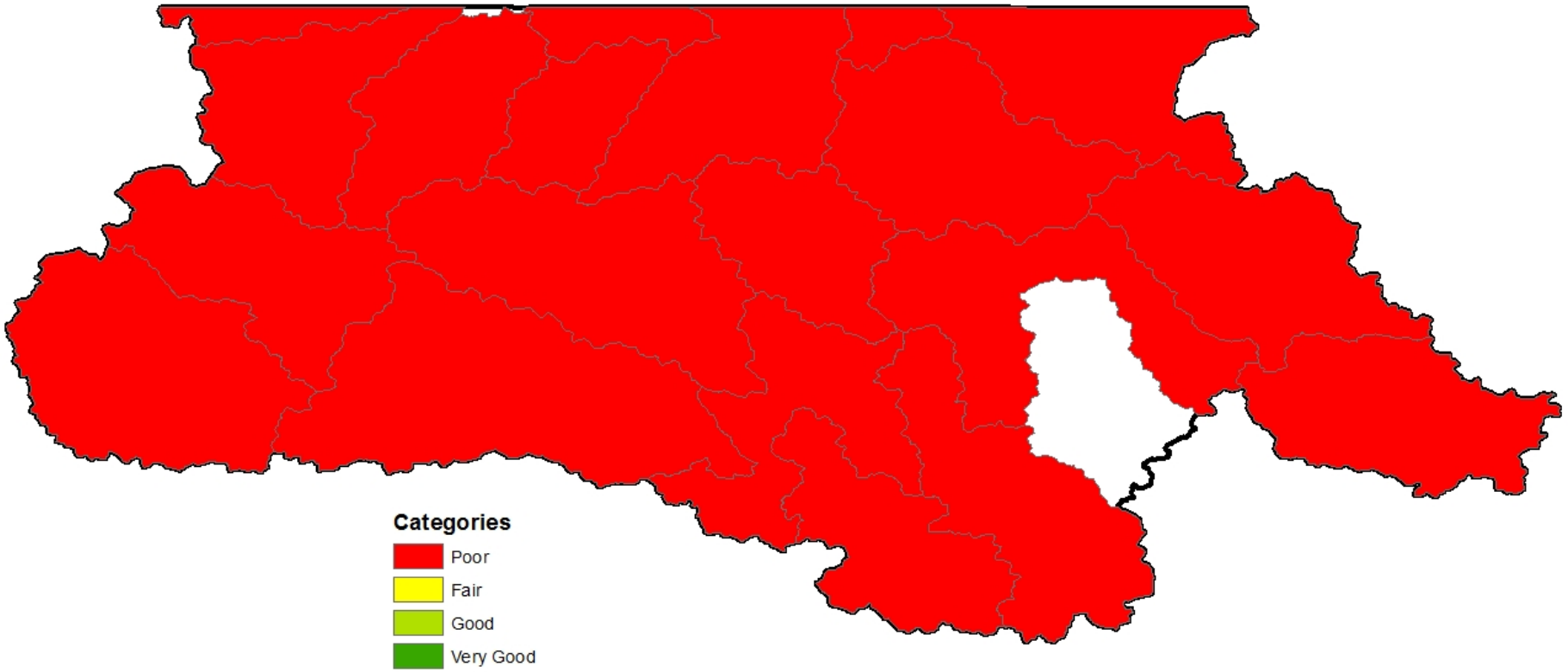
Wetlands Biodiversity



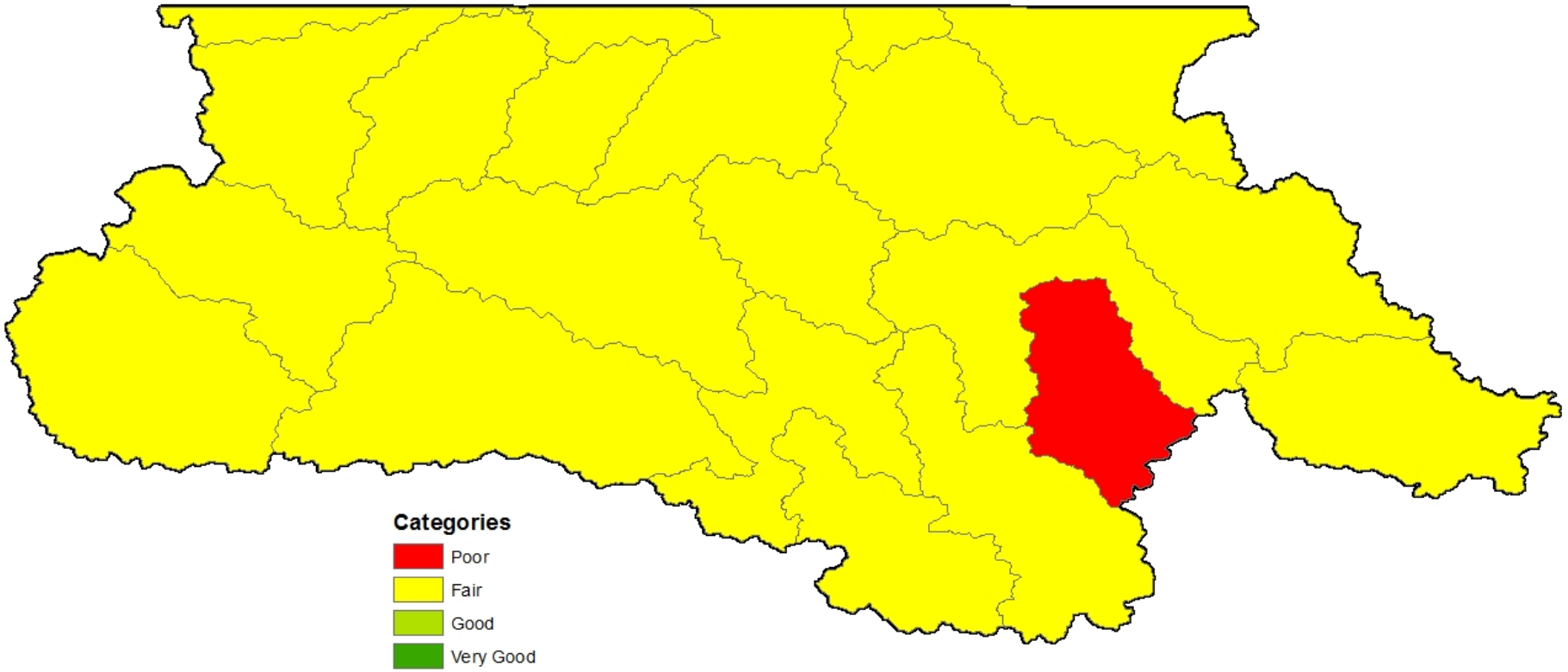
Wetlands
Wetland Habitat



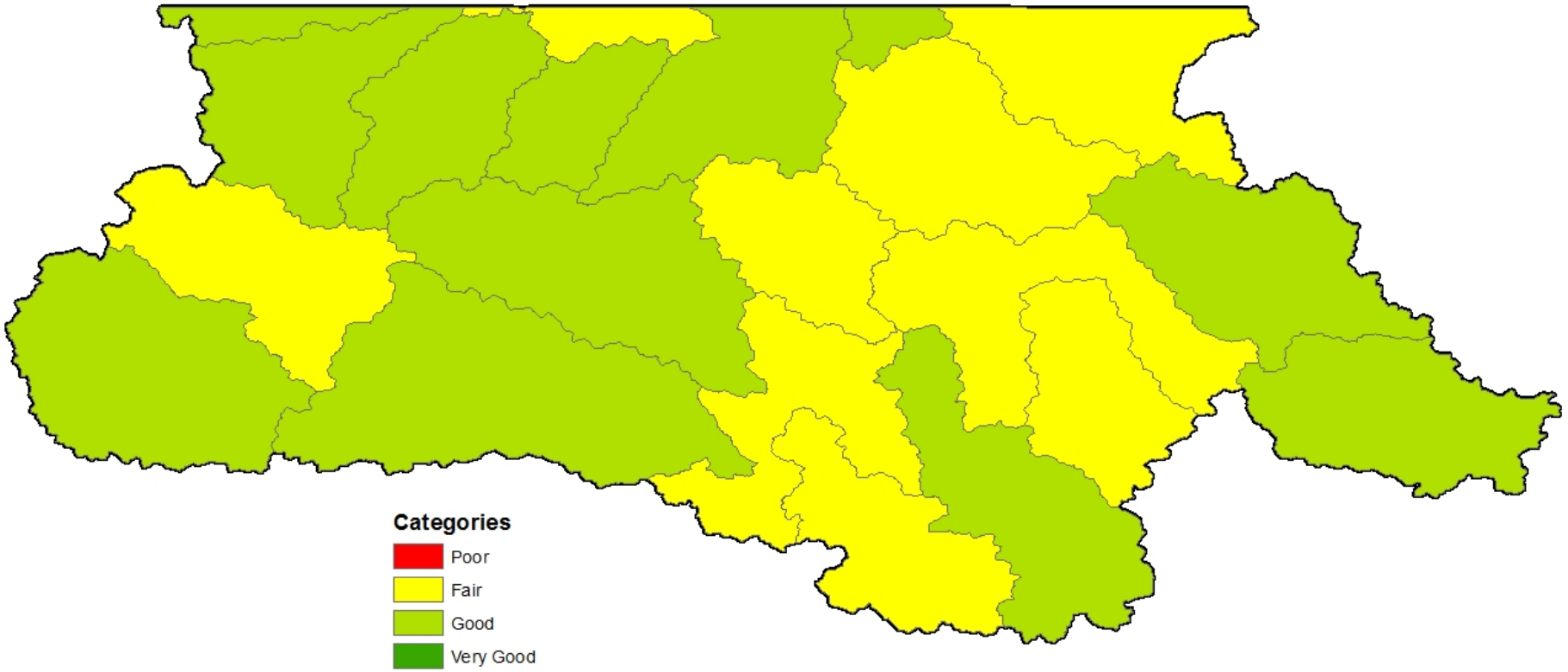
Wetlands
Protected Lands



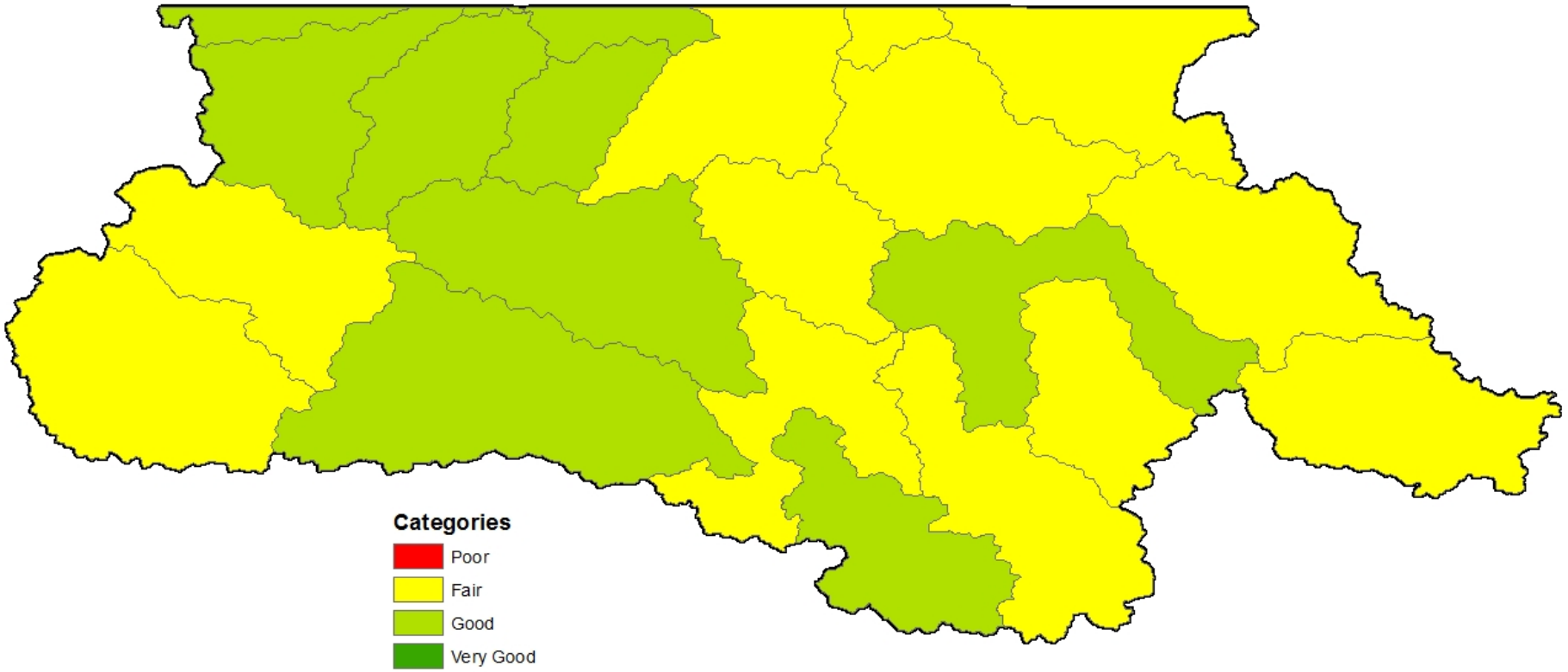
Wetlands
Overall



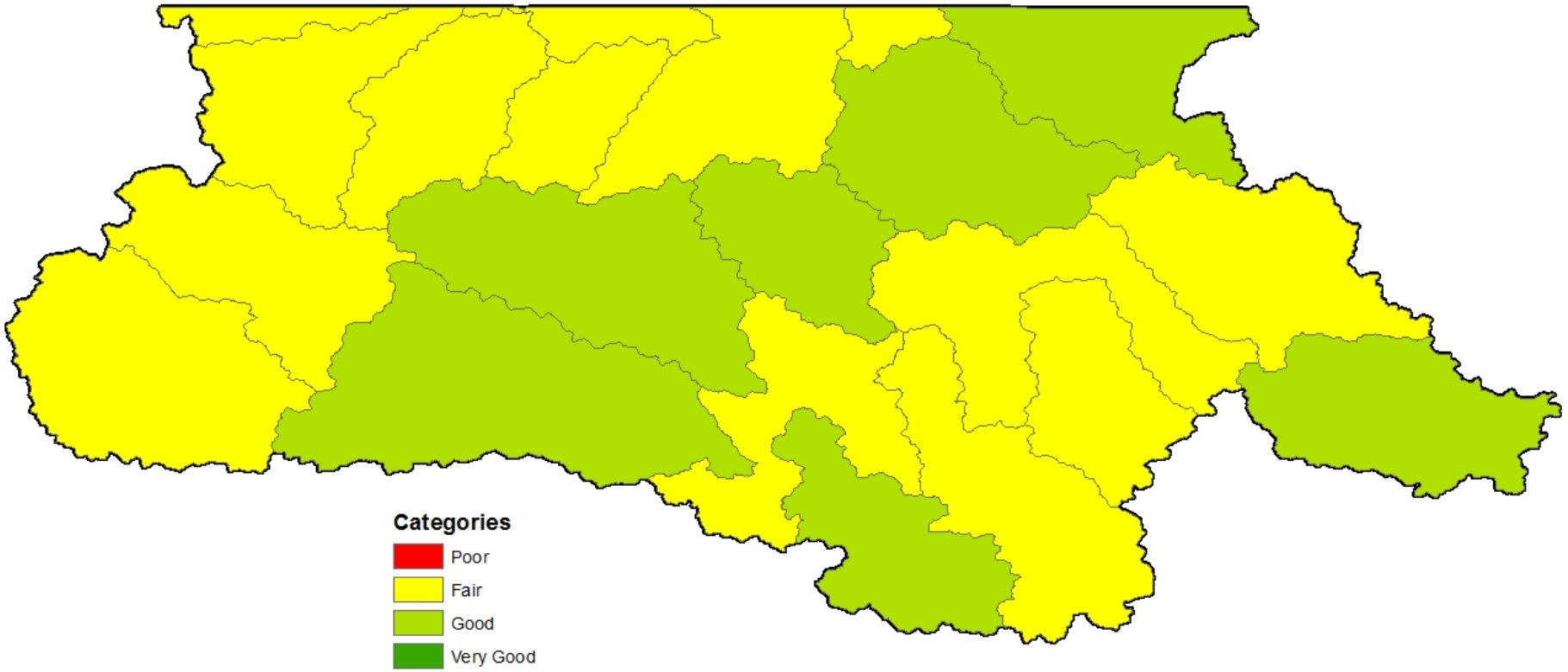
Uplands
Habitat Connectivity



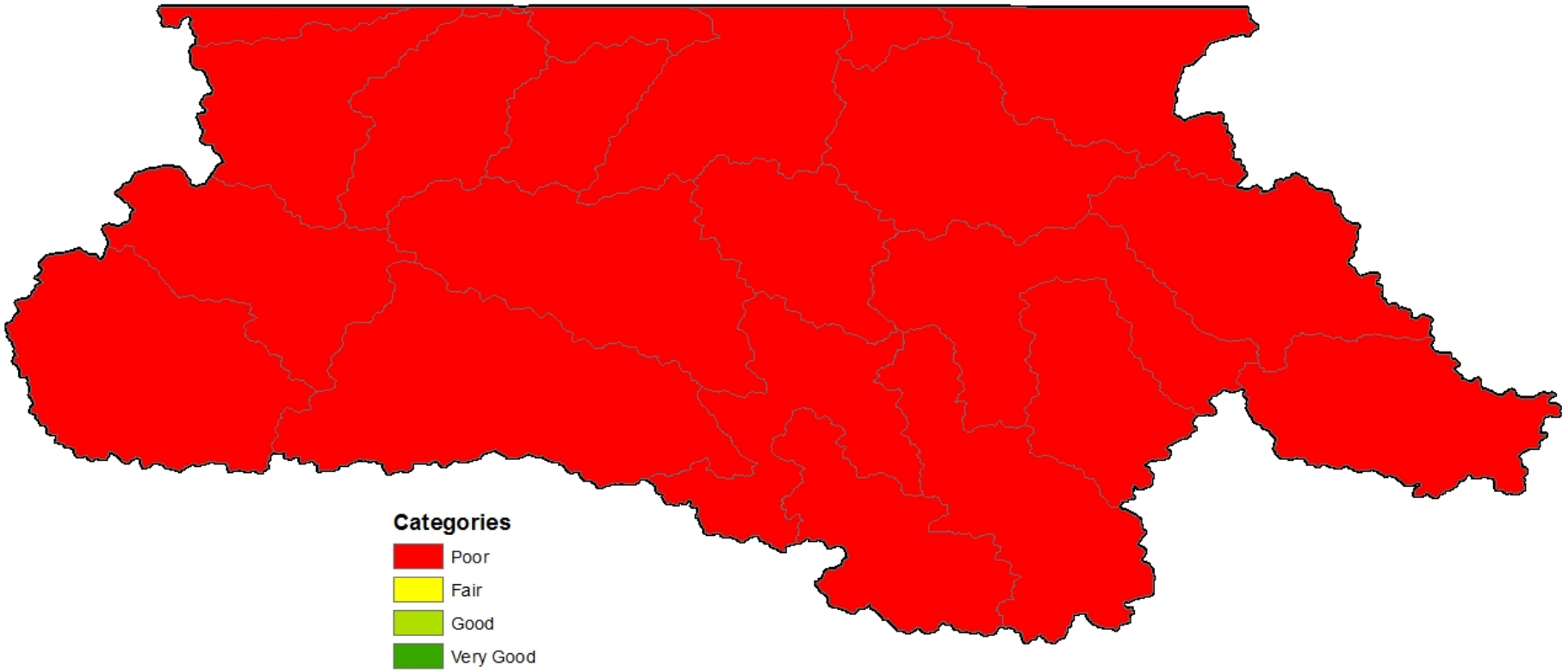
Uplands
Habitat Quality



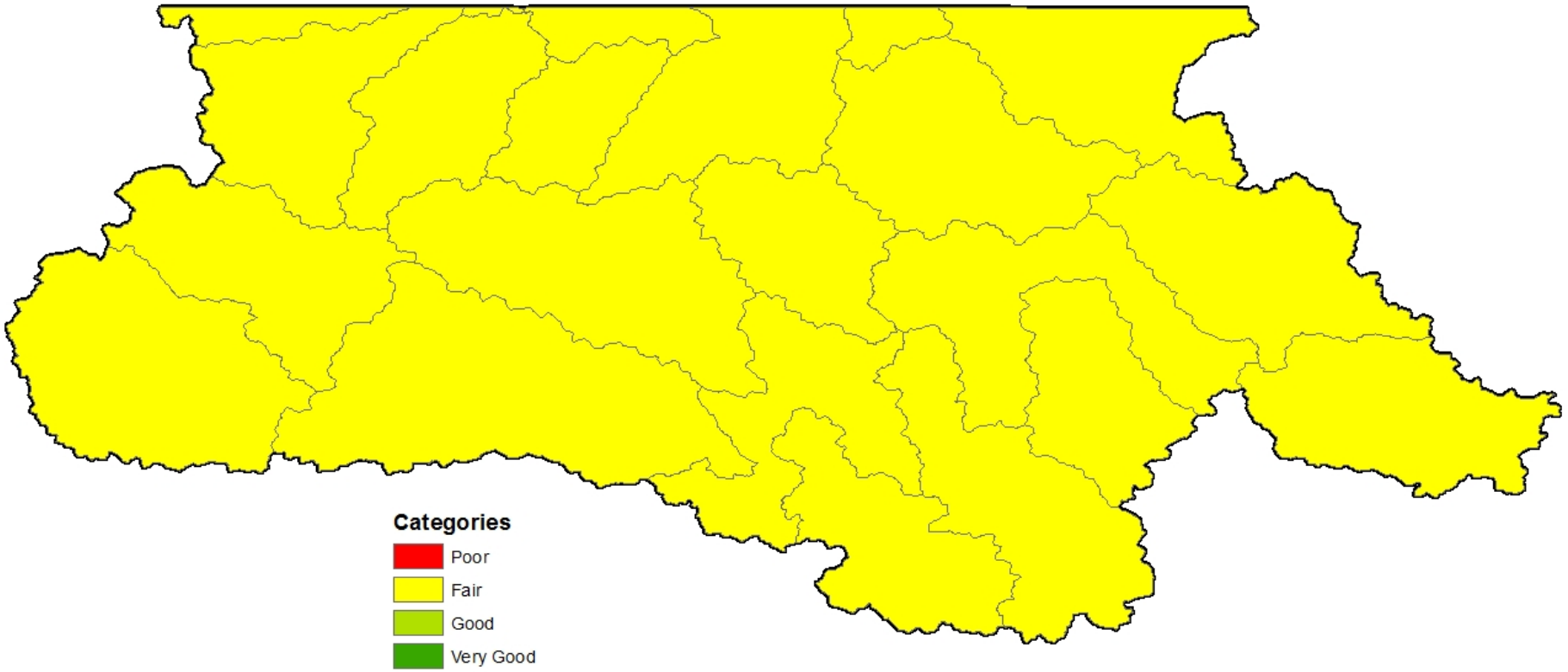
Uplands Biodiversity



Uplands
Protected Lands



Uplands
Overall



GROUP DISCUSSION 2

Please split up into assigned Groups to discuss the objective ratings and thresholds.

Questions to consider:

- What is the best method to define thresholds?
  - Literature review
  - Equal intervals
  - Quartiles
  - "Best Guess" from data
- With few data-derived thresholds, should we attempt an objective ranking?
- Should highest quality areas be automatic priorities for Protection?
- Should good-fair rated areas be automatic priorities for Restoration?