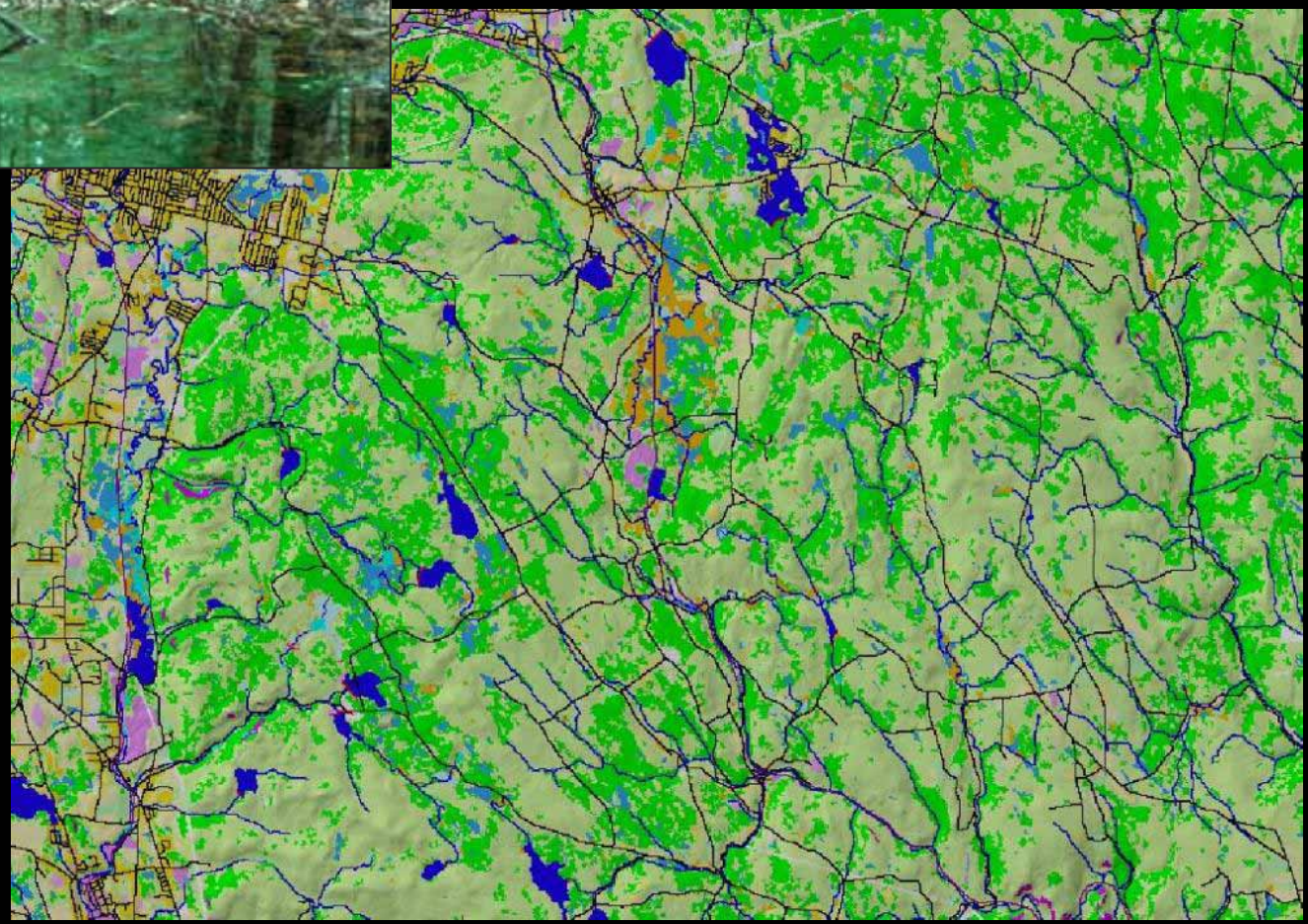
US EPA ARCHIVE DOCUMENT

A Landscape-level Approach to Wetlands Monitoring & Assessment

Scott Jackson

University of Massachusetts Amherst

UMassAmherst Outreach UMass Extension



Presentation Outline

- **What is CAPS?**
- **Important concepts, terms & considerations**
- **CAPS components & applications**

Conservation Assessment & Prioritization System (CAPS)

Assessing ecological integrity and supporting decision-making for land conservation, habitat management, project review & permitting to protect biodiversity

Landscape Ecology Program

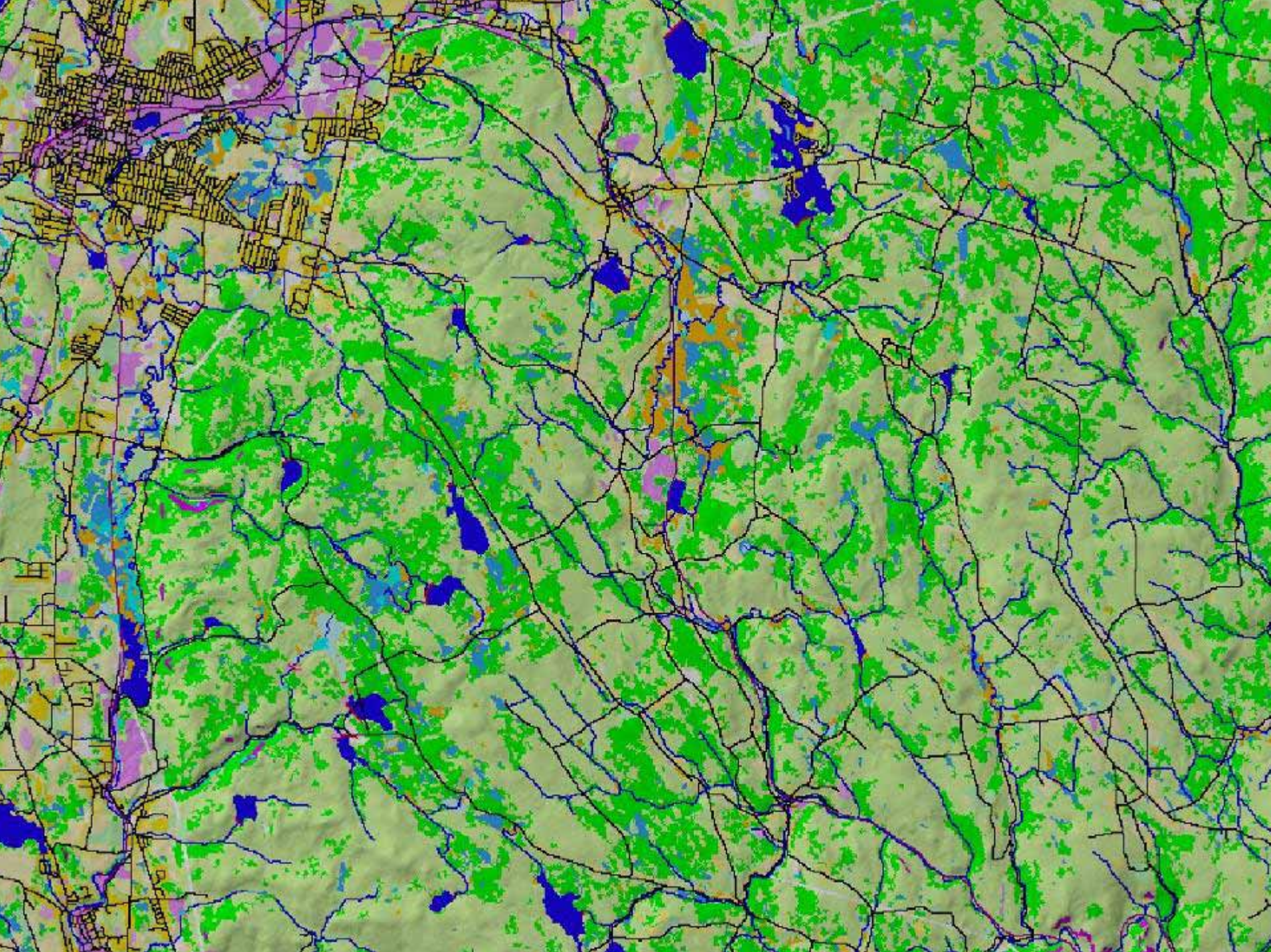
UNIVERSITY OF Massachusetts Amherst

UMassAmherst Outreach UMass Extension

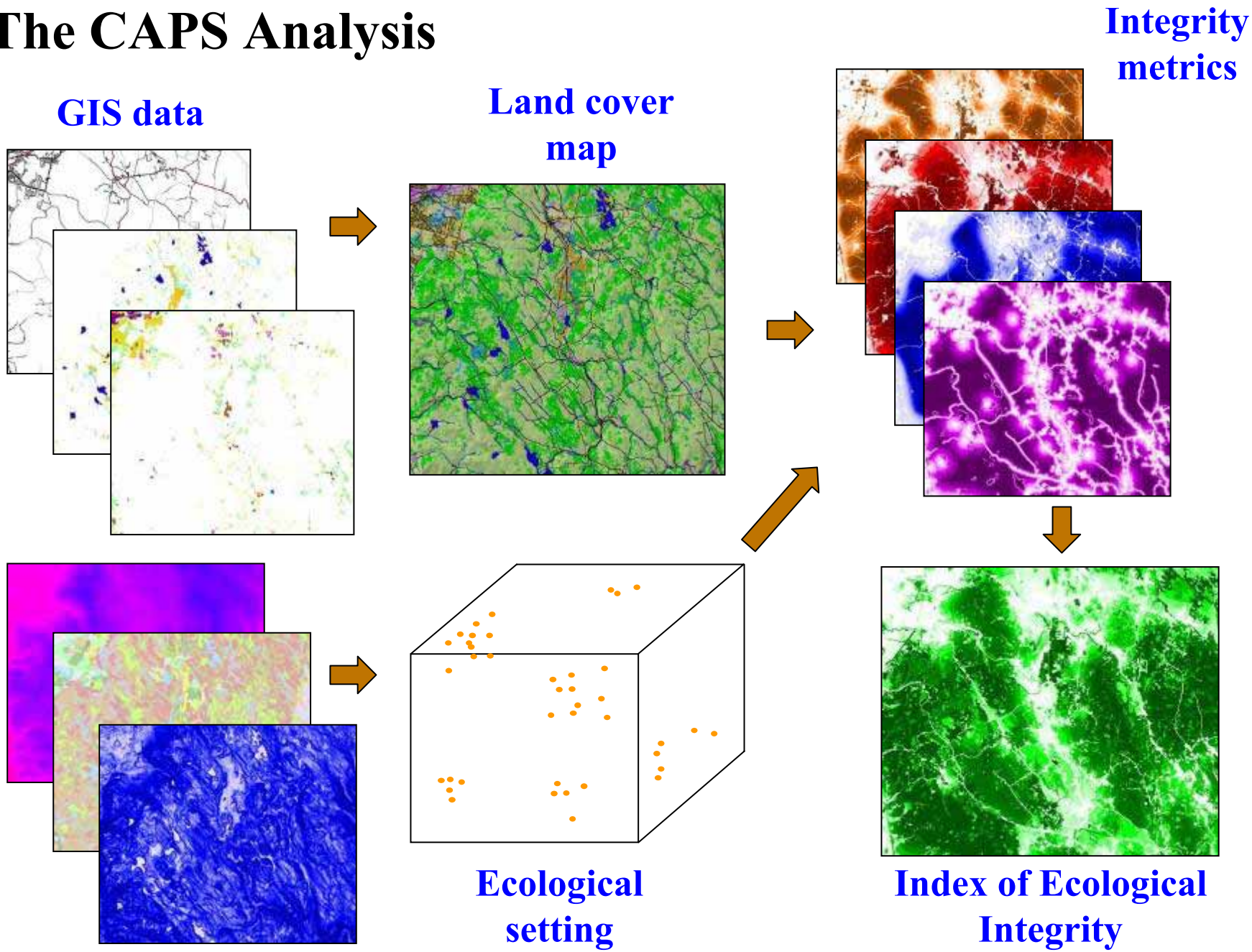
http://www.masscaps.org

Ecological Community Approach

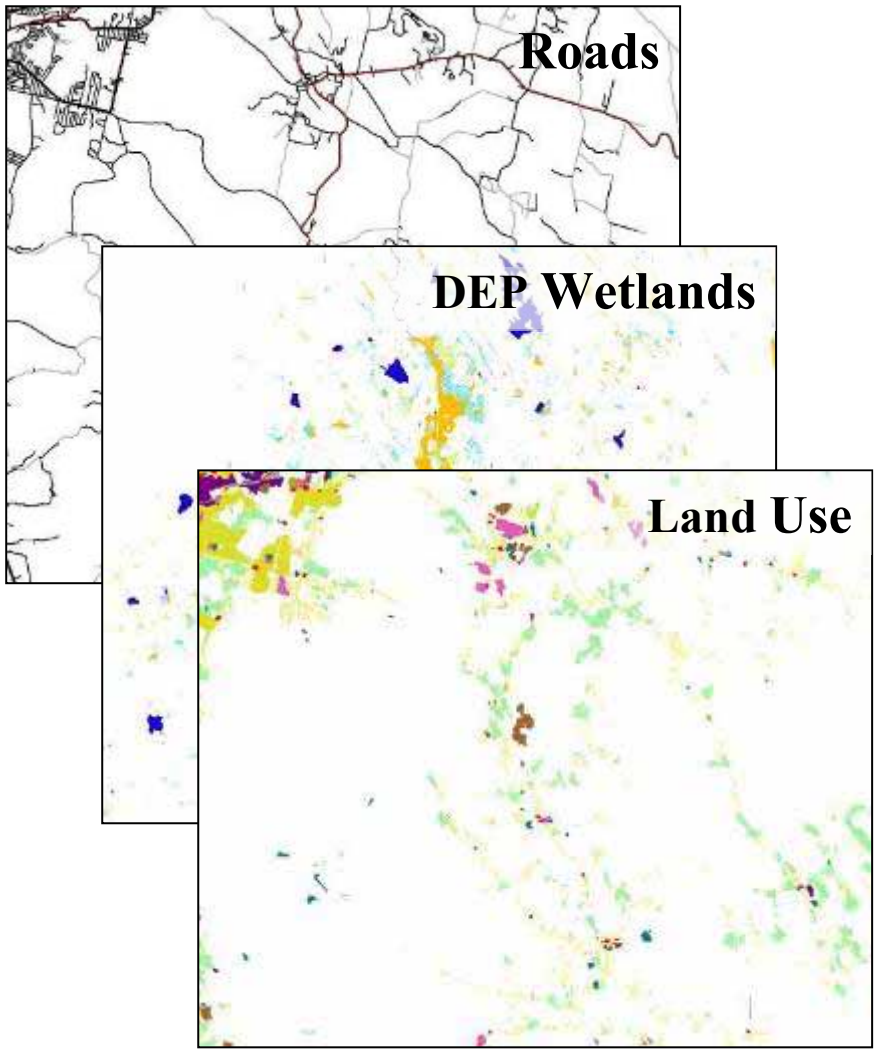
Ecological Integrity
…the long-term capability of the ecological community to sustain its composition, structure and function and thus also its resiliency to stress

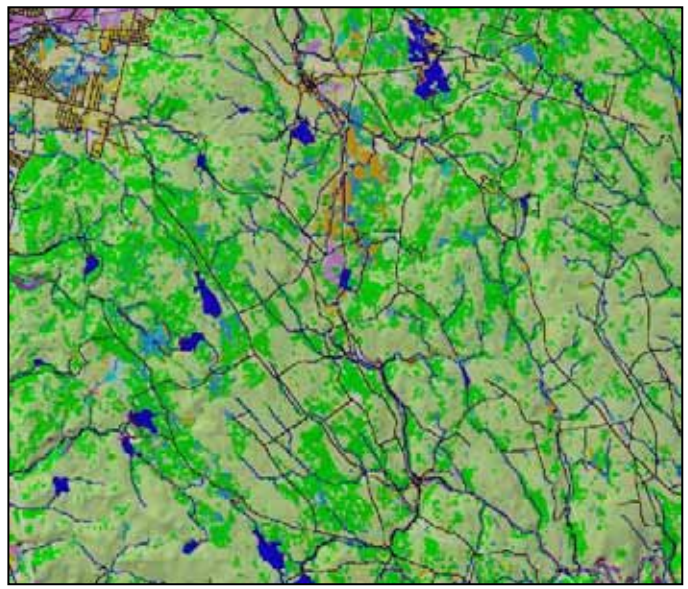


The CAPS Analysis



Land cover is mapped based on several GIS data layers





Land Cover Map

Land cover mapping

Ecological communities

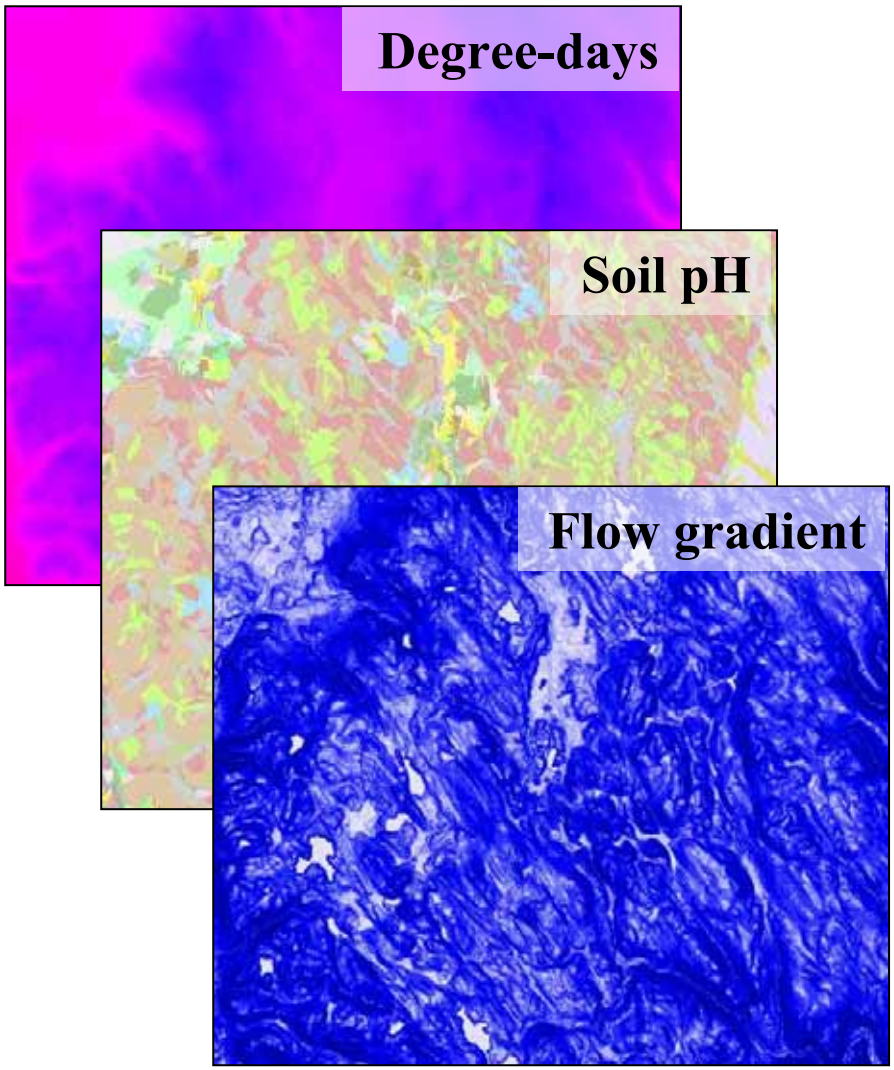
- Forested
  - Deciduous forest
  - Mixed forest
  - Conifer forest
  - Forested wetland
- Nonforested uplands
  - Shrubland
    - Powerline Shrubland
    - Old field
  - Grassland
    - Cultural Grassland
  - Cliff & Steep Slope
- Wetlands & aquatic
  - Palustrine
    - Shrub Swamp
    - Emergent Marsh
    - Pond
    - Vernal Pool
  - Lacustrine
    - Lake
- Wetlands & aquatic
  - Riverine
    - First order flatwater
    - First order pool-riffle
    - First order plane-bed
    - First order step-pool
    - First order cascade
    - Second order flatwater
    - Second order pool-riffle
    - Second order plane-bed
    - Second order step-pool
    - Second order cascade

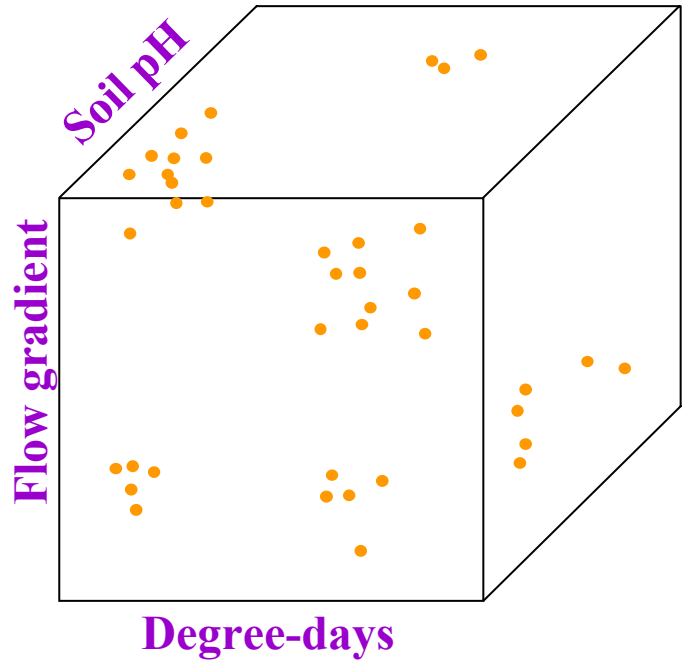
    - Sixth order flatwater
    - Sixth order pool-riffle
    - Sixth order plane-bed
    - Sixth order step-pool
    - Sixth order cascade

Forested Swamp

Wet Meadow

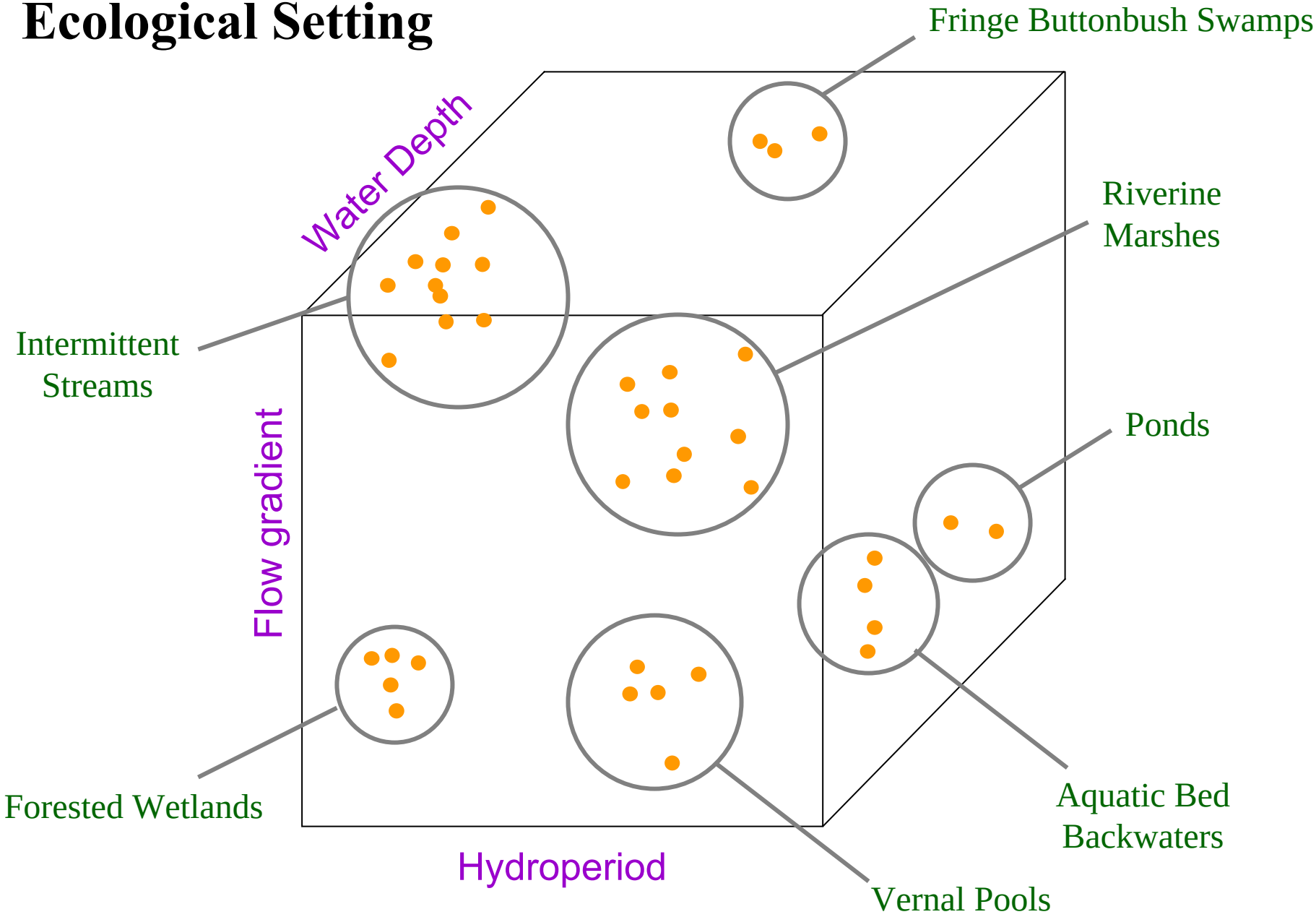
Ecological setting is determined for each point in the landscape is defined from GIS data



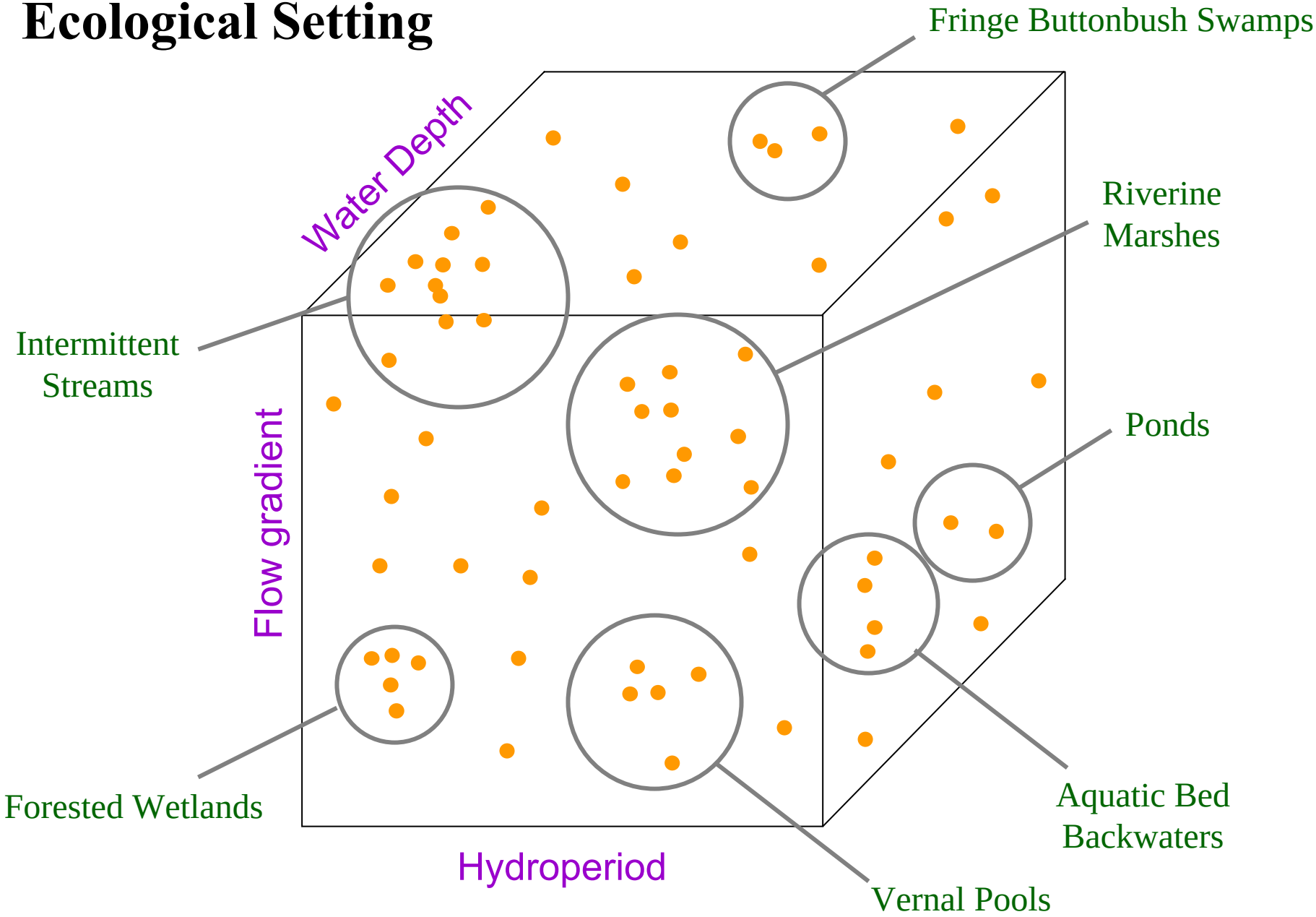


Ecological setting

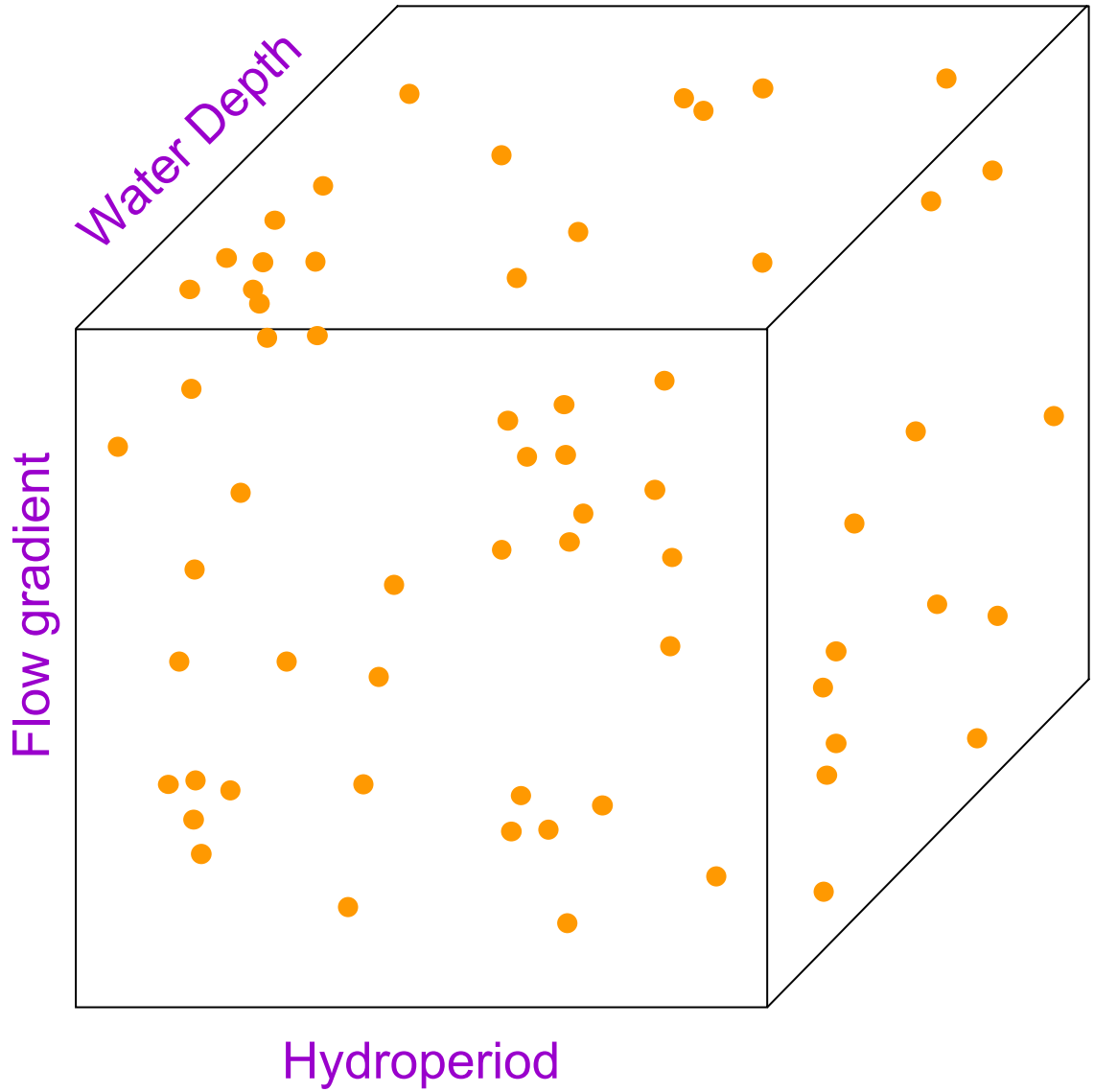
Ecological Setting



Ecological Setting



Ecological Setting



Ecological Setting Variables:

Temperature

- Growing season degree-days
- Minimum annual temperature

Chemical & physical substrate

- Soil pH
- Soil depth
- Water salinity
- Water $CaCO_4$ content

Geomorphology

- Channel constraint (sinuosity)
- Landscape position

Moisture

- Available soil moisture
- Relative humidity

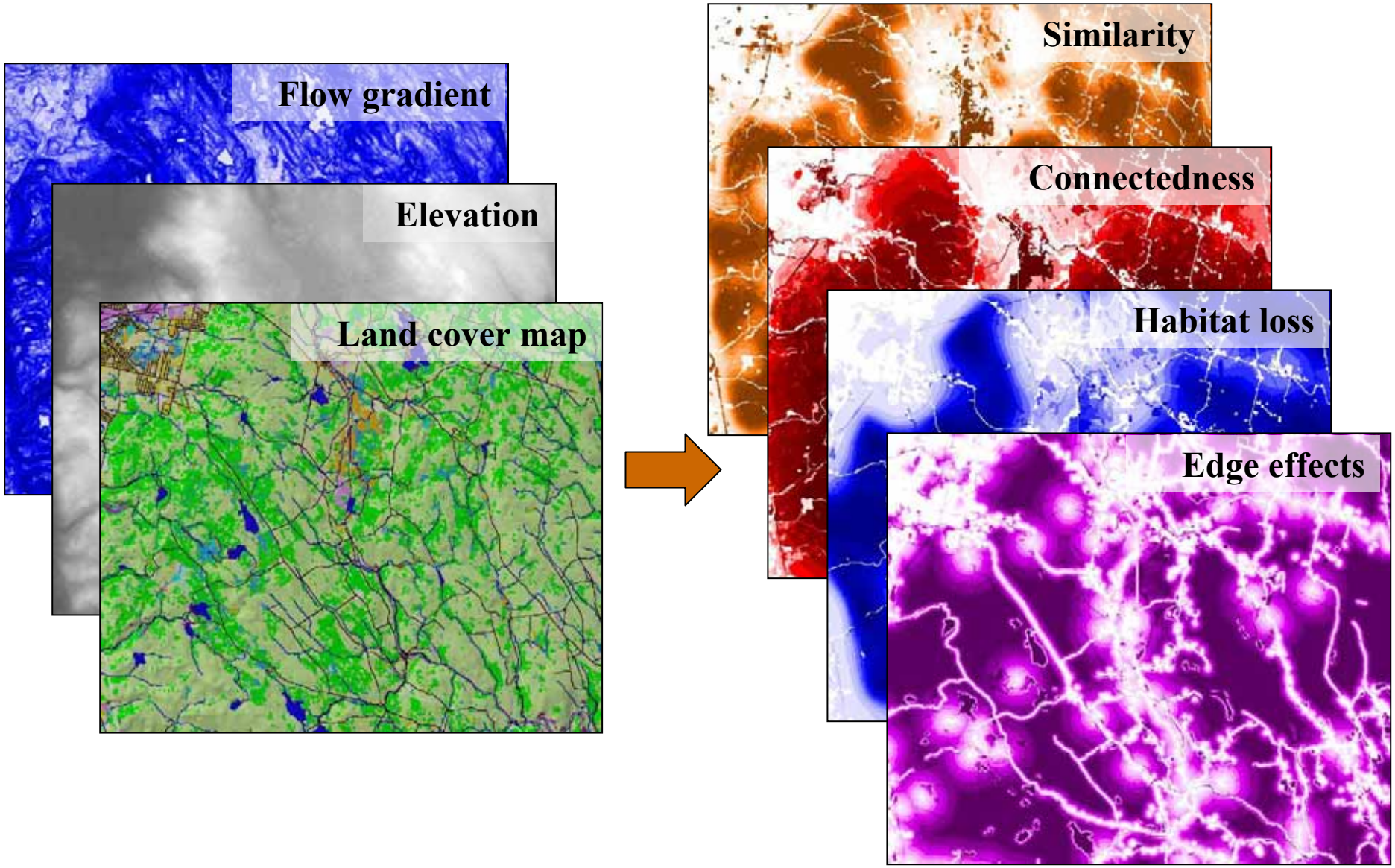
Hydrology

- Water depth
- Hydroperiod
- Flow gradient
- Flow volume
- Tidal influence

Solar energy

- Incident solar radiation

Several landscape metrics are calculated based on the land cover map and other data



CAPS Integrity Metrics

Stressor metrics

- Road Intensity
  - Road salt intensity
  - Road traffic intensity
  - Road sediment intensity
- Development Intensity
  - Habitat loss
  - Watershed habitat loss
  - Watershed imperviousness
  - Mowing & plowing intensity
  - Fertilizer intensity
  - Point-source pollution
  - Emissions intensity
  - Domestic predators
  - Mesopredators
- Edge effects
- Wetland buffer imperviousness
- Biotic alterations
  - Non-native invasive plants
  - Non-native invasive earthworms
- Watershed percent impounded
- Upstream road crossings
- Dam intensity
- Water withdrawals

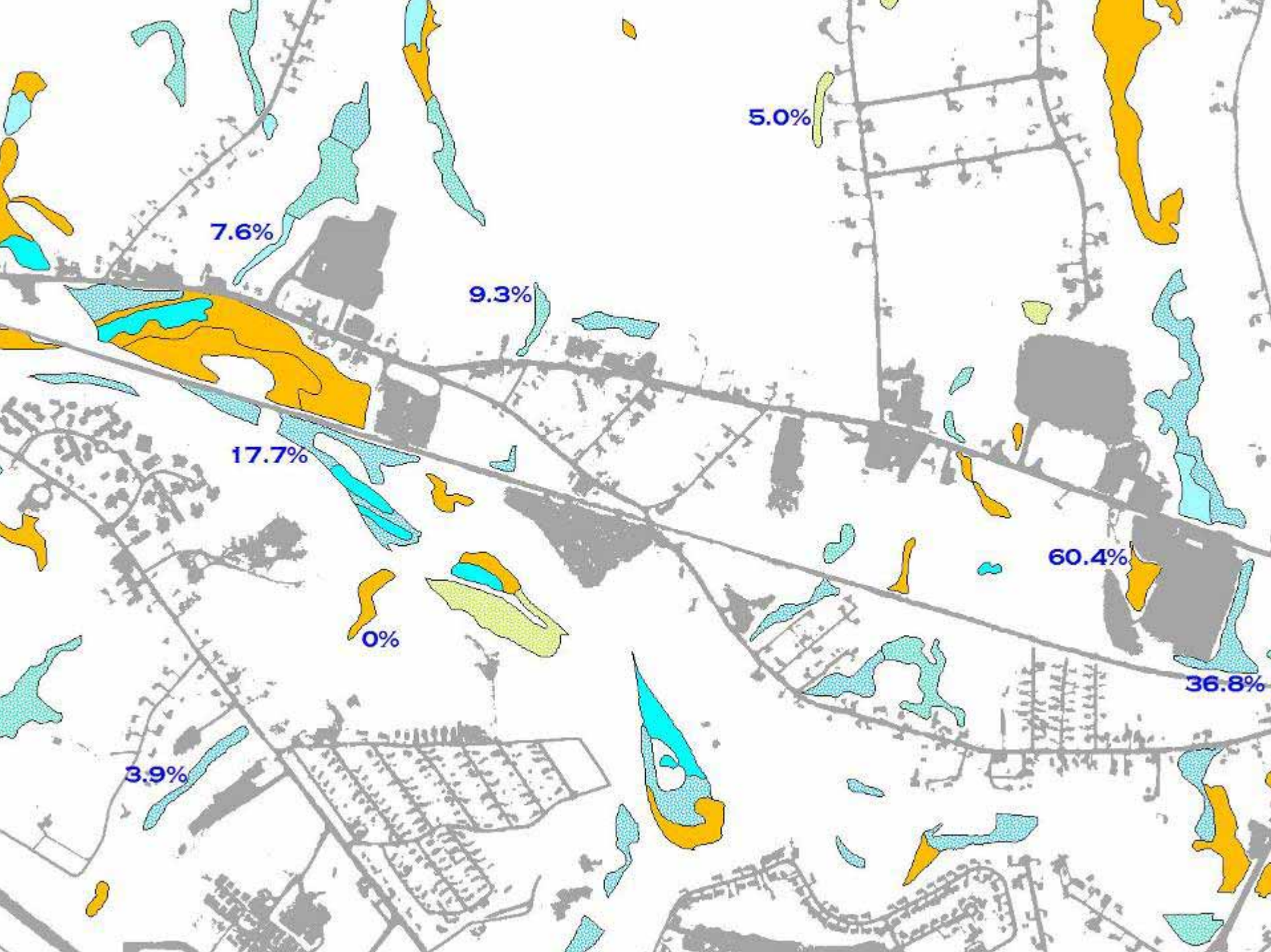
Resiliency metrics

- Connectedness
- Similarity

CAPS Integrity Metrics:
Wetland buffer imperviousness

60.4% of regulatory wetland buffer in impervious surface

60.4%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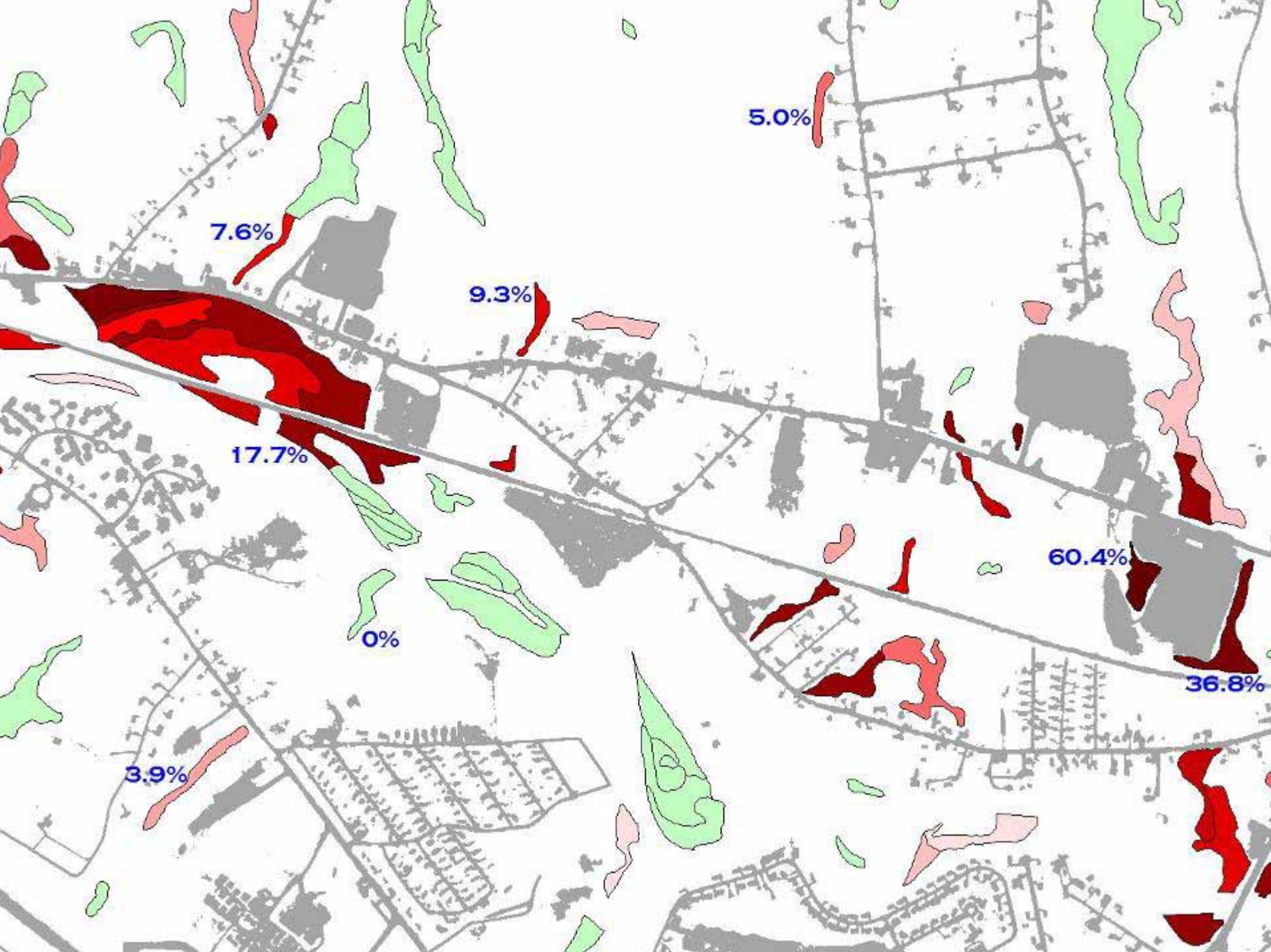
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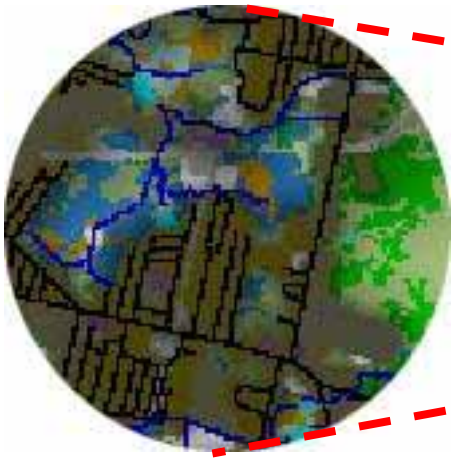
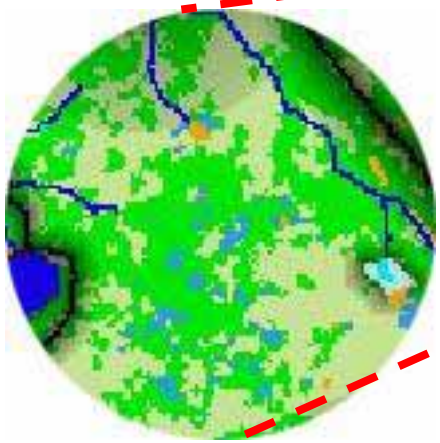
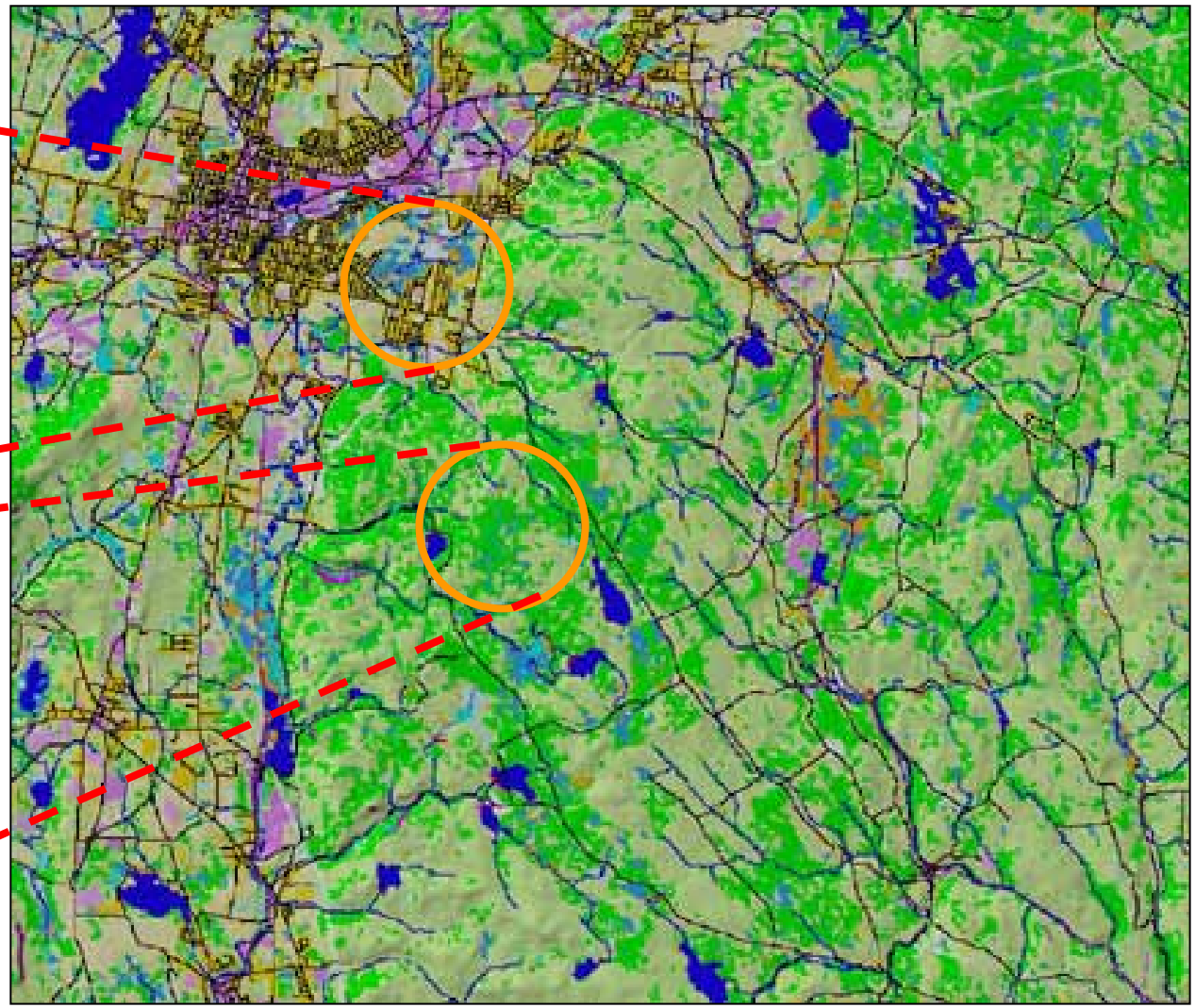
CAPS Integrity Metrics:
Edge effects

High edge effects

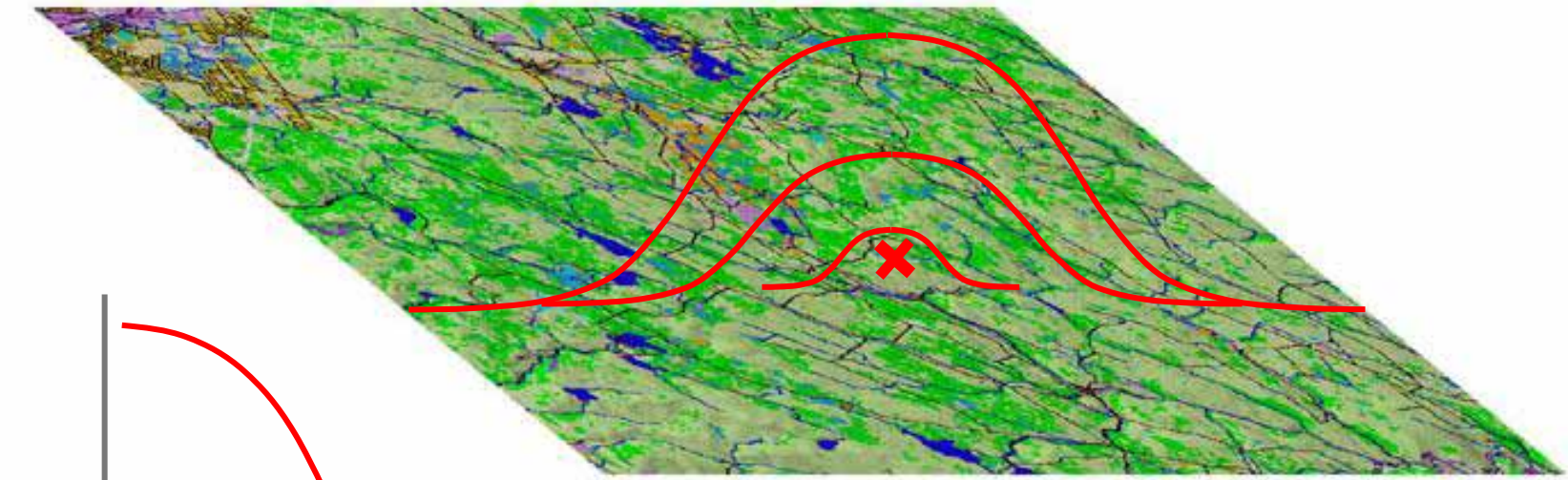


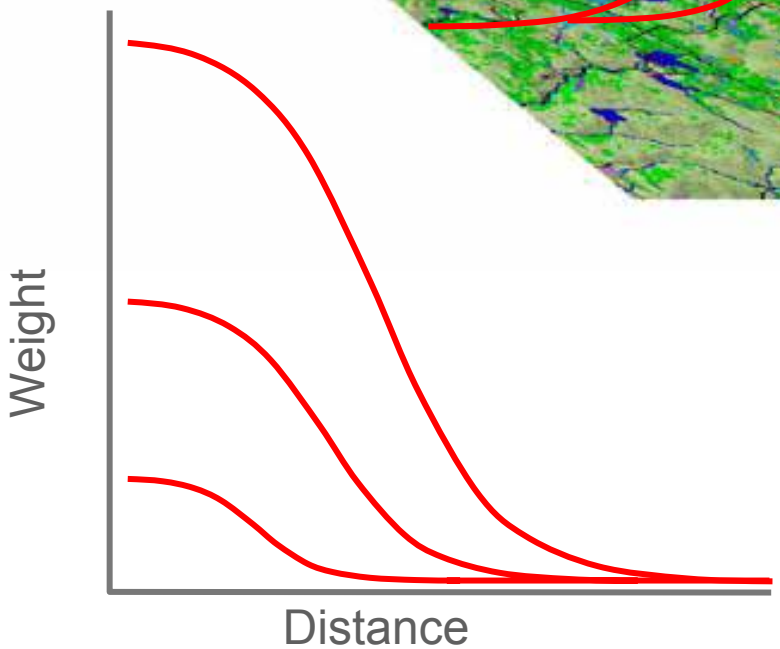


Low edge effects



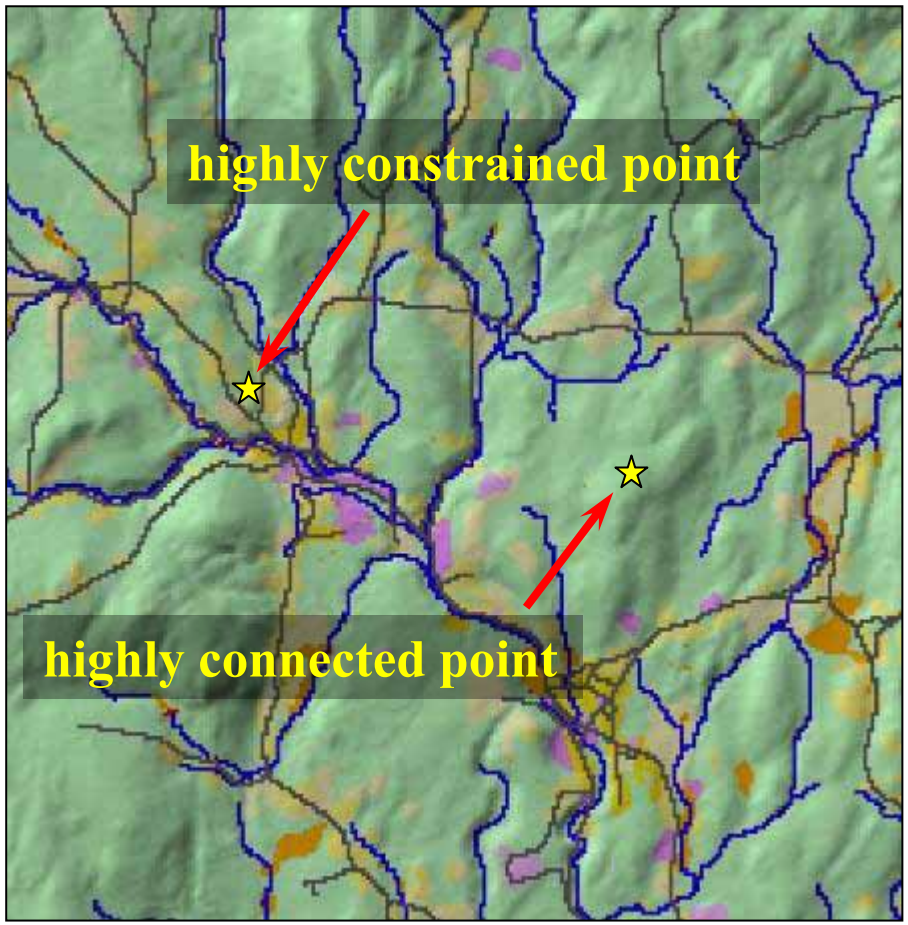
CAPS Integrity Metrics:
Scaling

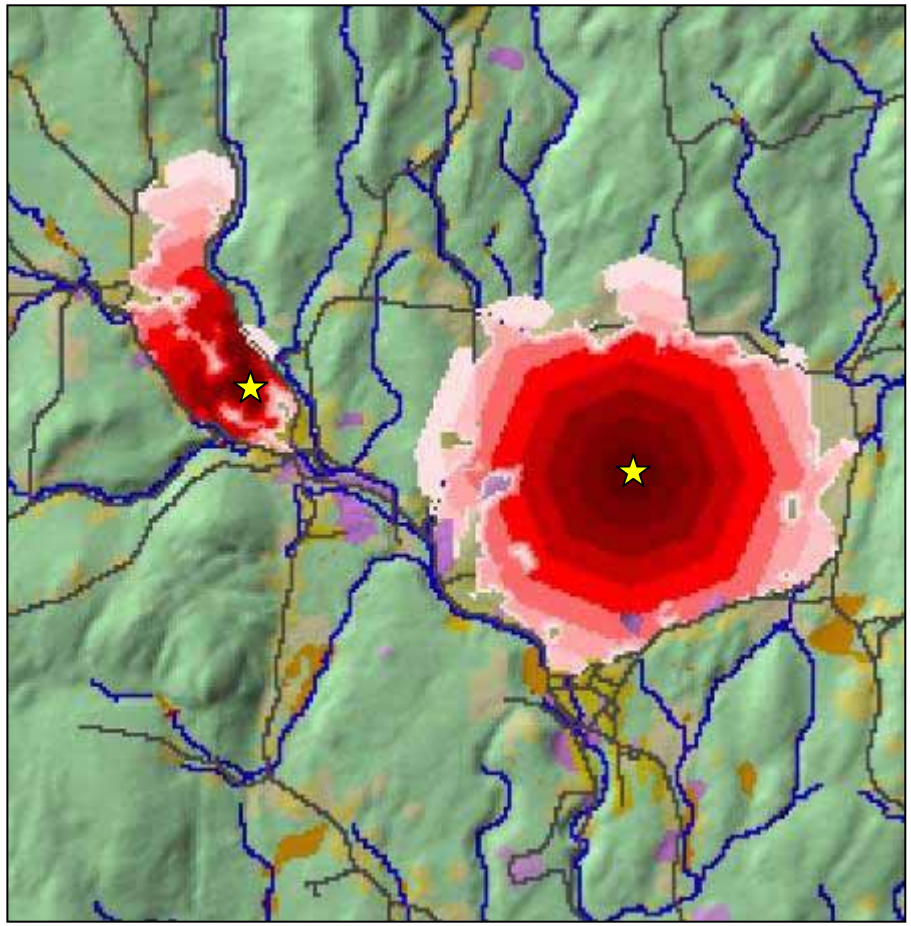




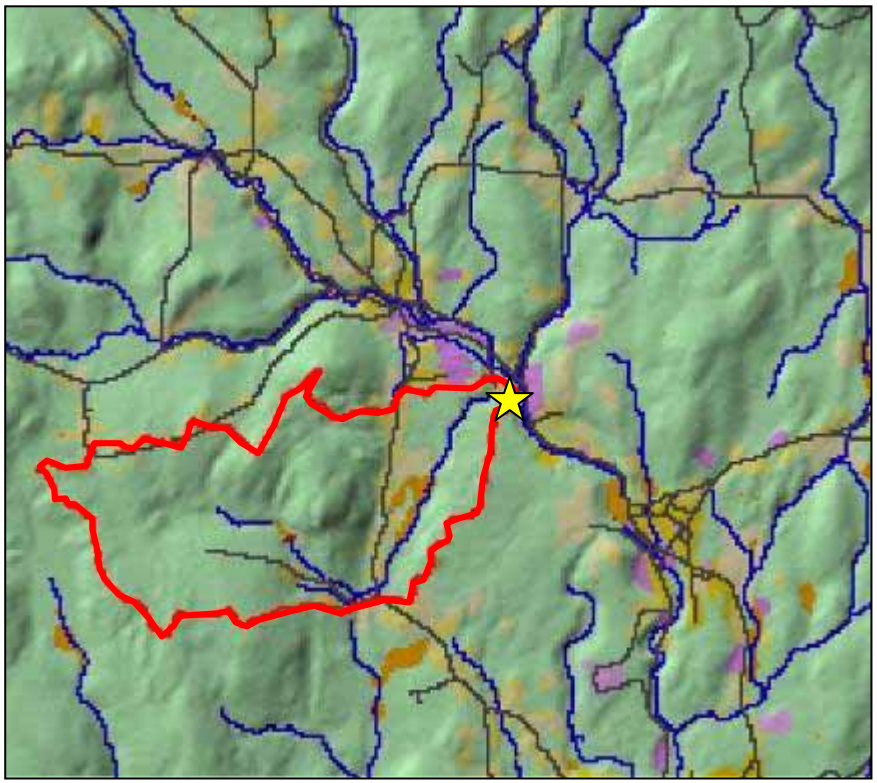
Integrity metrics can use different distance relationships when an assessing a cell

CAPS Integrity Metrics:
Connectedness

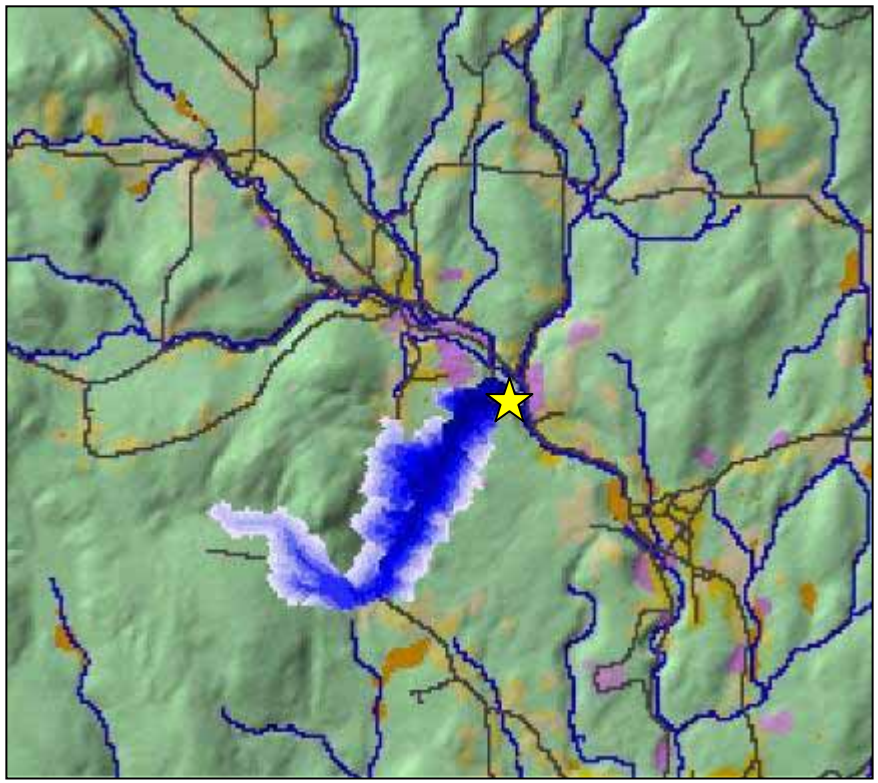




CAPS Integrity Metrics:
Watershed metrics

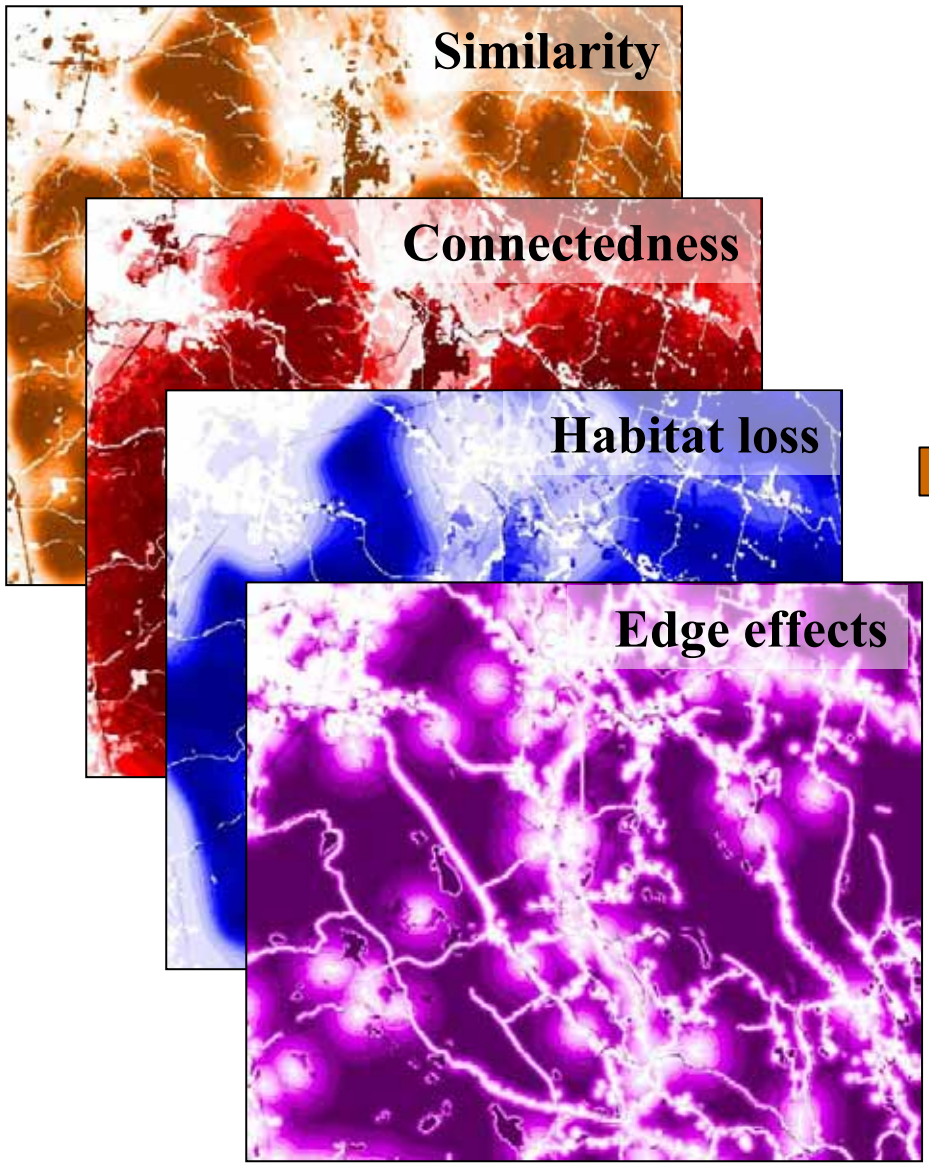


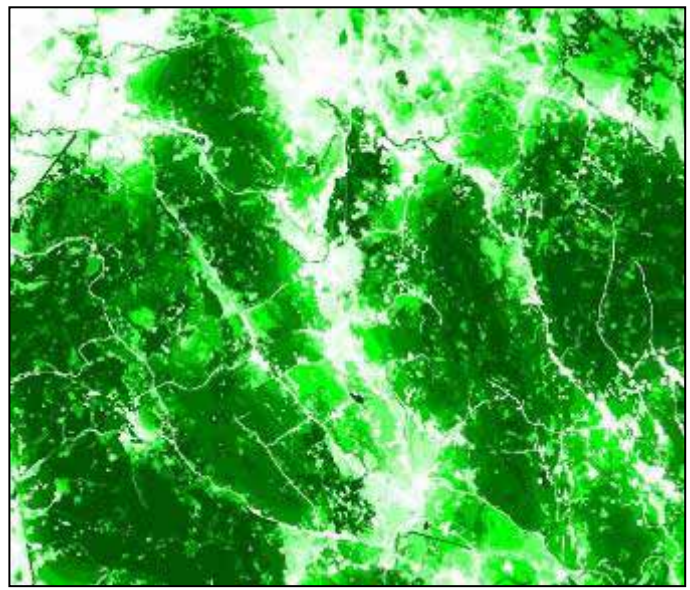
Full watershed above a point



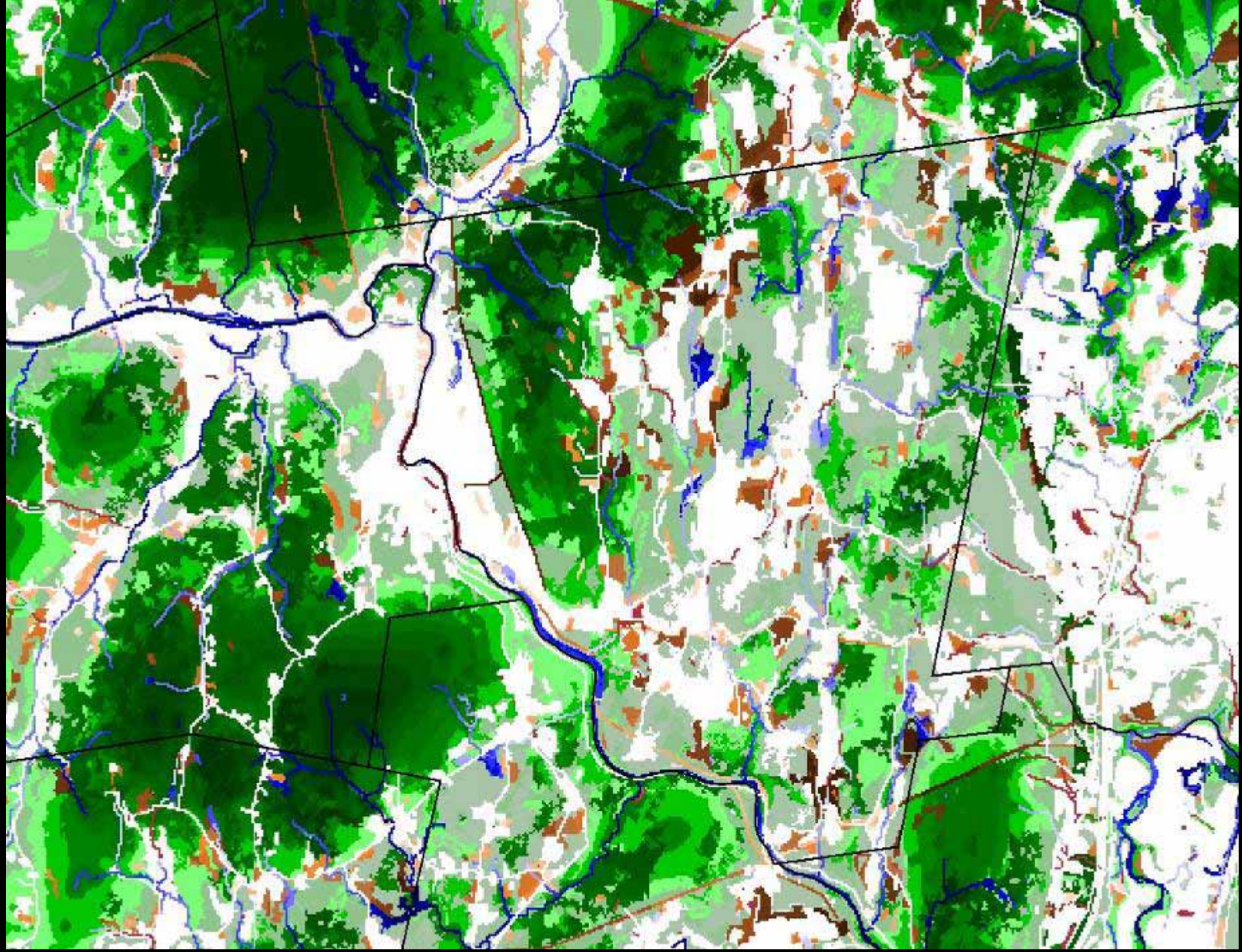
Constrained watershed
Based on time-of-flow model

Metrics are combined into an index of ecological integrity





Index of
Ecological Integrity



Ecological Condition

…refers to the current ecological status of an ecosystem within its ecological setting, in terms of its biophysical characteristics relative to a reference standard condition.

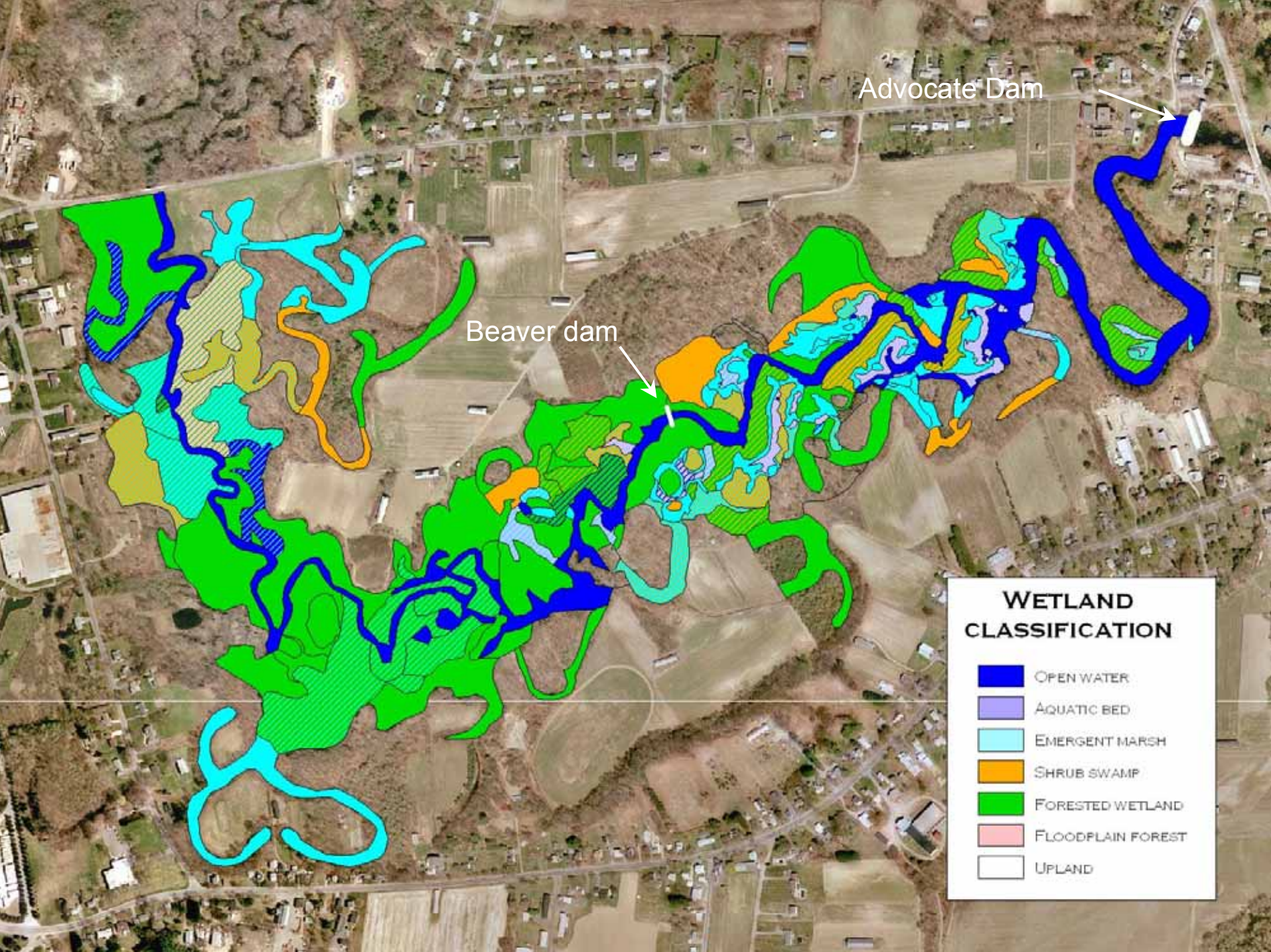
Ecological Integrity

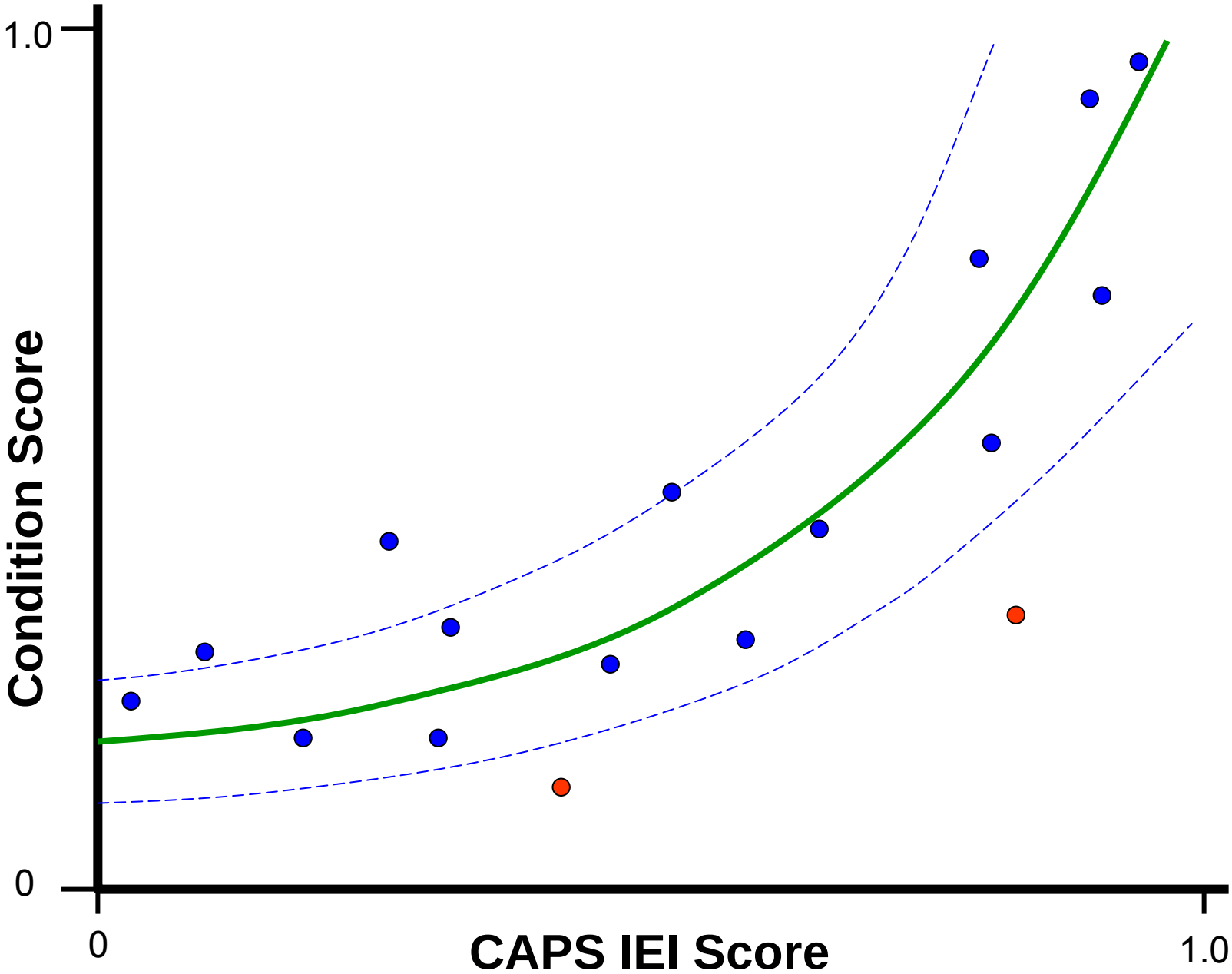
… refers to the long-term capability of the ecosystem to sustain its composition, structure and function and thus also its resiliency to stress.

Important Considerations & Challenges

- Limitation of wetland classification systems
- The dynamic nature of wetland systems
- Legacy effects of past land use
- Time lags
- Determining the relationship between stressors (local & landscape) and condition
- Validating landscape-based models

Mill River


Advocate Dam
Beaver dam
WETLAND CLASSIFICATION
OPEN WATER
AQUATIC BED
EMERGENT MARSH
SHRUB SWAMP
FORESTED WETLAND
FLOODPLAIN FOREST
UPLAND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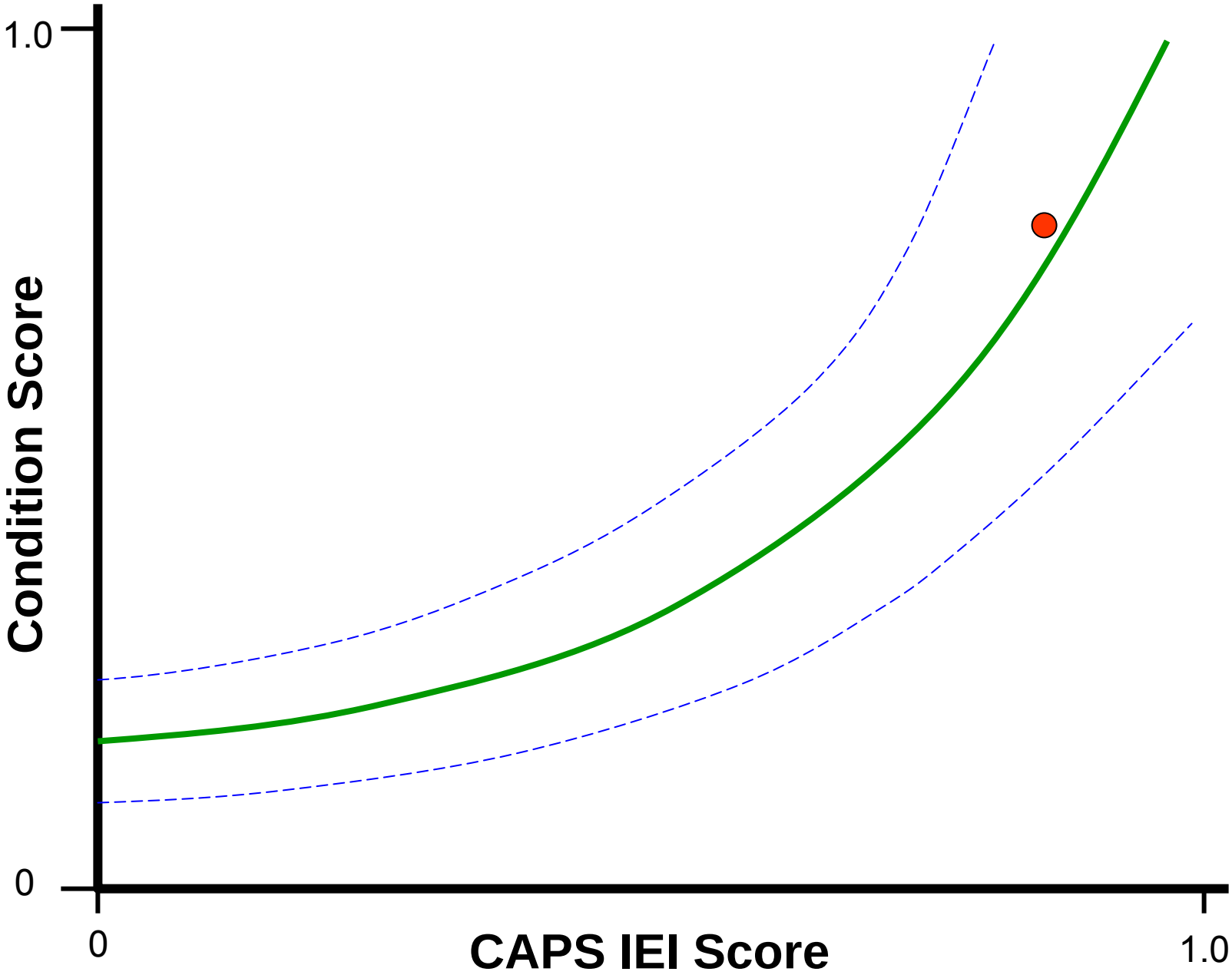
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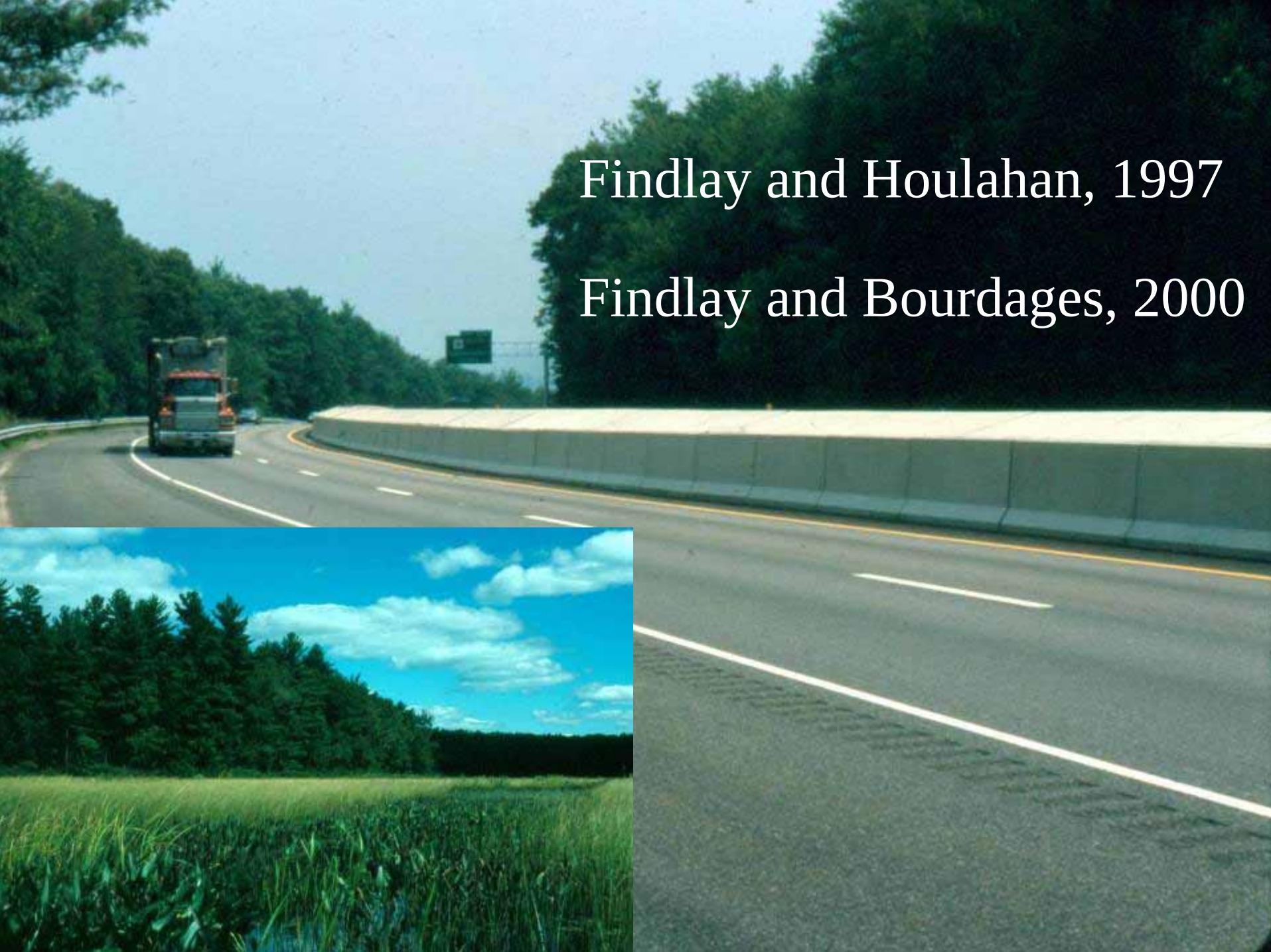
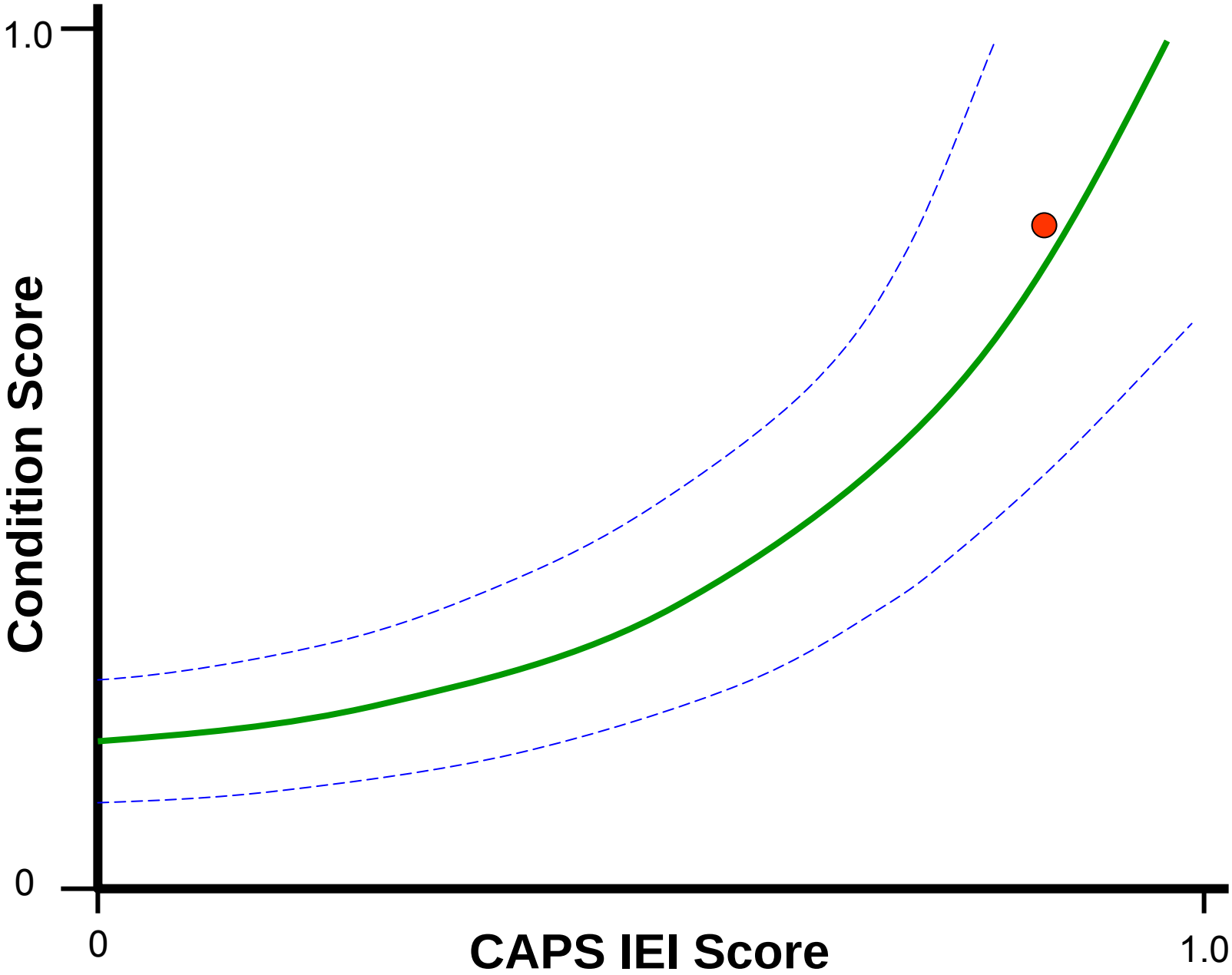

Findlay and Houlahan, 1997
Findlay and Bourdages, 2000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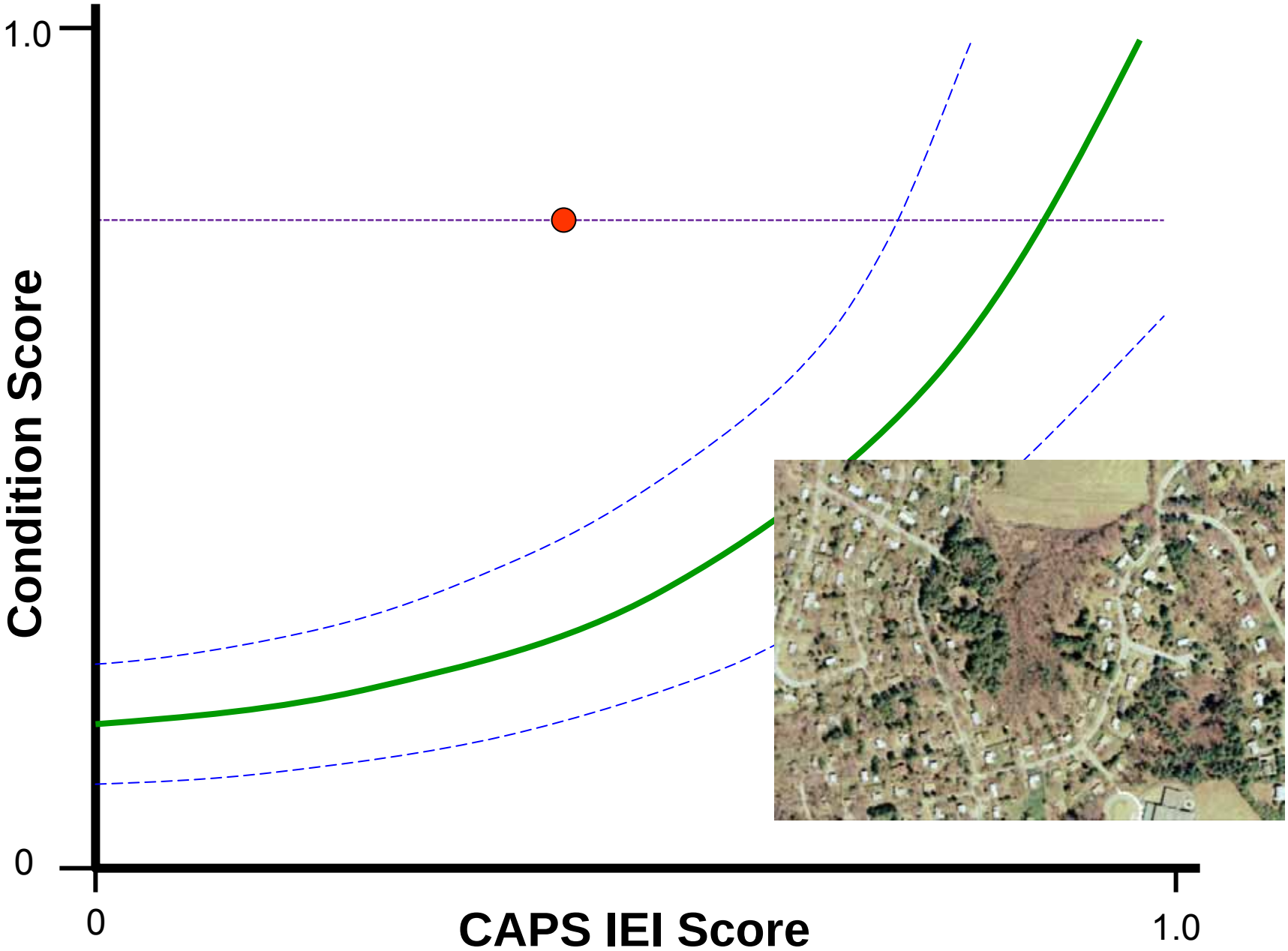
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CAPS three-Tiered Approach

- **Level 1: Landscape-level assessment (CAPS)** – A comprehensive landscape-level analysis of ecological integrity based solely on GIS-derived metrics
- **Level 2: Rapid Assessment (RAM)** – A relatively quick site- level analysis estimating ecological condition based on direct field observations of condition and local stressors
- **Level 3: Site-level Assessment (SLAM)** – A combination of rapid and intensive field sampling to assess ecological condition of a particular site

Role of Landscape-based Assessments

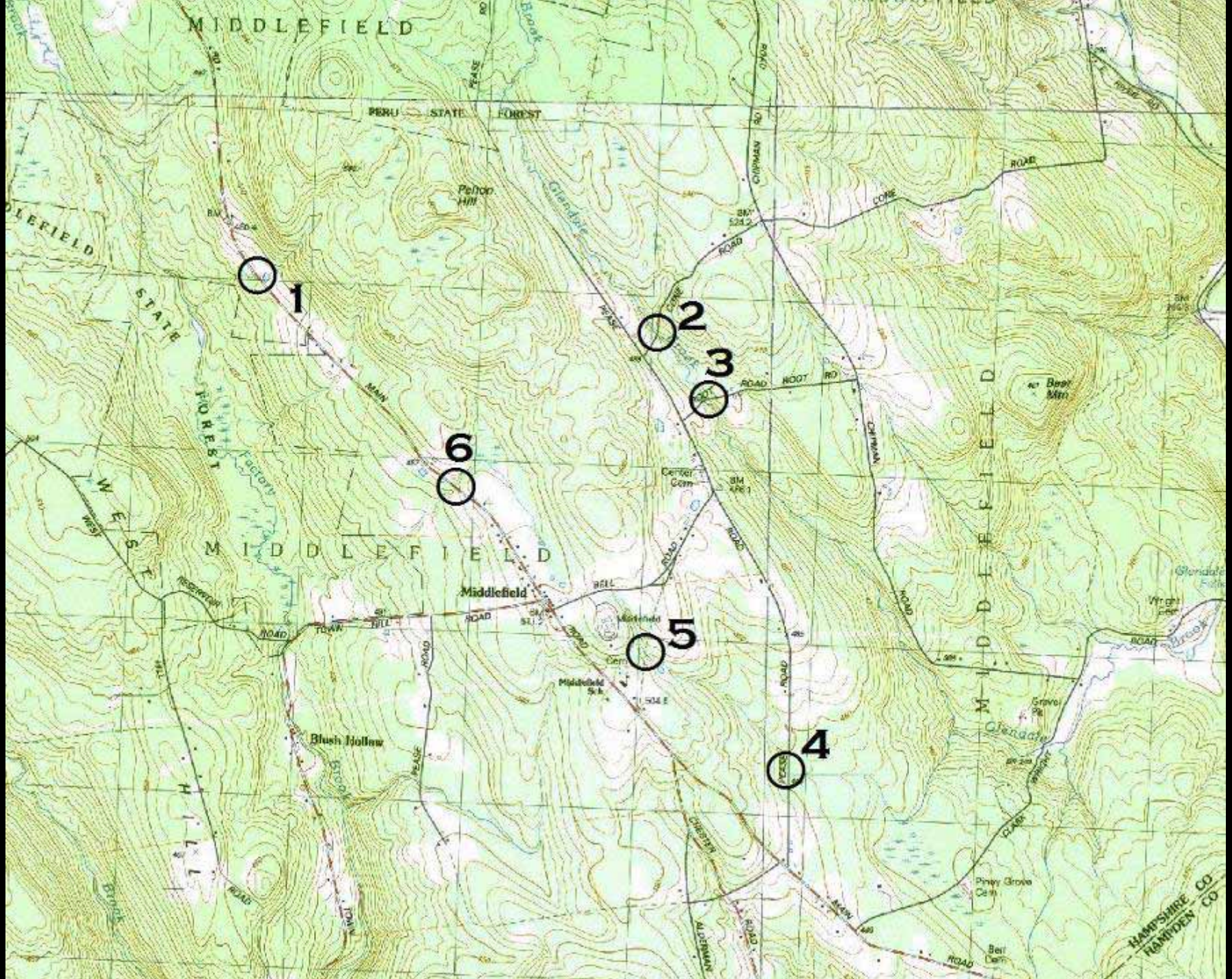
- Rigorous modeling of landscape-scale stressors
- Comprehensive coverage (all wetlands are evaluated)
- Quantitative (allows scenario testing)
- Assesses Ecological Integrity
  - Predicts future condition
  - Accounts for time lags in effects of stressors on ecological condition

Applications

- Land acquisition
- Prioritize sites for enhanced regulatory protection
- Prioritize sites for environmental restoration
- Identification of degraded wetlands
- Predict impact of climate change on the amount and distribution of wetland community types
- Monitor change in wetland community characteristics over time
- Monitor changes in wetland integrity and condition over time
- Increase understanding of how development, land protection, and BMPs affect ecological condition
- Project review, permitting and mitigation design
- Evaluate performance/success of restoration efforts, mitigation projects and mitigation banks
- Establish standards for ecological condition and integrity

Prioritizing sites for ecological restoration

- Assessment of Ecological Integrity
- Scenario Analysis



MIDDLEFIELD
PERU STATE FOREST
Pelton Hill
Glendale
PEASE
CHIPMAN RD
CONE ROAD
ROOT RD
Bear Mtn
MAIN
Factory
Center Cem
Middlefield
Middlefield Sch
Blush Hollow
Brook
Glendale
Wright Cem
Gravel Pit
Piney Grove Cem
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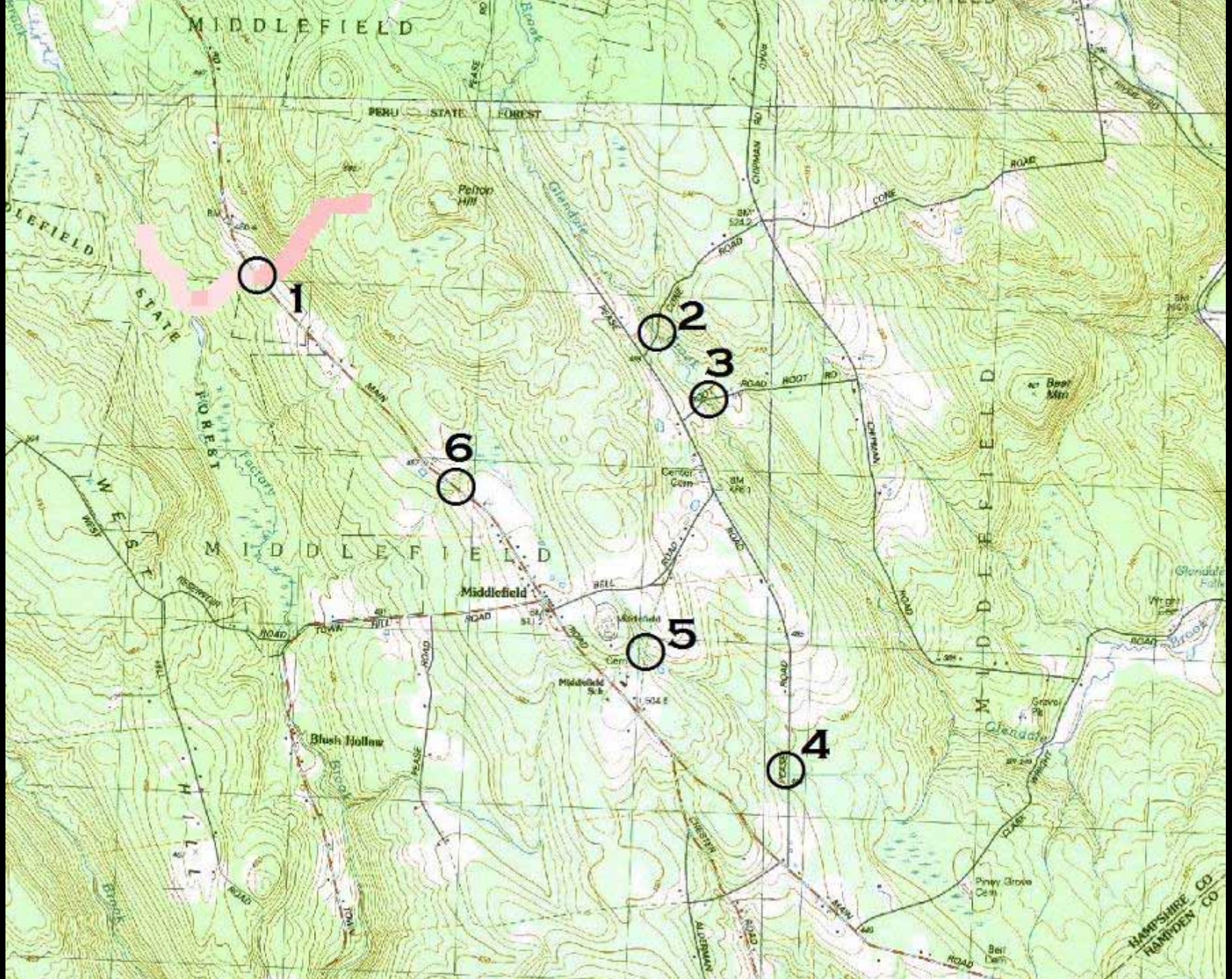

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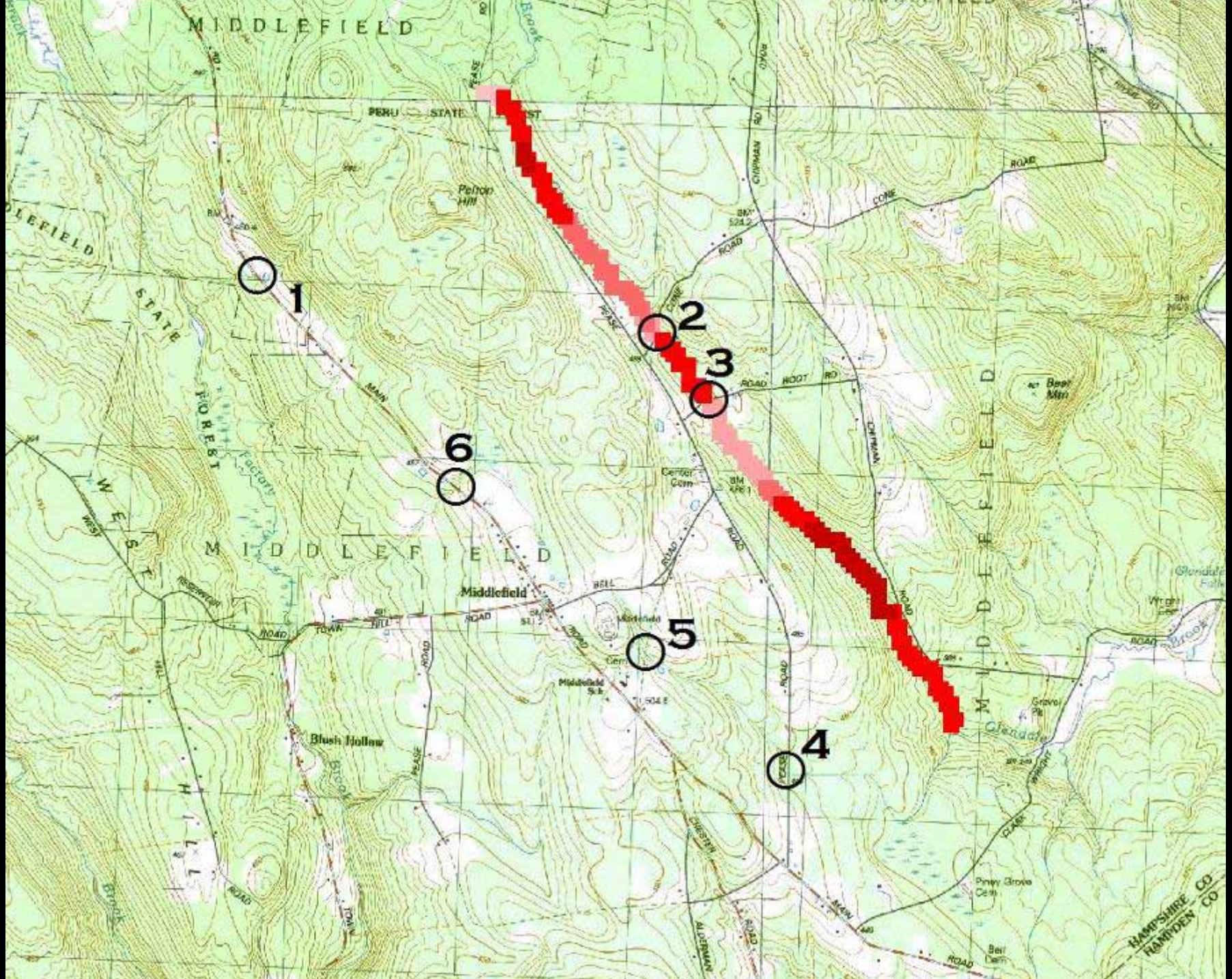

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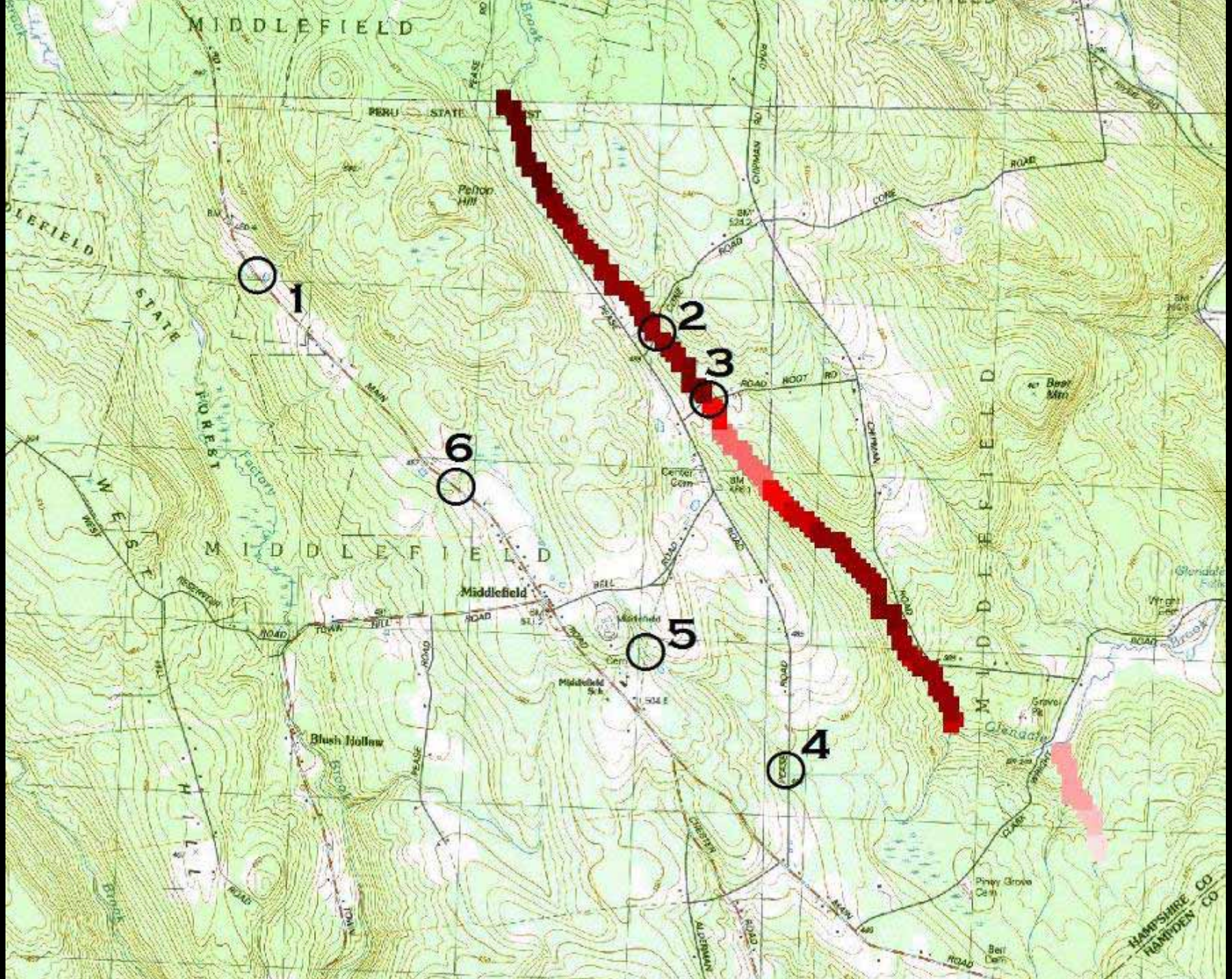

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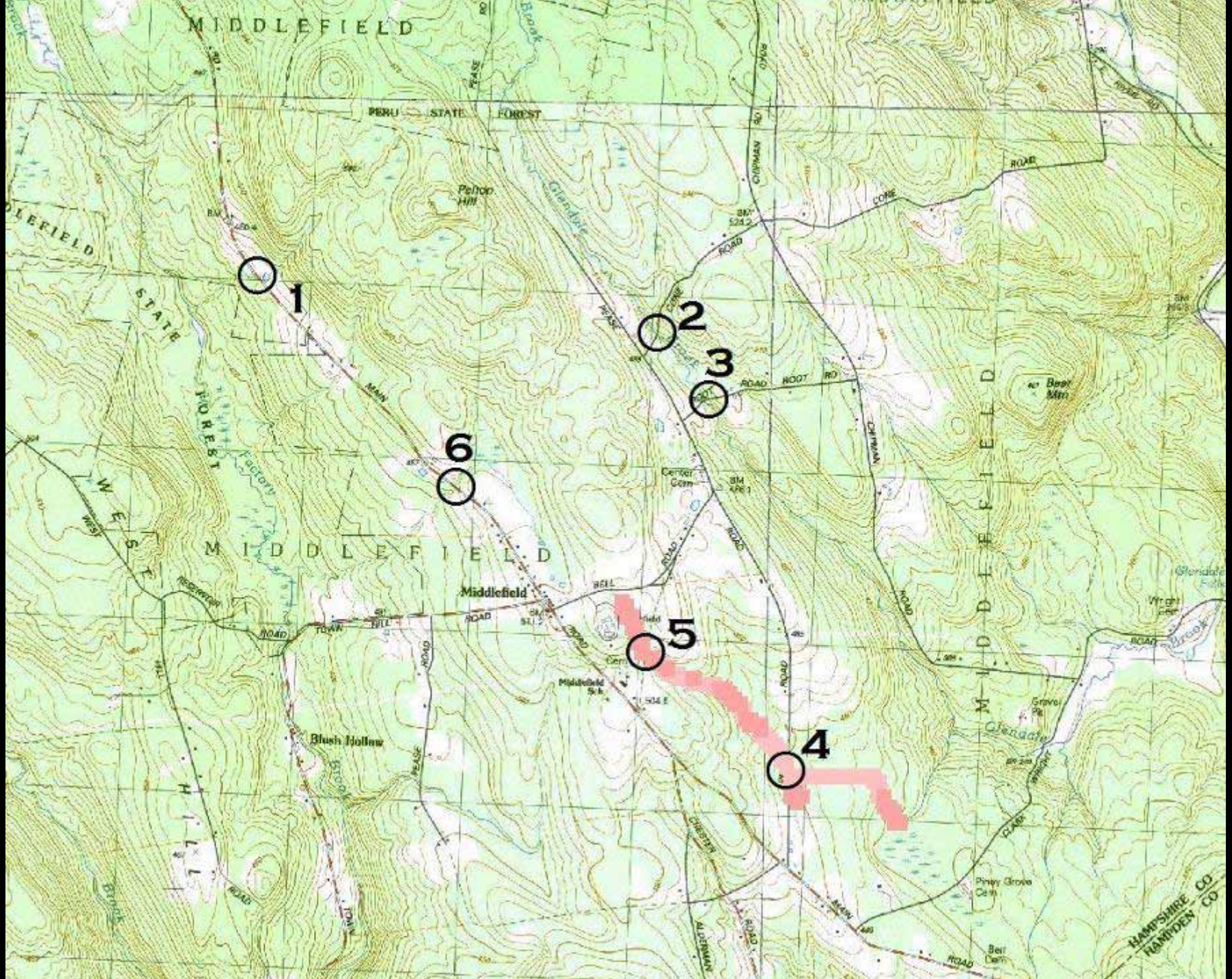

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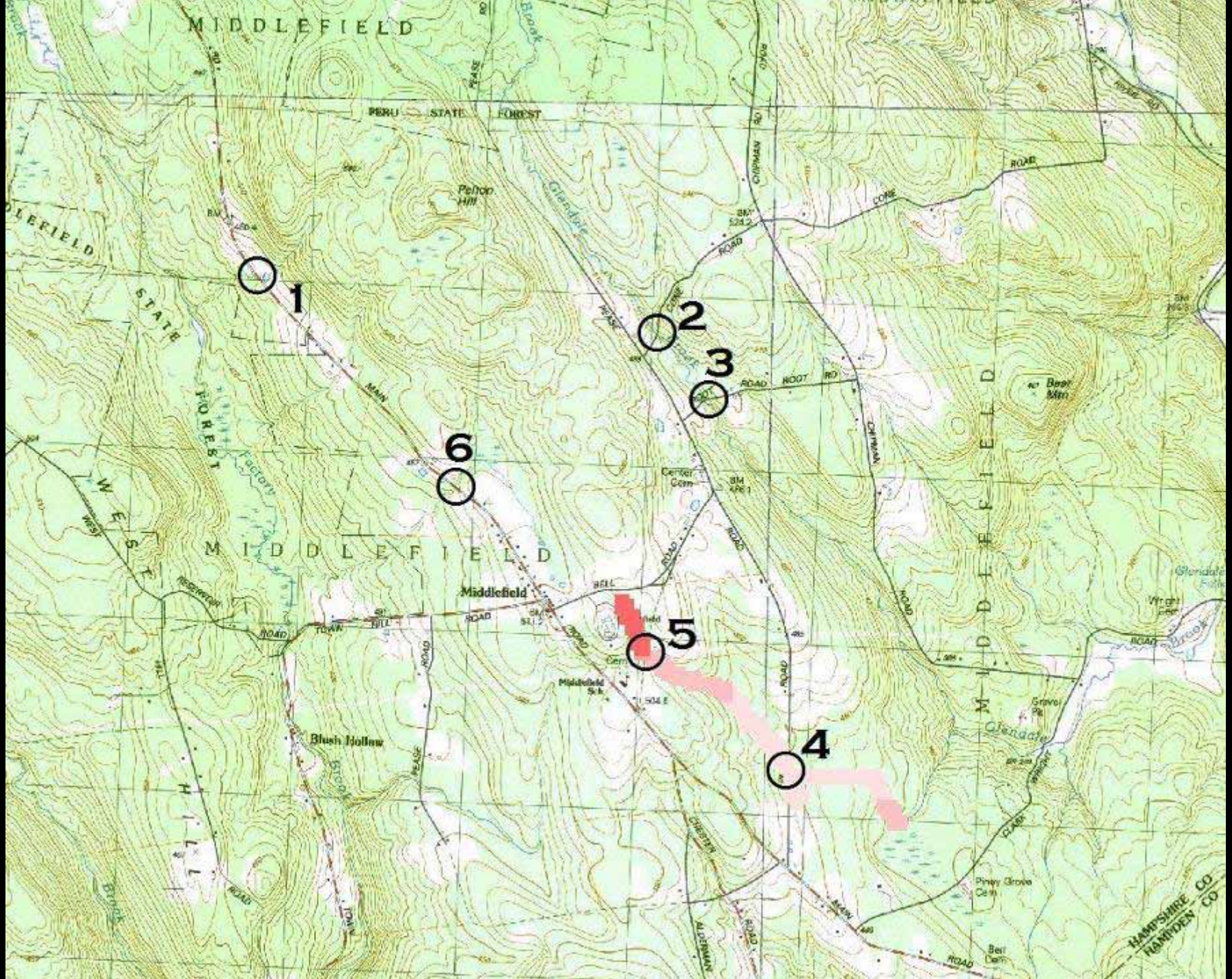

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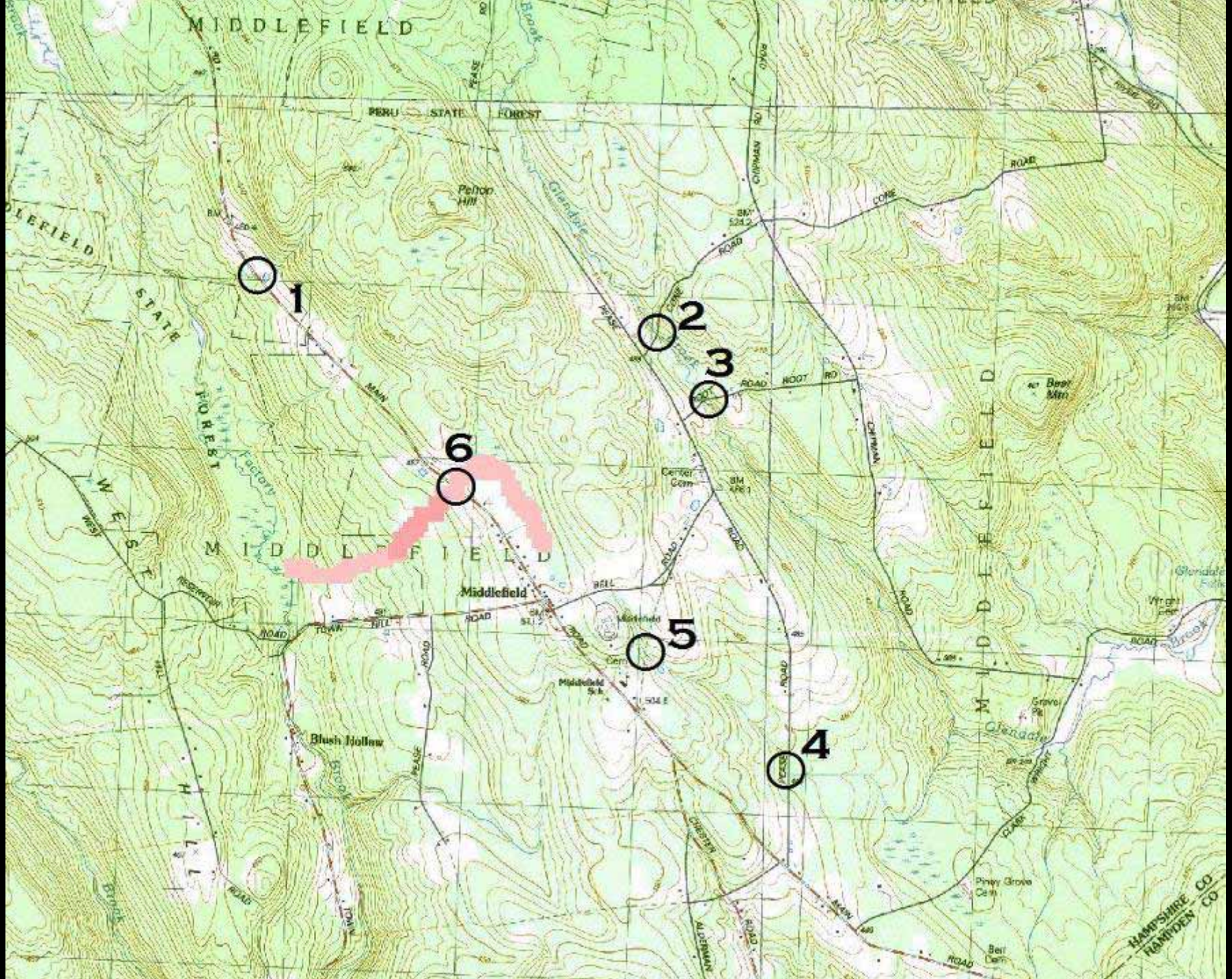

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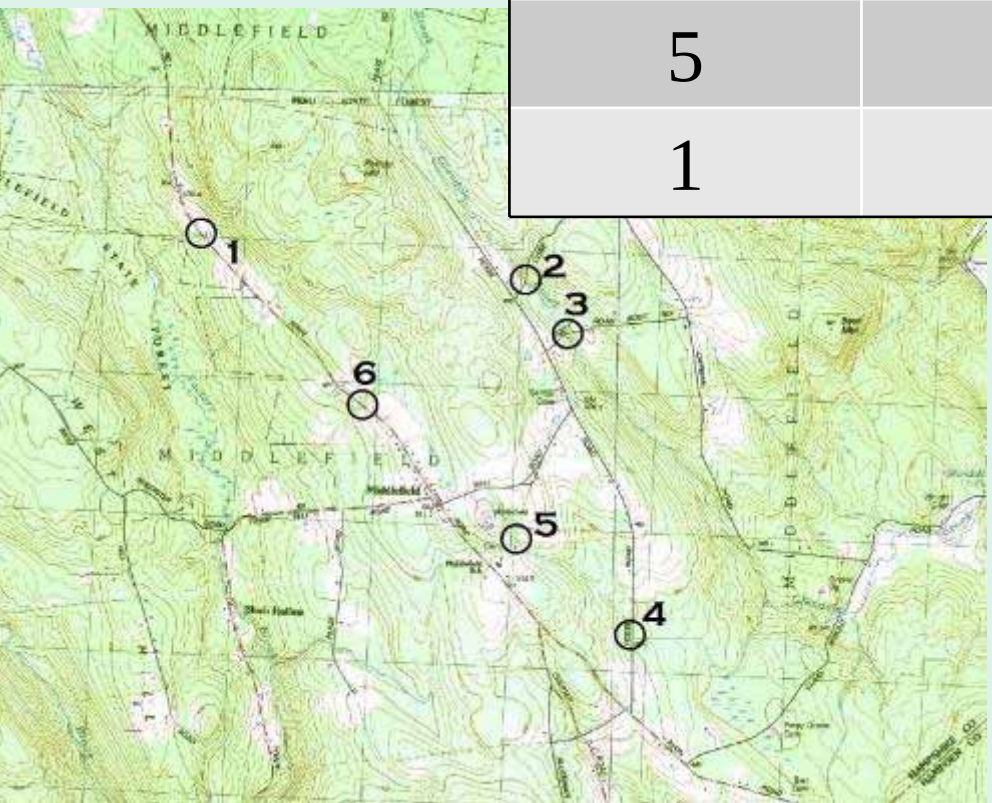
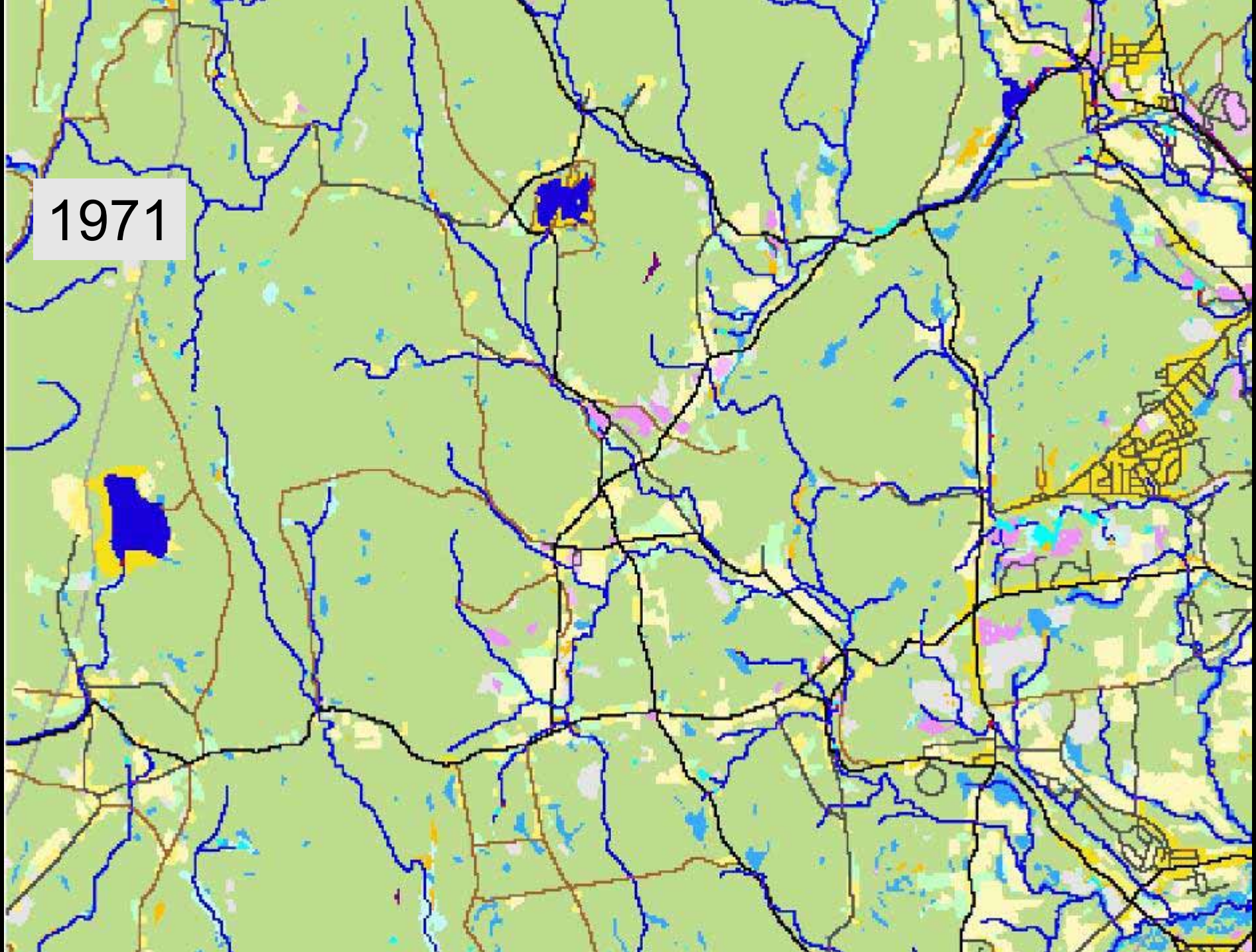
ROOT RD
Bear Mtn
MAIN
Factory
Center Cem
BM 486.1
Middlefield
BELL
TOWN HILL
RESERVOIR
Middlefield Sch
Blush Hollow
Brook
CHESTER
ALDERMAN
CLARK
WRIGHT
Piney Grove Cem
Bell Cem
Wright Cem
Gravel Pit
HAMPSHIRE CO
HAMPDEN CO
1
2
3
4
5
6

Culvert	Increase in Connectedness	Percent of Best
3	1301.12	100
2	813.41	62.5
4	194.60	15.0
6	141.15	10.8
5	117.24	9.0
1	65.25	5.0



Monitor changes in wetland integrity and condition over time

- Assessment of Ecological Integrity
- SLAM/RAM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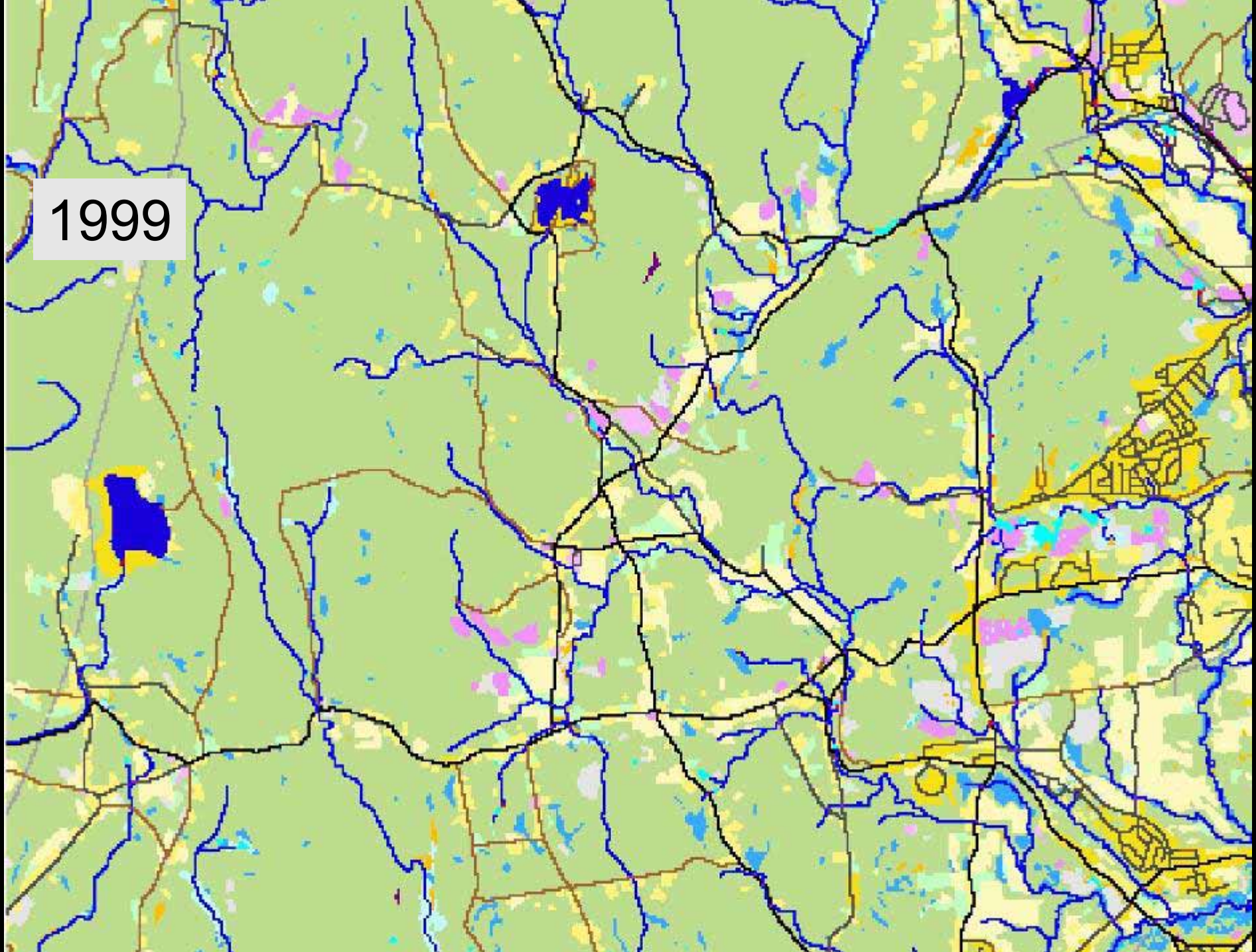
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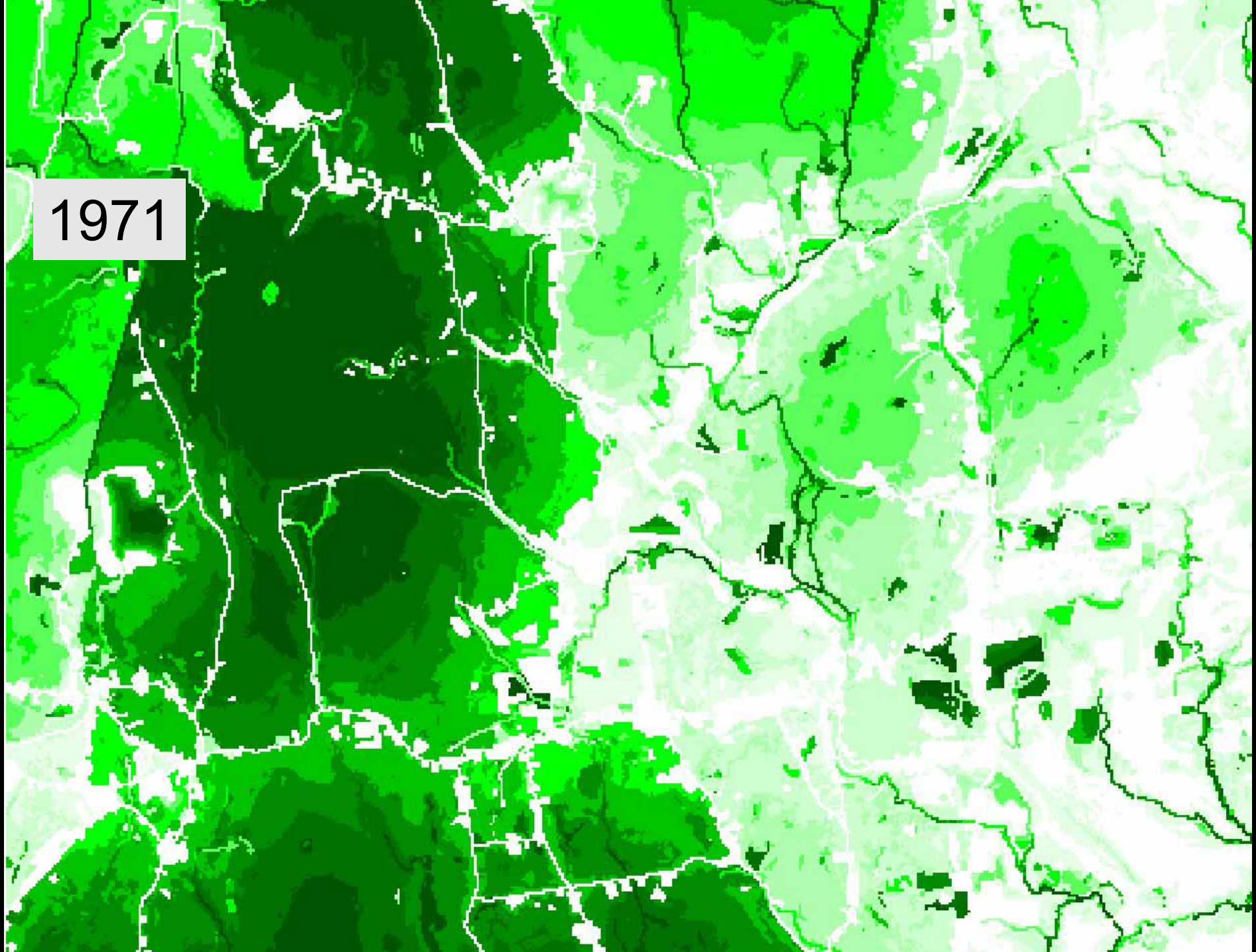
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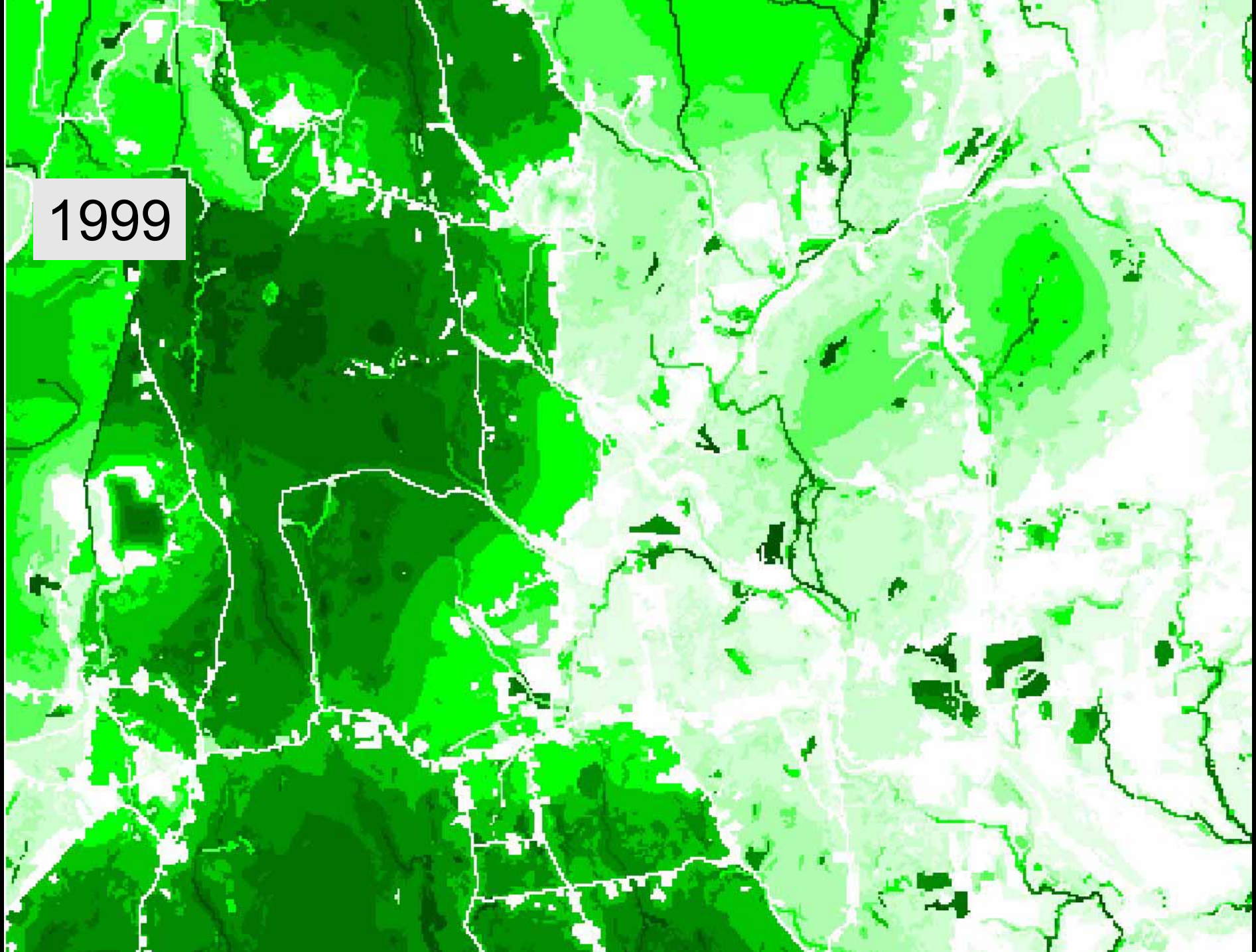
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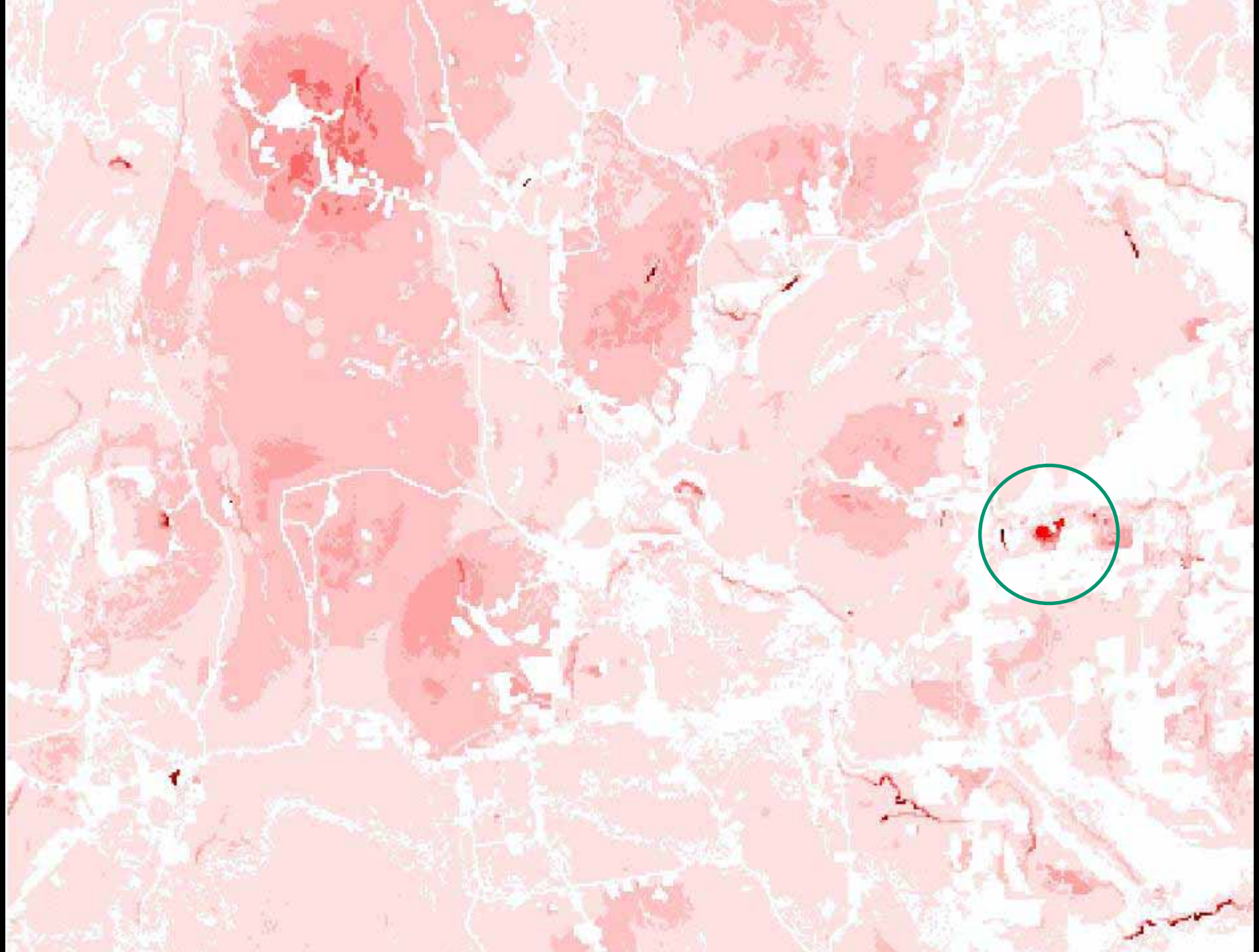
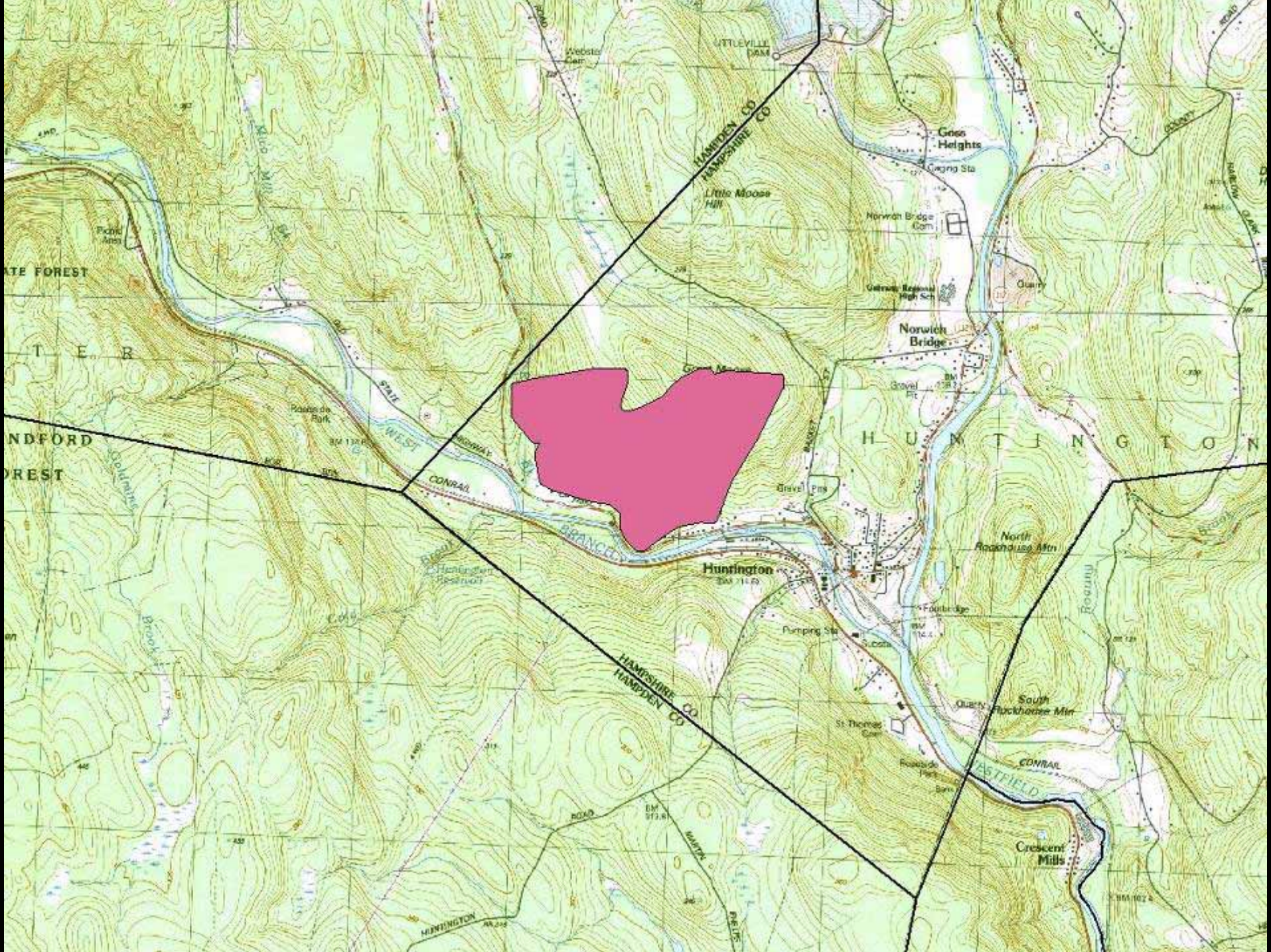


Increase understanding of how development, land protection, and BMPs affect ecological condition

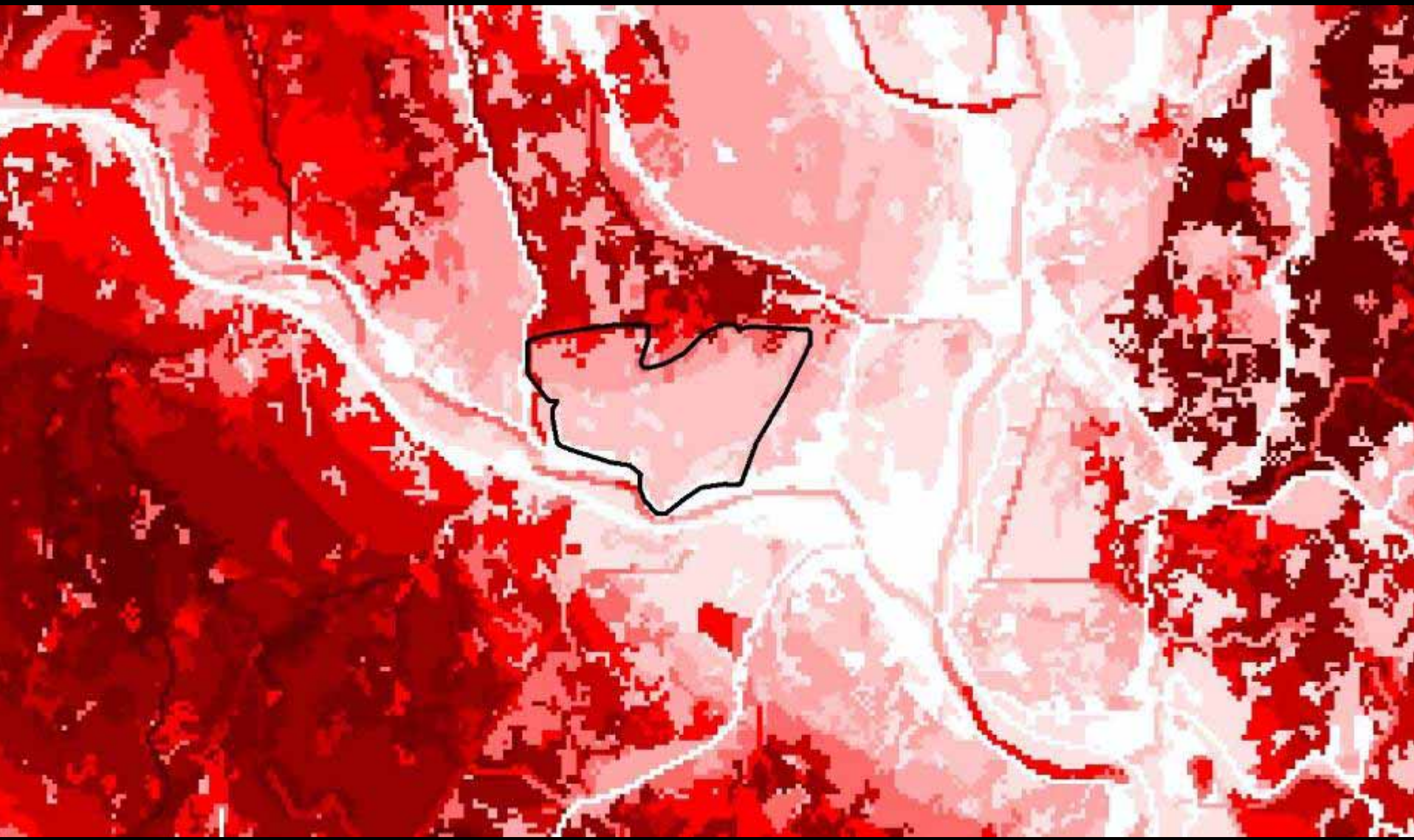
- Assessment of Ecological Integrity
- Stressor mapping
- Scenario analysis

Webster Corp
LITTLEVILLE DAM
HAMPDEN CO
HAMPSHIRE CO
Goss Heights
Gaging Sta
Little Moose Hill
Norwich Bridge Corn
Picnic Area
Old State Highway
Norwich Bridge
Great Moose Hill
Gravel Pit
Roaring Brook
Roaring Brook Valley
Roadside Park
Gaging Sta
Foodbridge
CONRAIL
WEST BRANCH
Huntington
Gravel Pits
North Rockhouse Mtn
Foodbridge
Pumping Sta
St. Cobb
Quarry
South Rockhouse Mtn
St. Thomas Corn
Roadside Park
CONRAIL
EASTFIELD
Crescent Mills
HUNTINGTON
MARTIN
ROAD
Huntington Reservoir
Brook
Stoddard
Rico Mill Brook
Quarry
Gilman Regional High Sch
Quarry
Roaring Brook
Roaring Brook
Roaring Brook

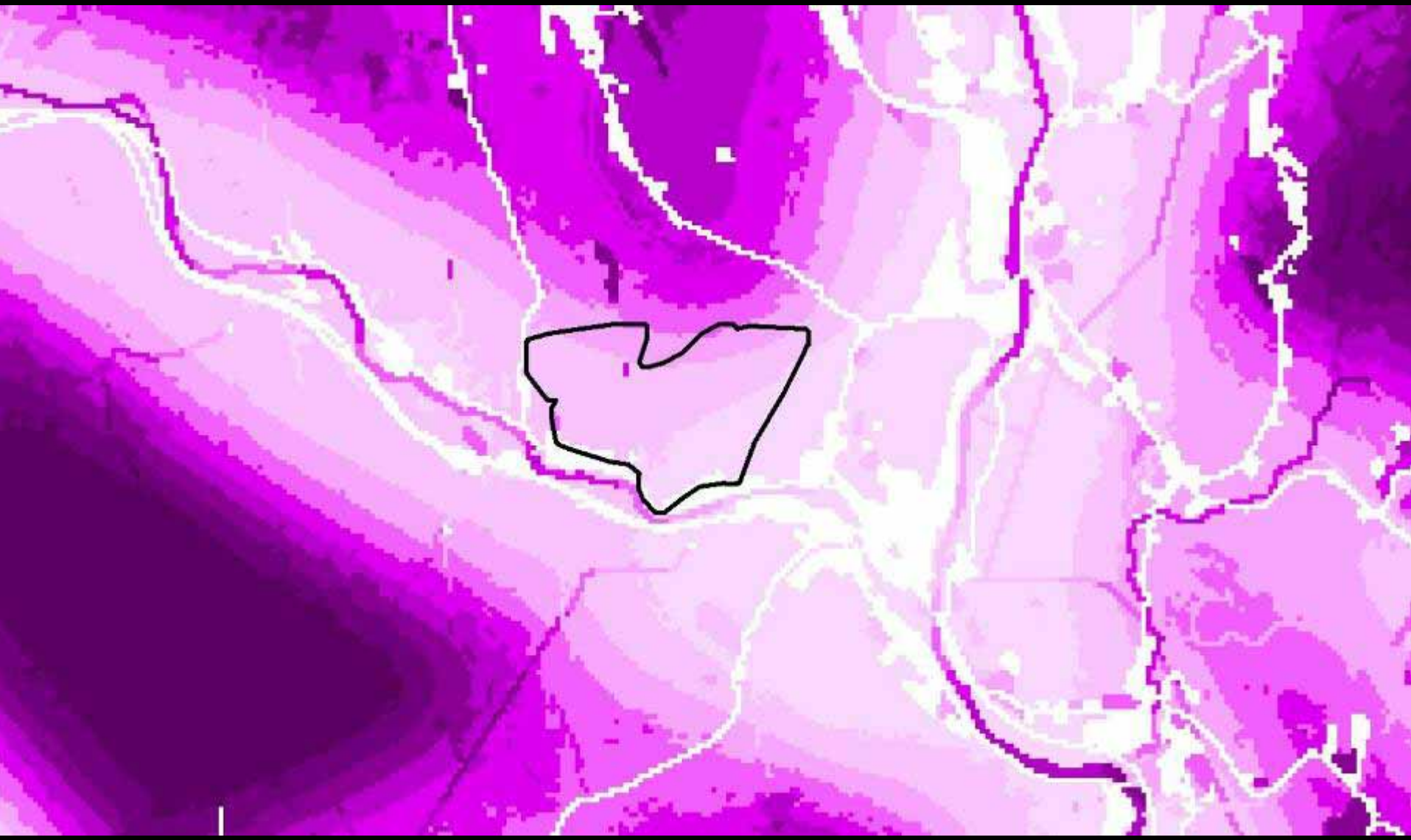


UTTLEVILLE DAM
Webster Cem
HAMPDEN CO
HAMPSHIRE CO
Goss Heights
Little Moose Hill
Norwich Bridge Cem
Norwich Bridge
Gravel Pit
Gravel Pits
H U N T I N G T O N
North Rockhouse Mtn
Huntington
Fourbridge
Pumping Sta
Substa
South Rockhouse Mtn
St Thomas Cem
Crescent Mills
CONRAIL
WESTFIELD
HAMPSHIRE CO
HAMPDEN CO
ATE FOREST
NDFORD
OREST
Roadside Park
Picnic Area
Goldmine
Brook
Cole
Roaring

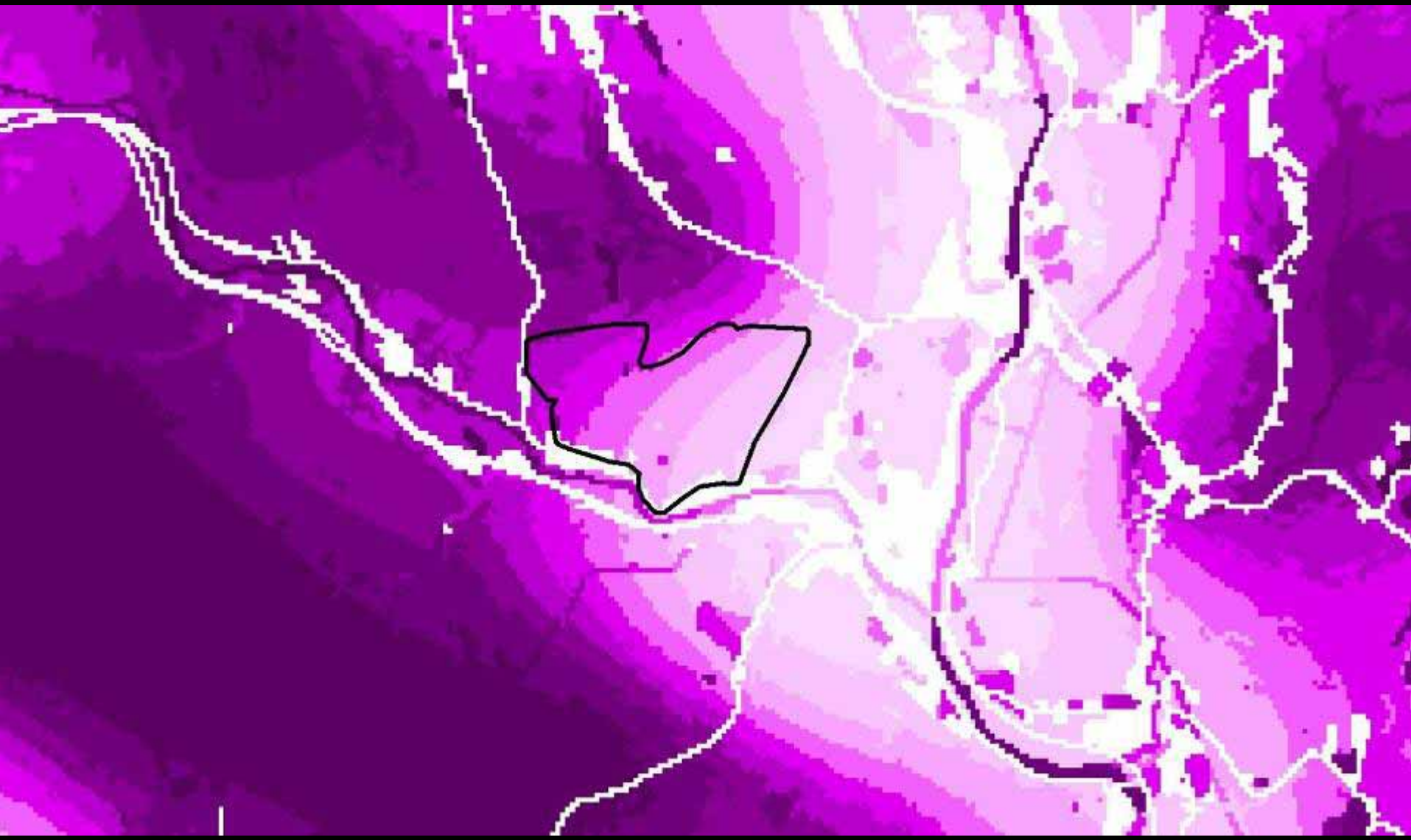
Index of Ecological Integrity (IEI)



Road Intensity



Development Intensity



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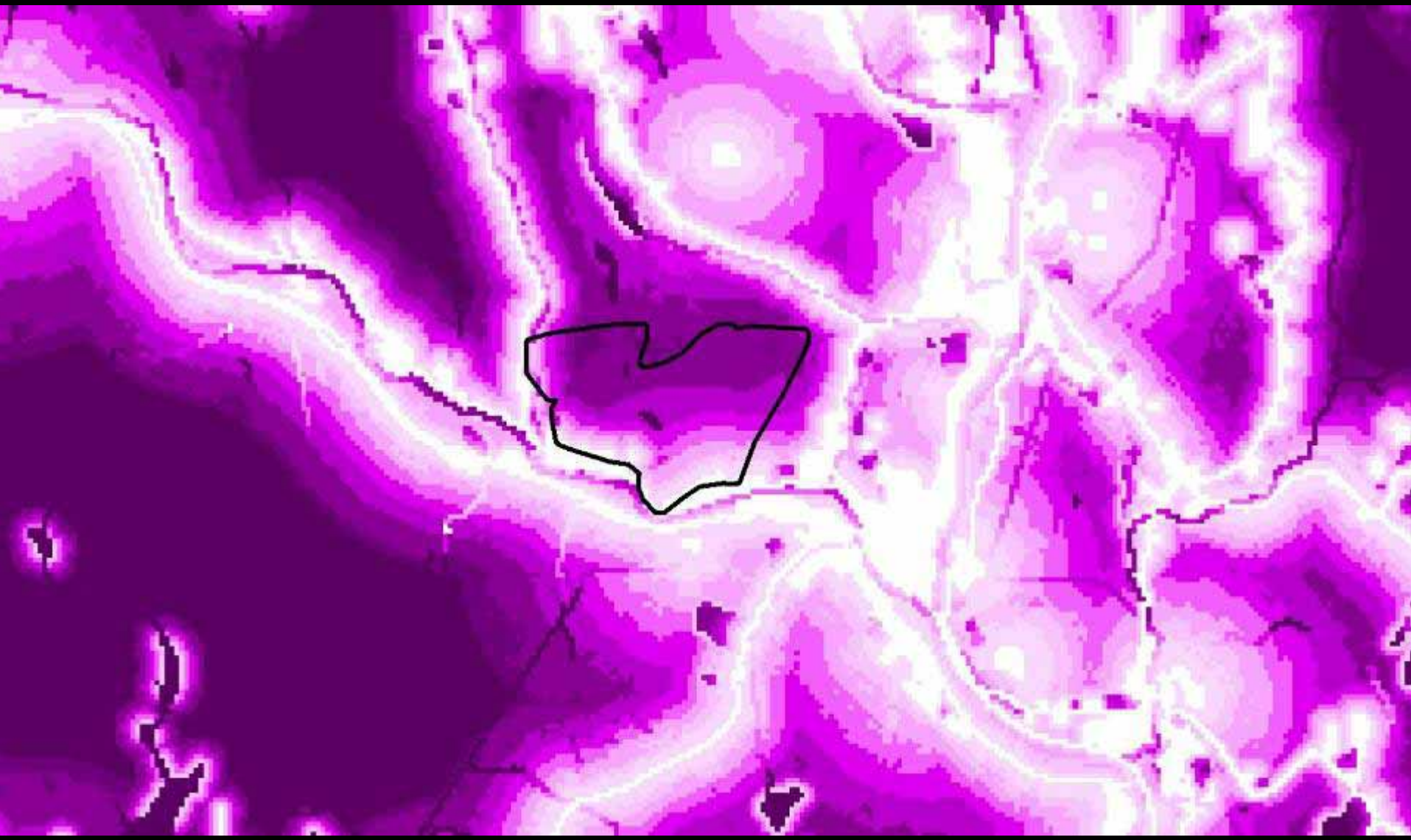
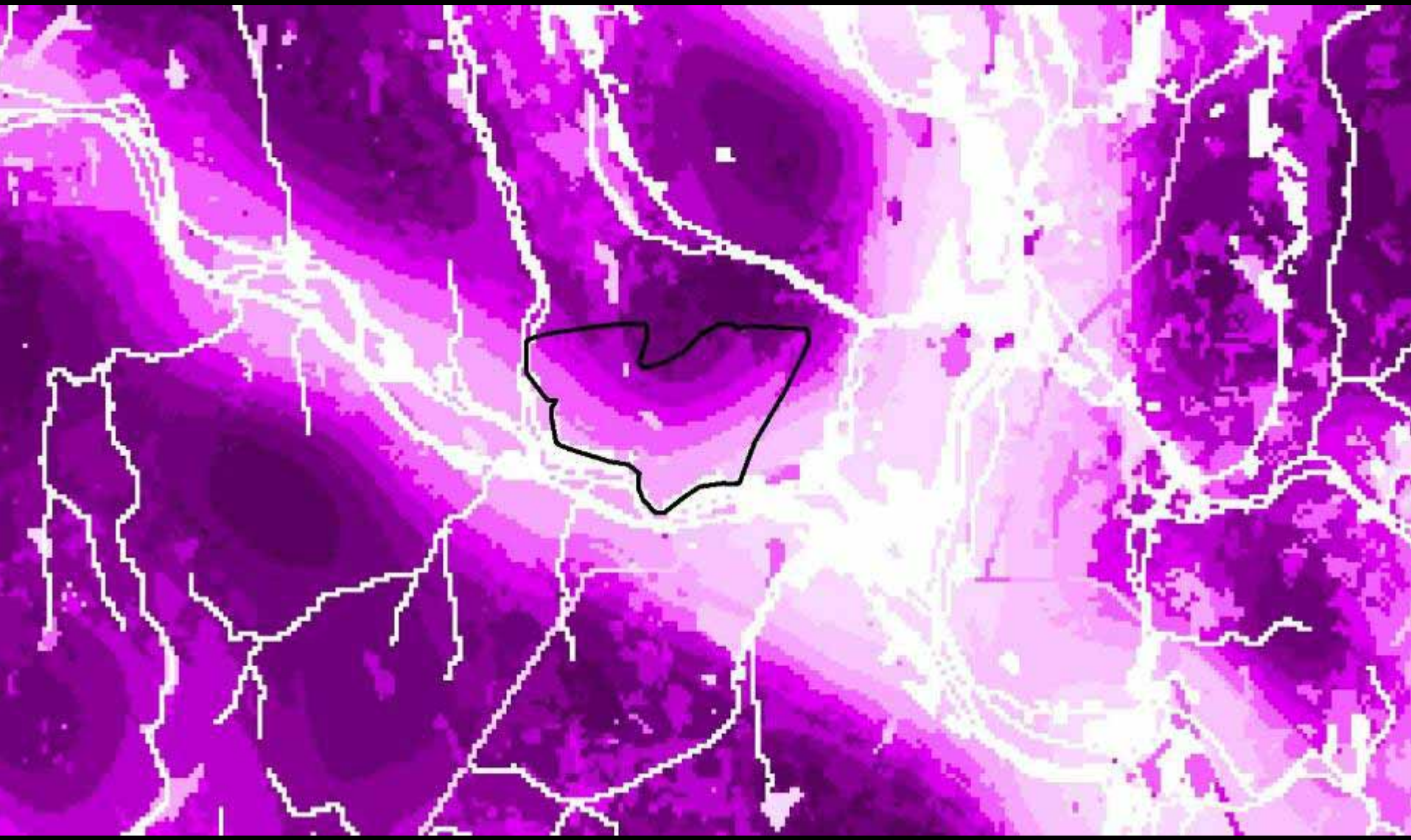
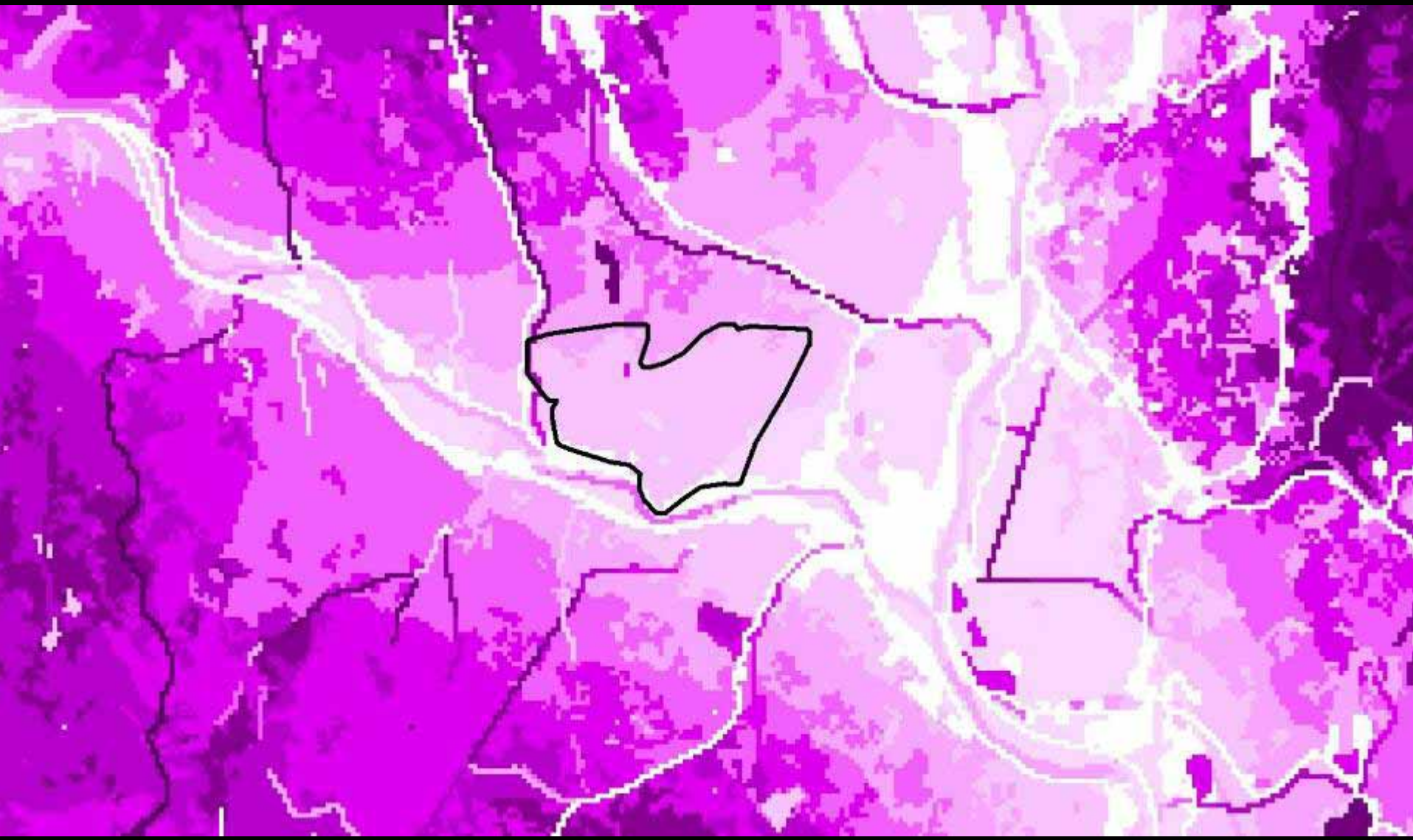


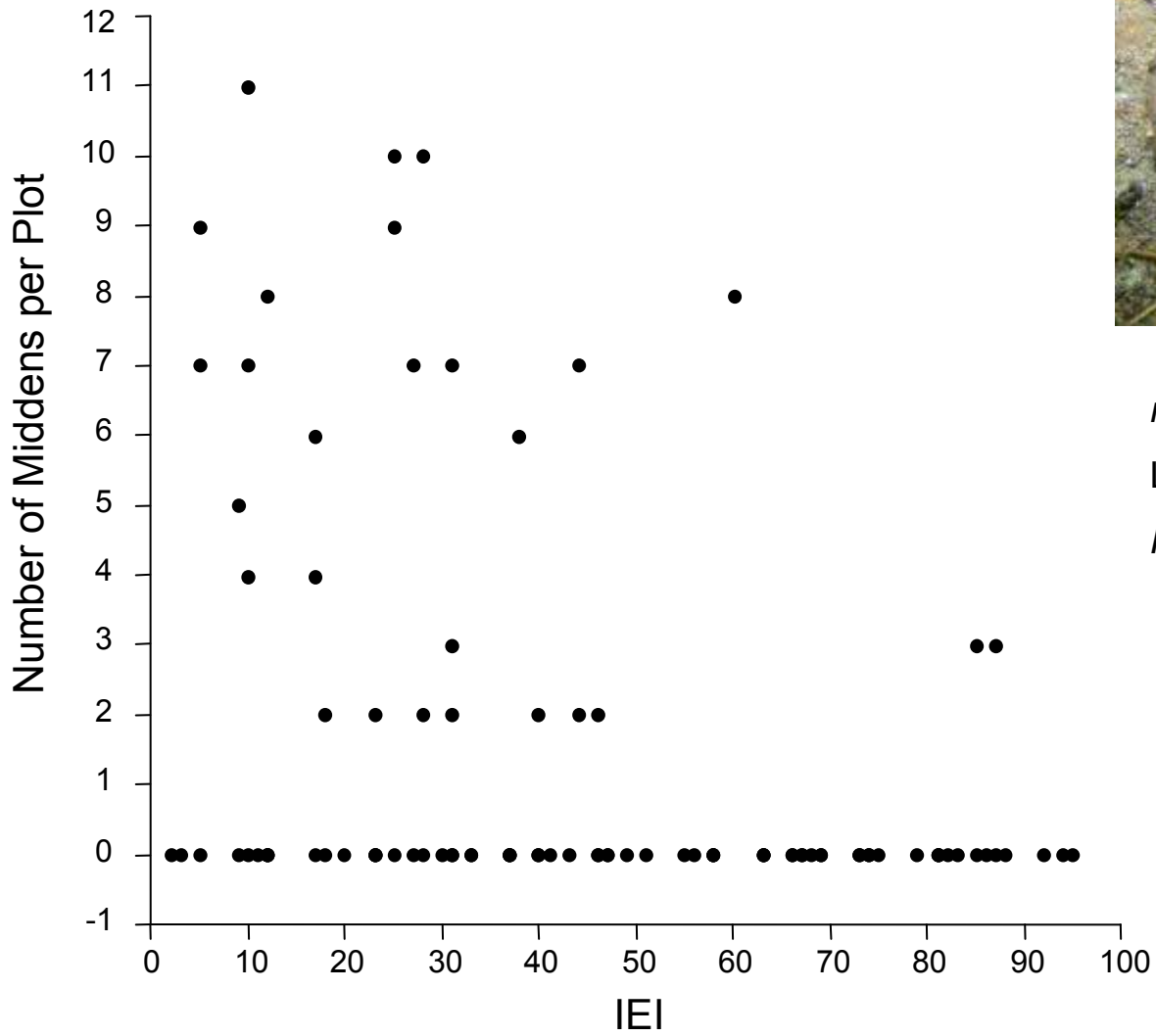
Similarity



Connectedness



Lumbricus terrestris – Upland Forests
Deerfield Watershed

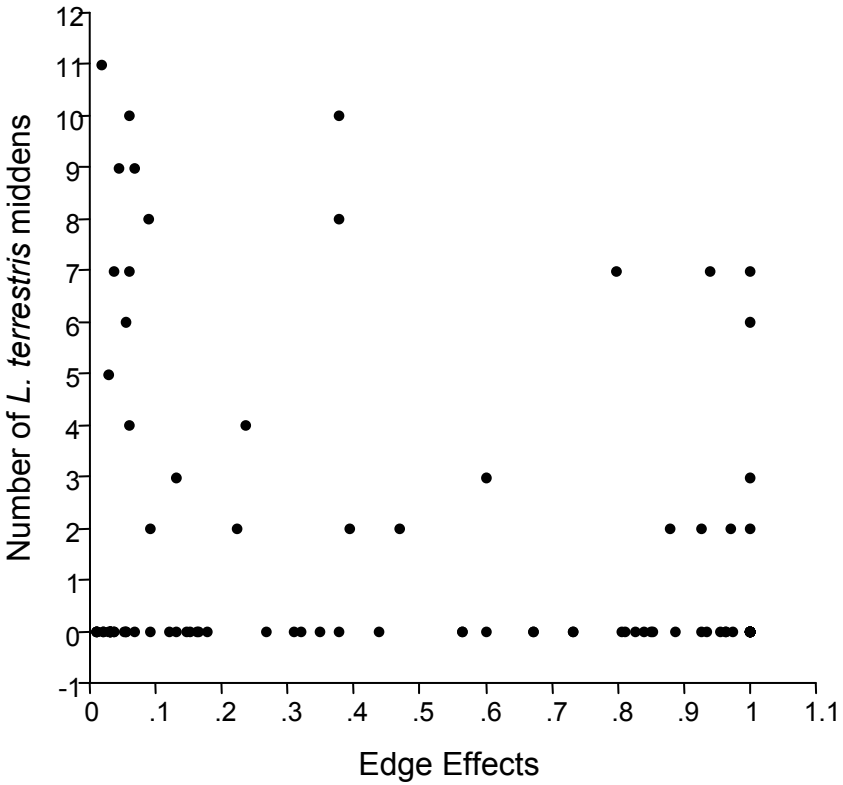


n = 96

Logistic Regression

P = 0.0003, ρ^2 = .10

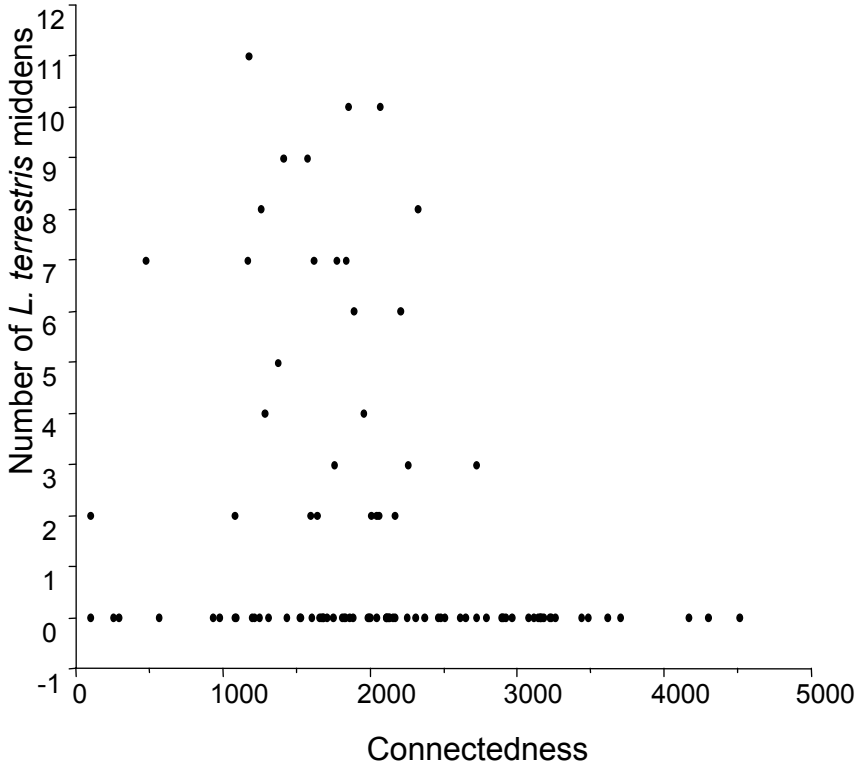
Lumbricus terrestris – Upland Forests
Deerfield Watershed



n = 96

Logistic Regression

P = 0.09, ρ^2 = .02



n = 96

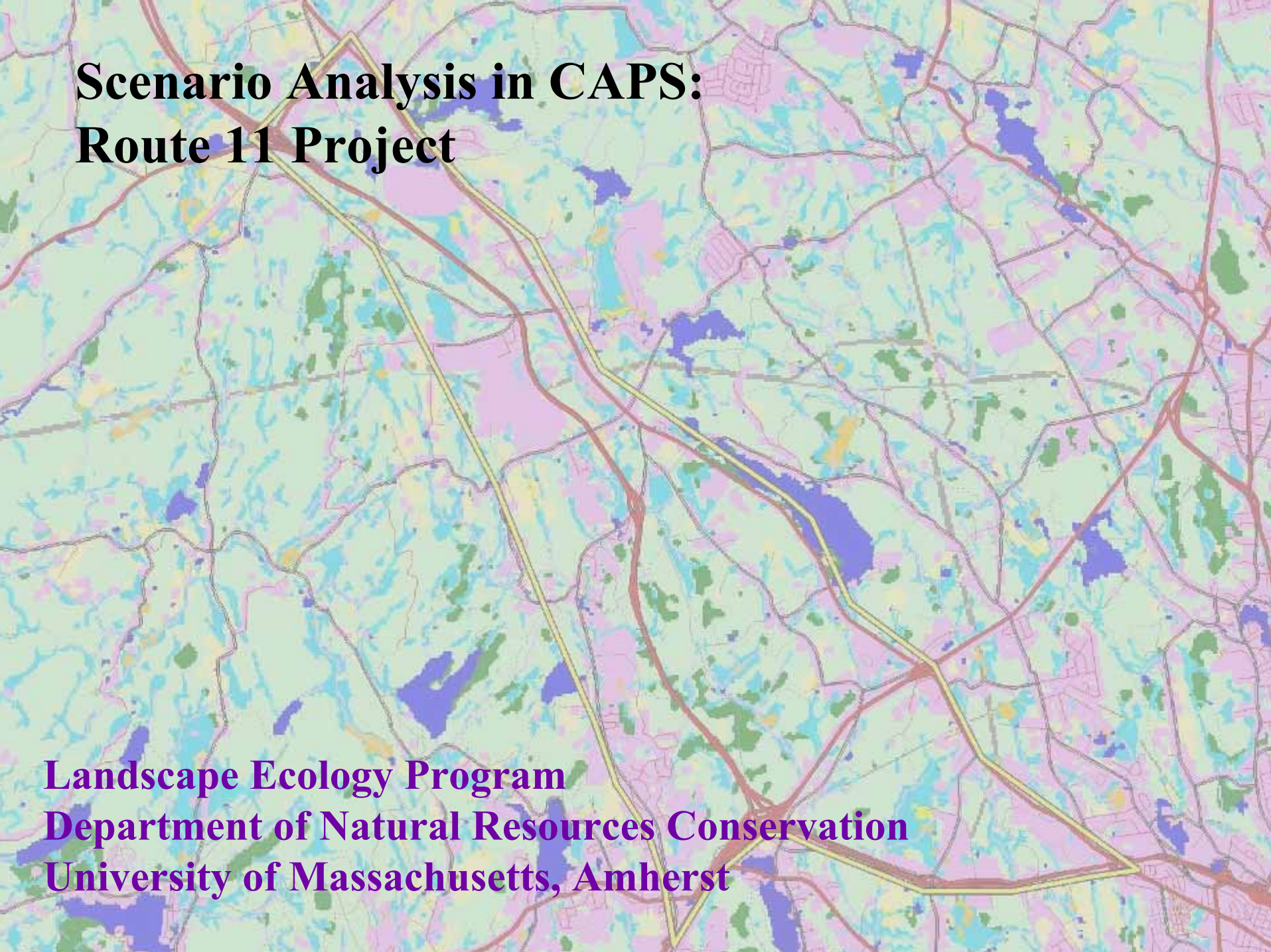
Logistic Regression

P = 0.0005, ρ^2 = .09

Project review, permitting and mitigation design

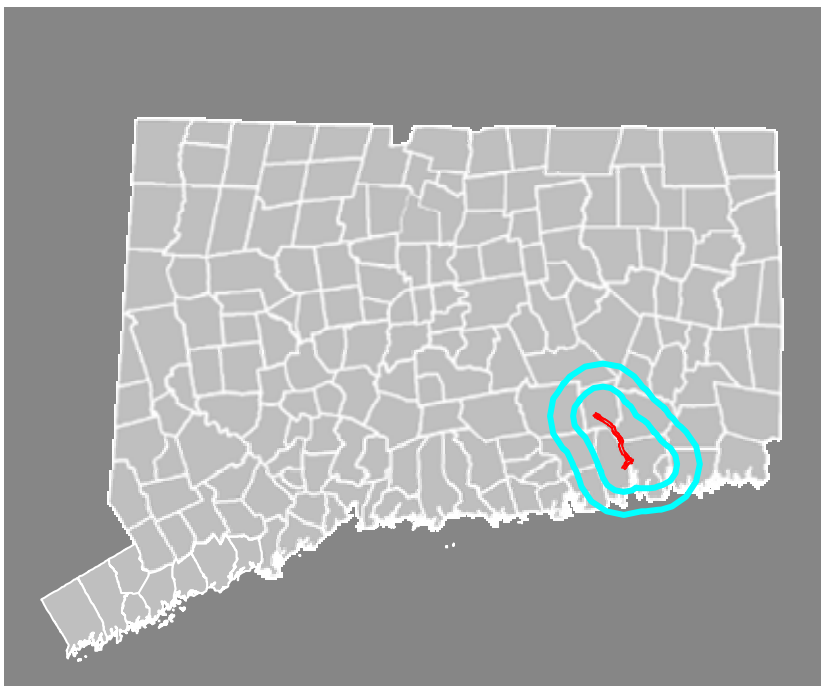
- Scenario Analysis
- SLAM/RAM

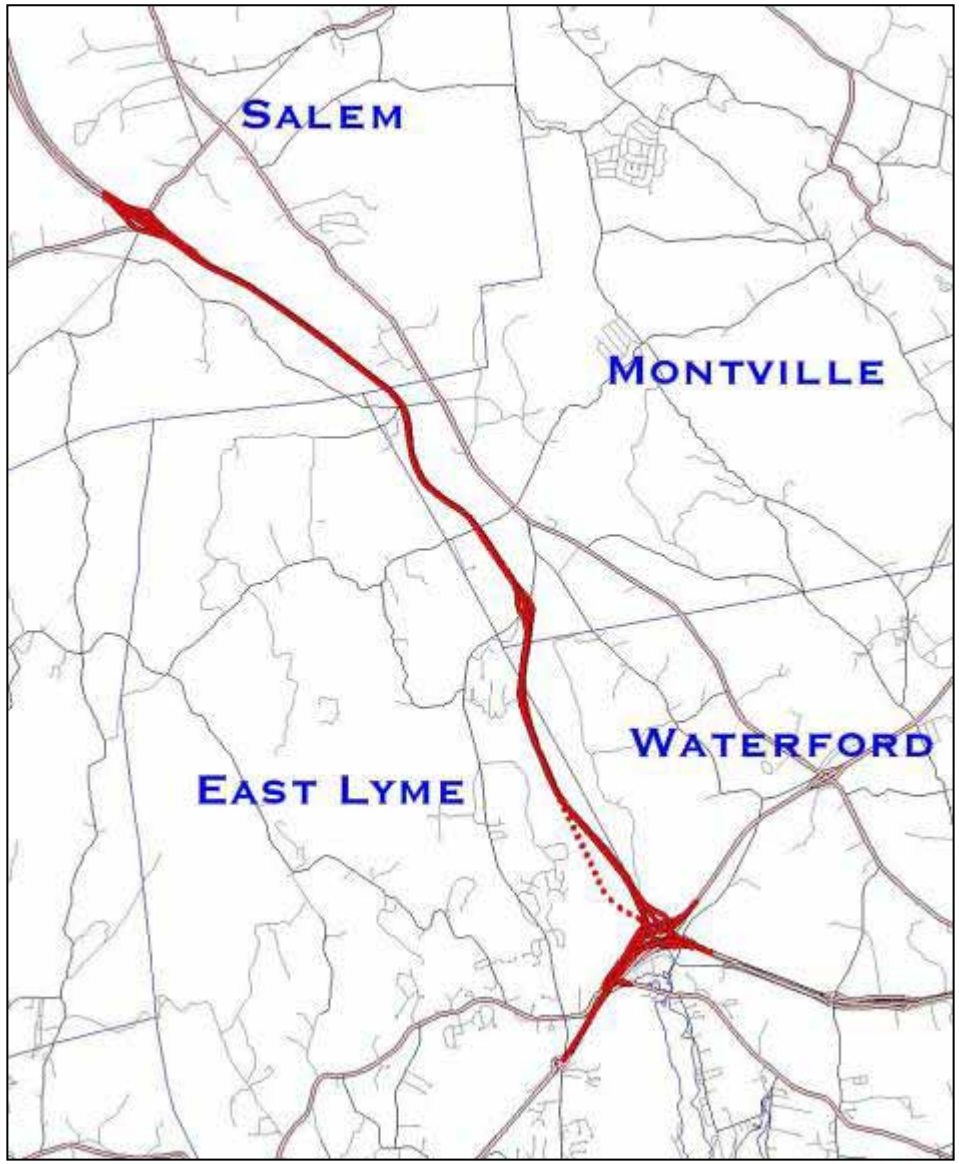
Scenario Analysis in CAPS: Route 11 Project

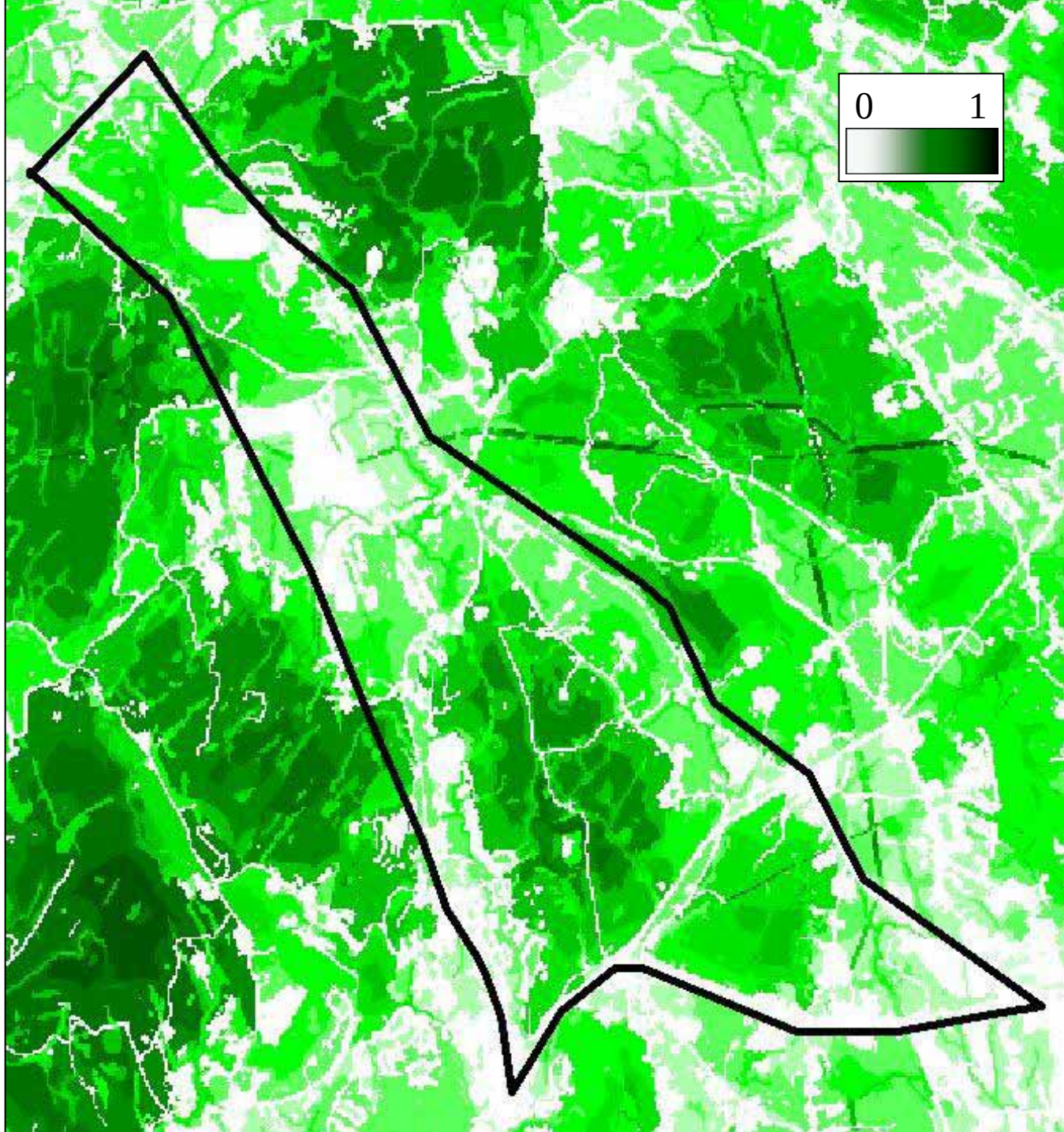


Landscape Ecology Program
Department of Natural Resources Conservation
University of Massachusetts, Amherst

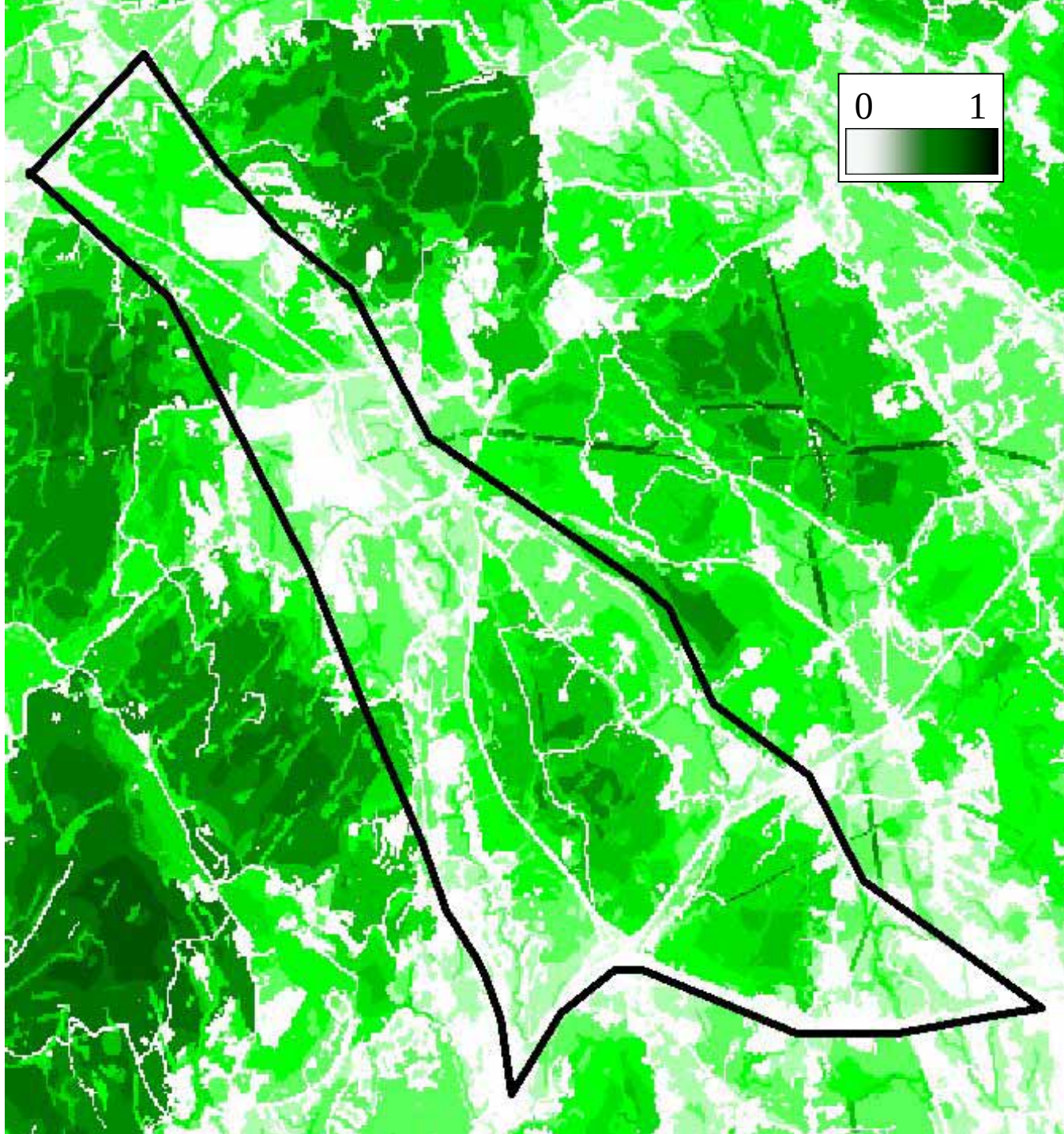
Route 11 Extension







Biodiversity value
Base scenario



Biodiversity value
With Route 11 v3

Results: 3 highway alternatives

	Δ Ecological Integrity		
Community	**v1**	**v3**	**v3 (np)**
Deciduous forest	442	474	621
Coniferous forest	59	70	86
Forested wetland	73	75	98
Powerline shrubland	2	2	2
Non-forested wetland	4	4	5
Farmed wetland	3	3	4
Headwater stream	13	13	14
Perennial stream	36	36	39
Coastal river	3	3	3
Pond or lake	4	4	4
TOTAL	638	686	876

Funding and Other Support Provided by:

MA Office of Energy & Environmental Affairs

Federal Highway Administration

US Environmental Protection Agency

MA Natural Heritage & Endangered Species Program

The Nature Conservancy

MA Department of Environmental Protection

The Trustees of Reservations

Massachusetts Audubon Society

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