



## Critical Linkages:

Identifying Culvert Replacement  
Priorities for Maintaining Connectivity  
of Cold Water Fish Habitat in the Face  
of Climate Change



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Kevin McGarigal,  
and  
Brad Compton



# Evaluating Restoration Potential for Aquatic Barrier Removal

- Habitat quality
  - Occupancy
  - Habitat suitability
  - Habitat condition/ecological integrity
- Enhanced connectivity
  - Stream miles
  - Connectivity metric

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# 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 Lab**



<http://www.umasscaps.org>



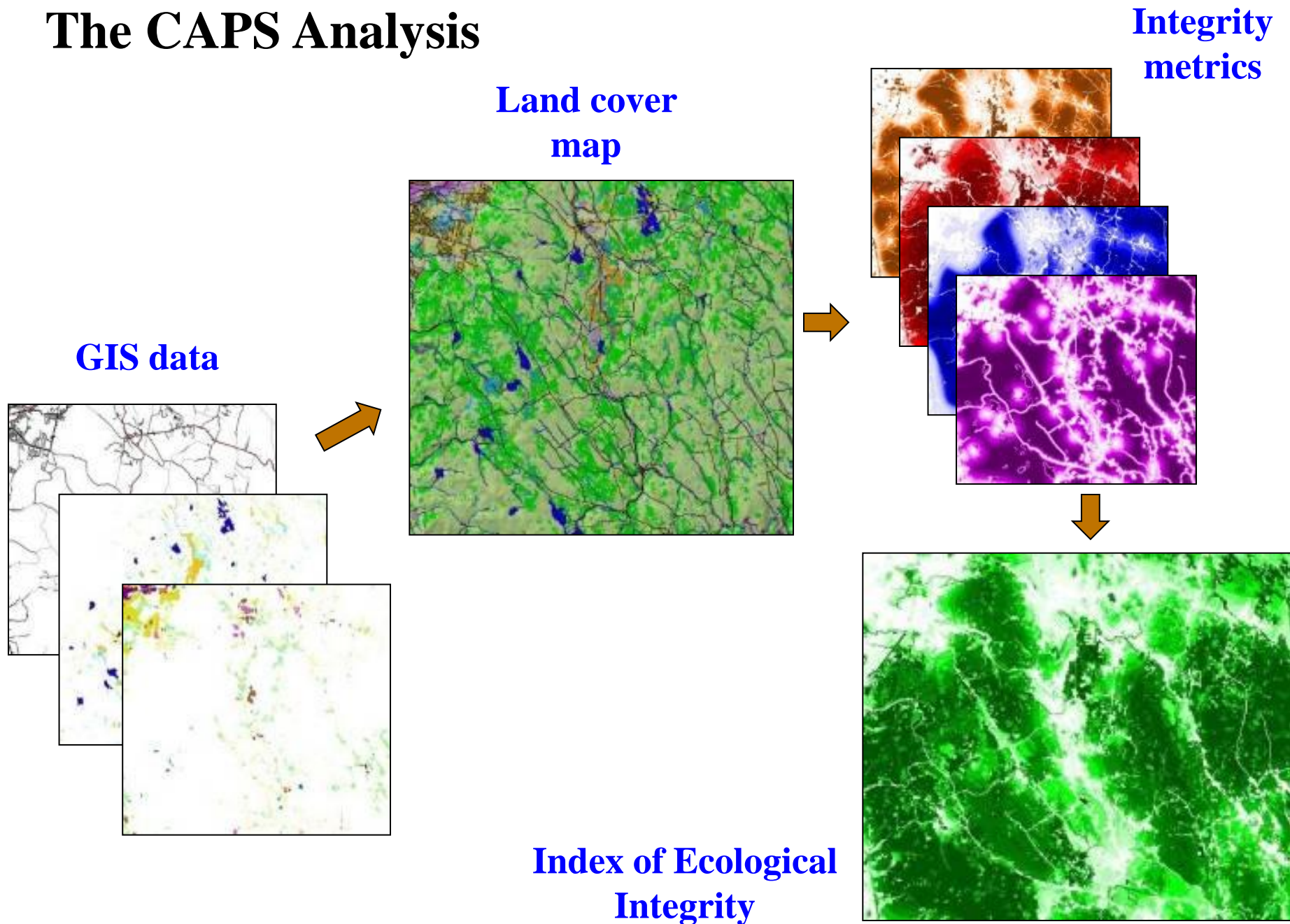


# Ecological Community Approach

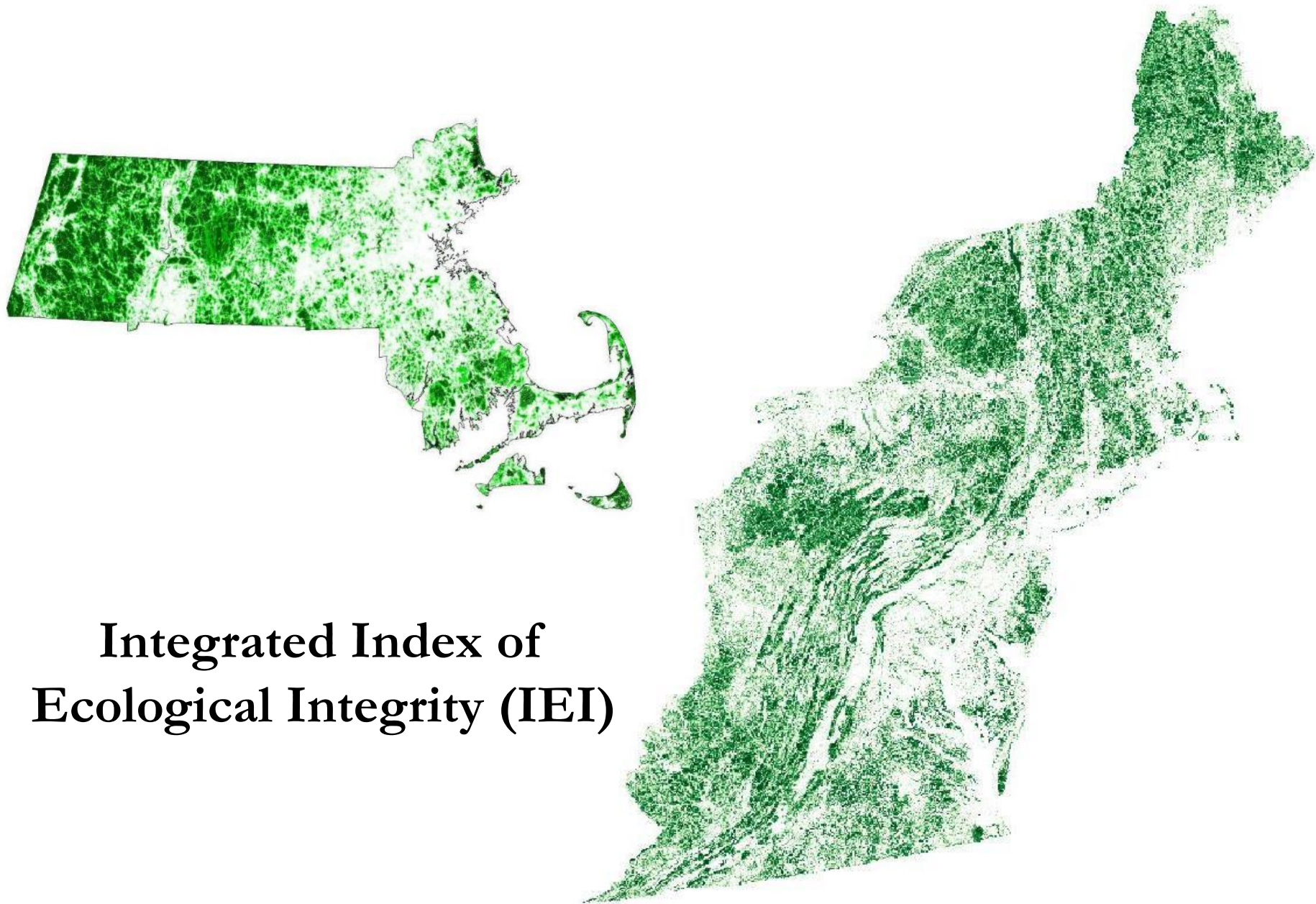




# The CAPS Analysis







**Integrated Index of  
Ecological Integrity (IEI)**

# CAPS Integrity Metrics

## Stressor metrics

Road Traffic  
Habitat loss  
Microclimatic alterations  
Mowing & plowing intensity  
Domestic predators  
Edge predators  
Non-native invasive plants  
Non-native invasive earthworms  
Tidal restrictions  
Salt marsh ditching  
Coastal structures  
Beach pedestrian traffic  
Beach ORVs  
Boat traffic intensity  
Emissions intensity

## Watershed-based stressor metrics

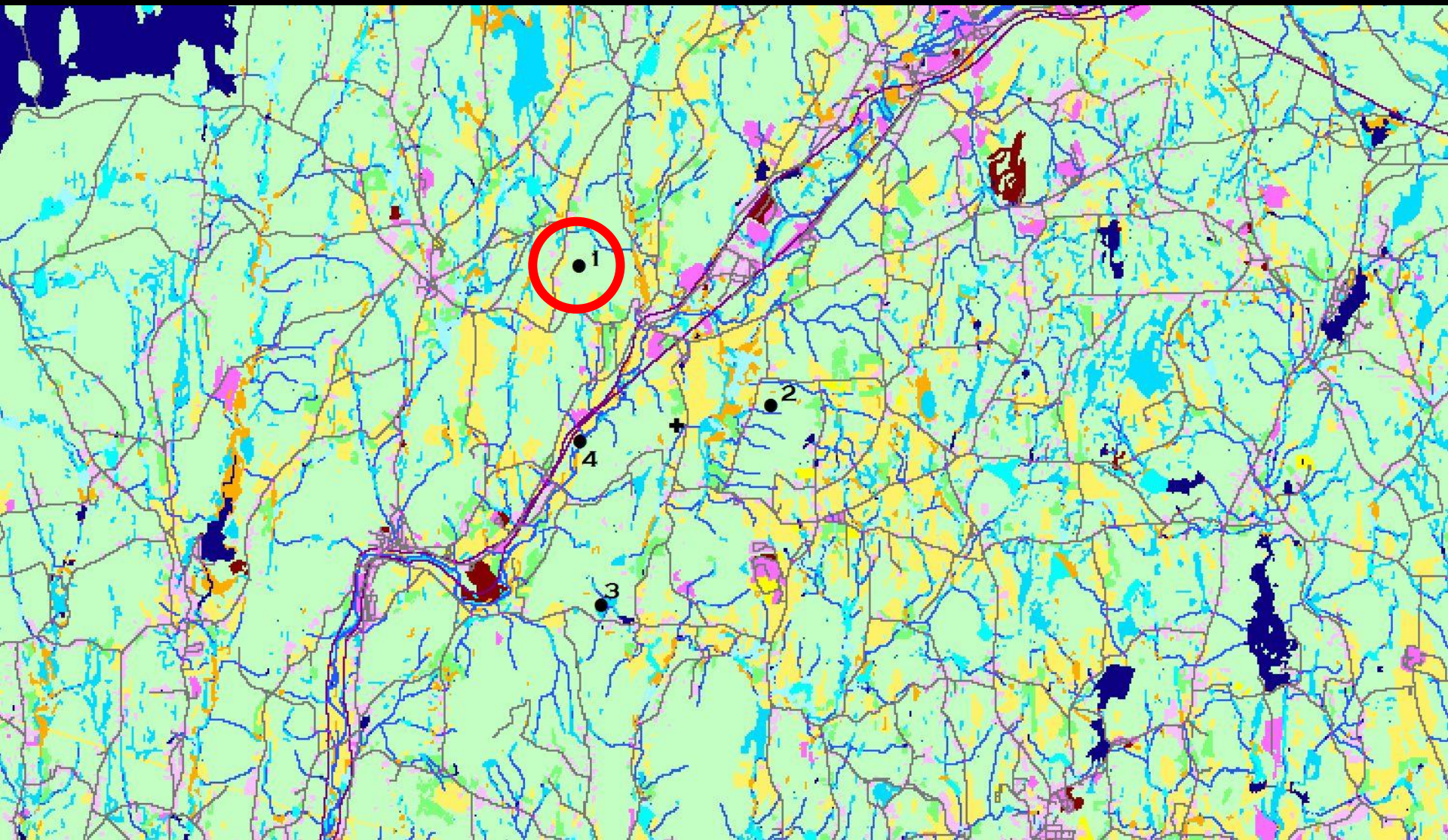
Road salt  
Road sediment  
Nutrient enrichment  
Dam intensity  
Watershed habitat loss  
Imperviousness  
Hydrological alterations  
Impounded  
Percent impounded  
Altered stream geomorphology  
Stream temperature alteration

## Resiliency metrics

Similarity  
Connectedness  
Aquatic connectedness



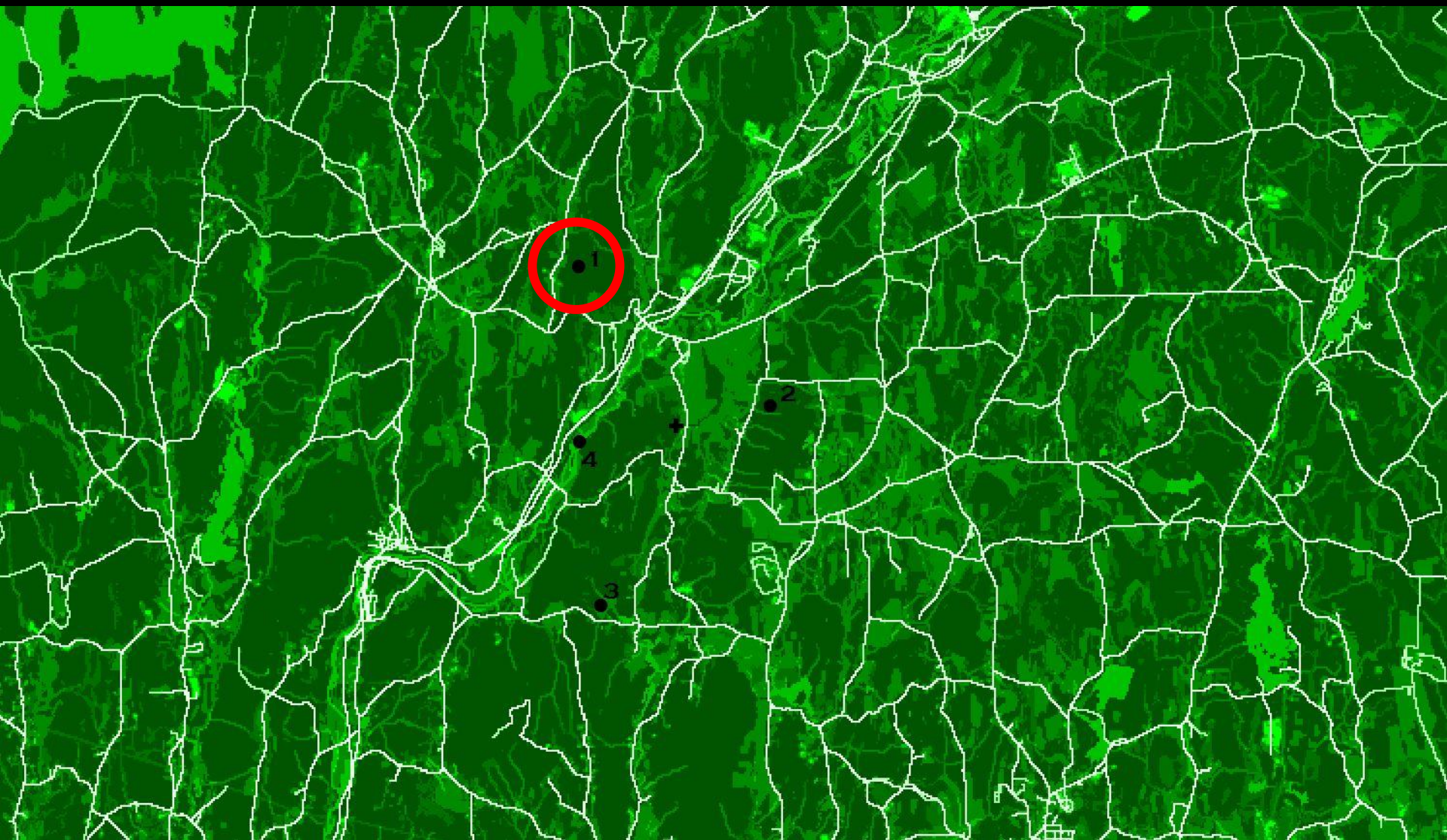
# Land Cover





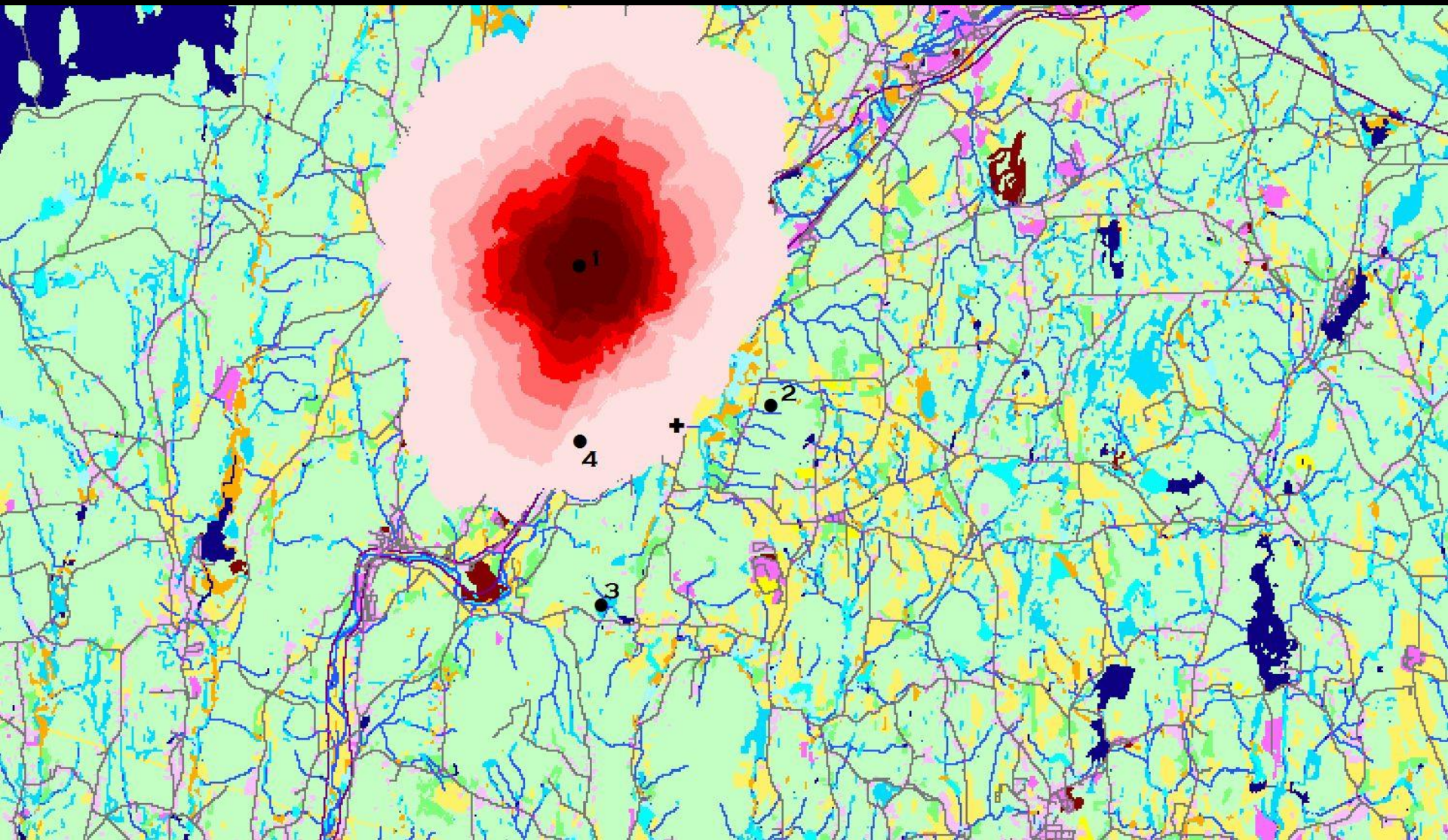
Resistant Surface

Cell #1: Forest





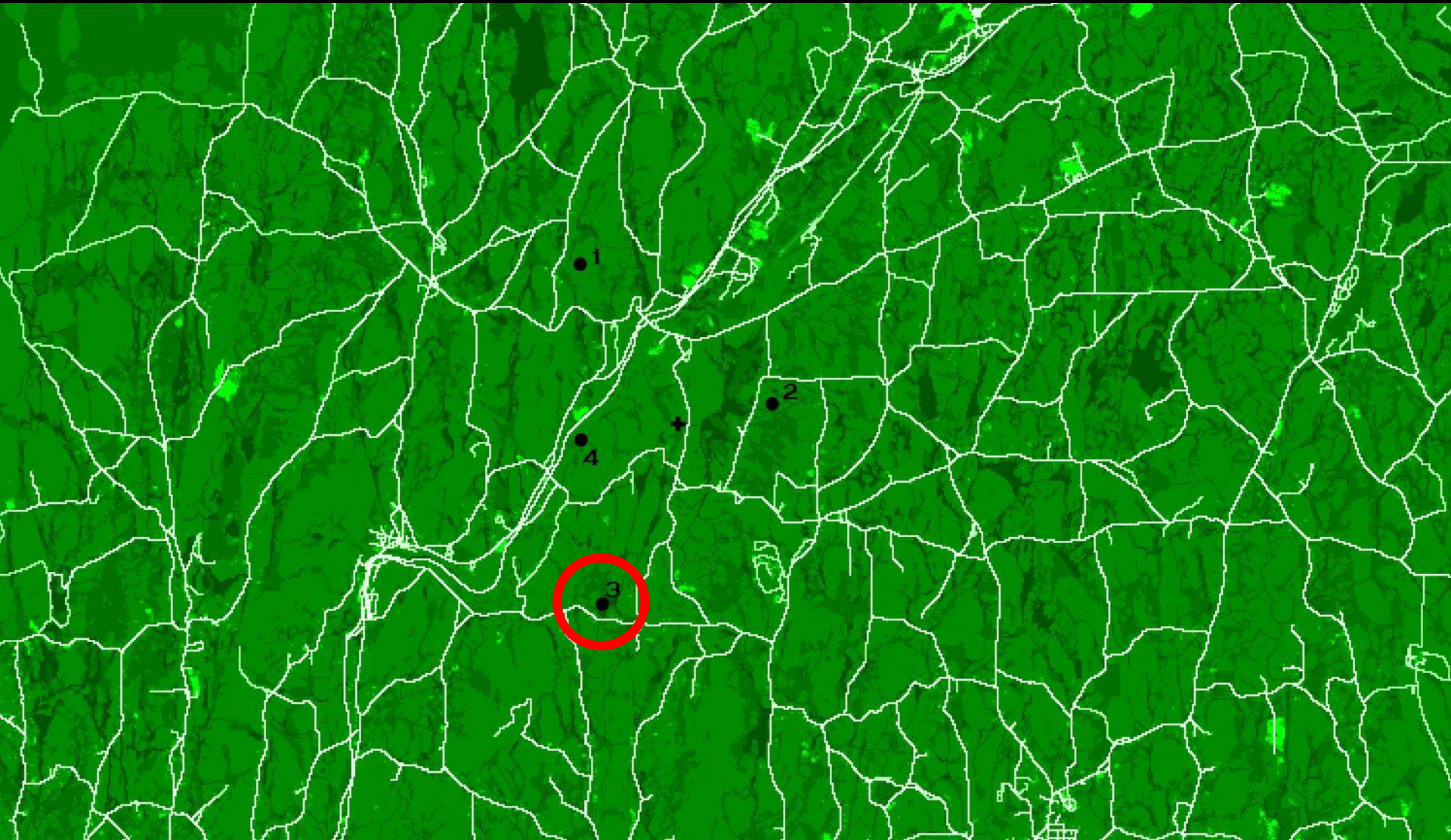
# Resistant Kernel





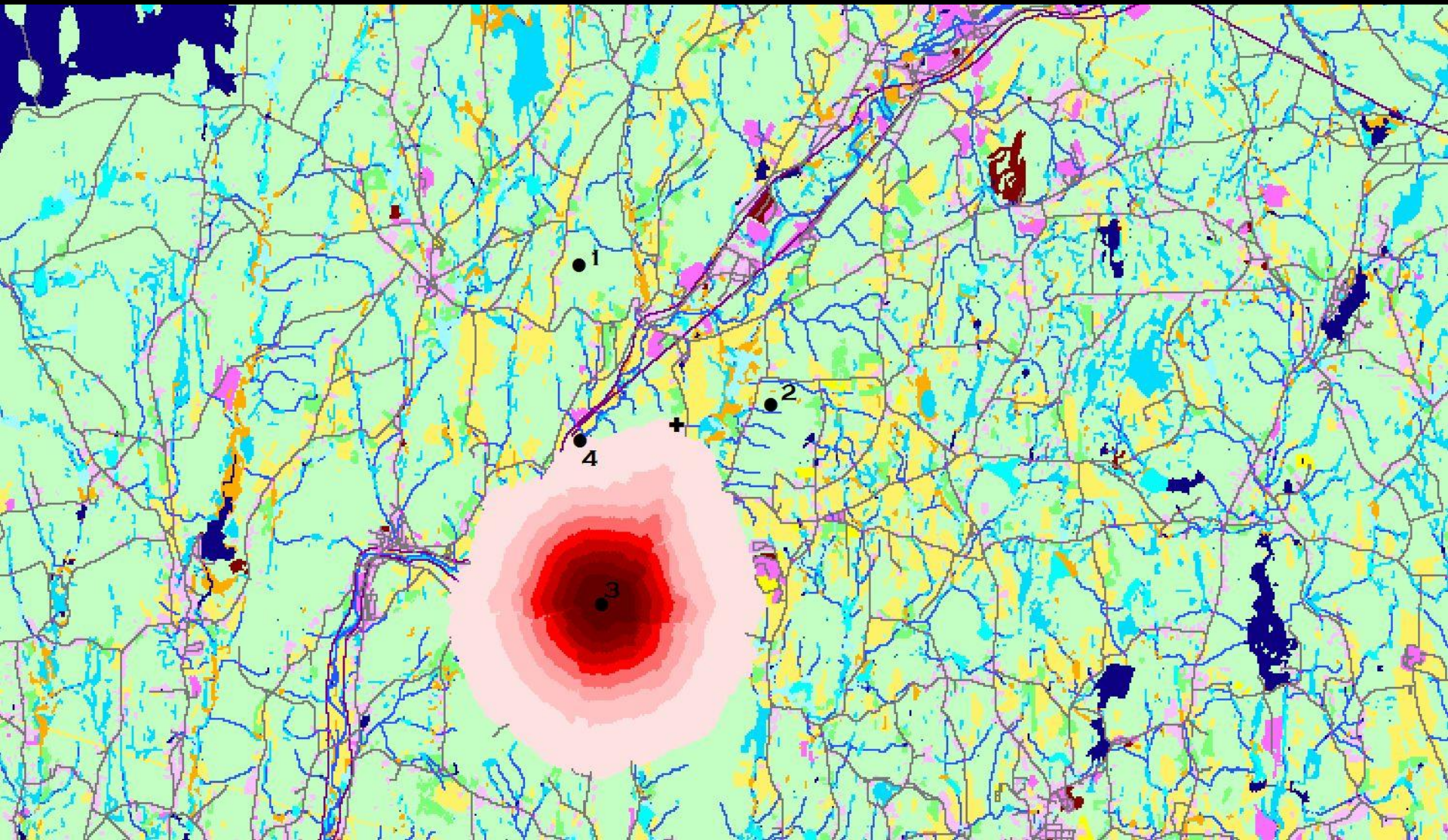
Resistant Surface

Cell #3: Forested Wetland





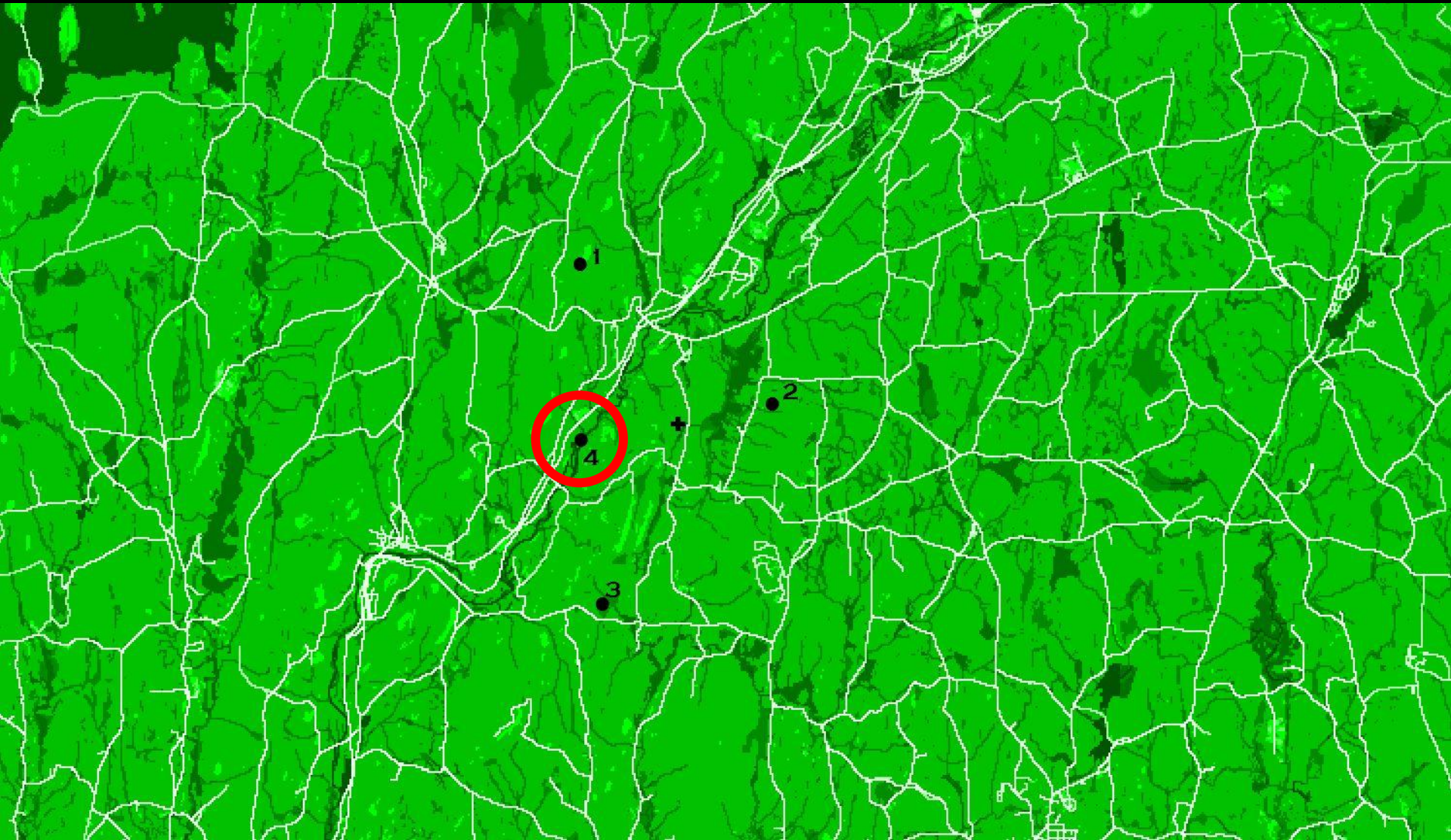
# Resistant Kernel





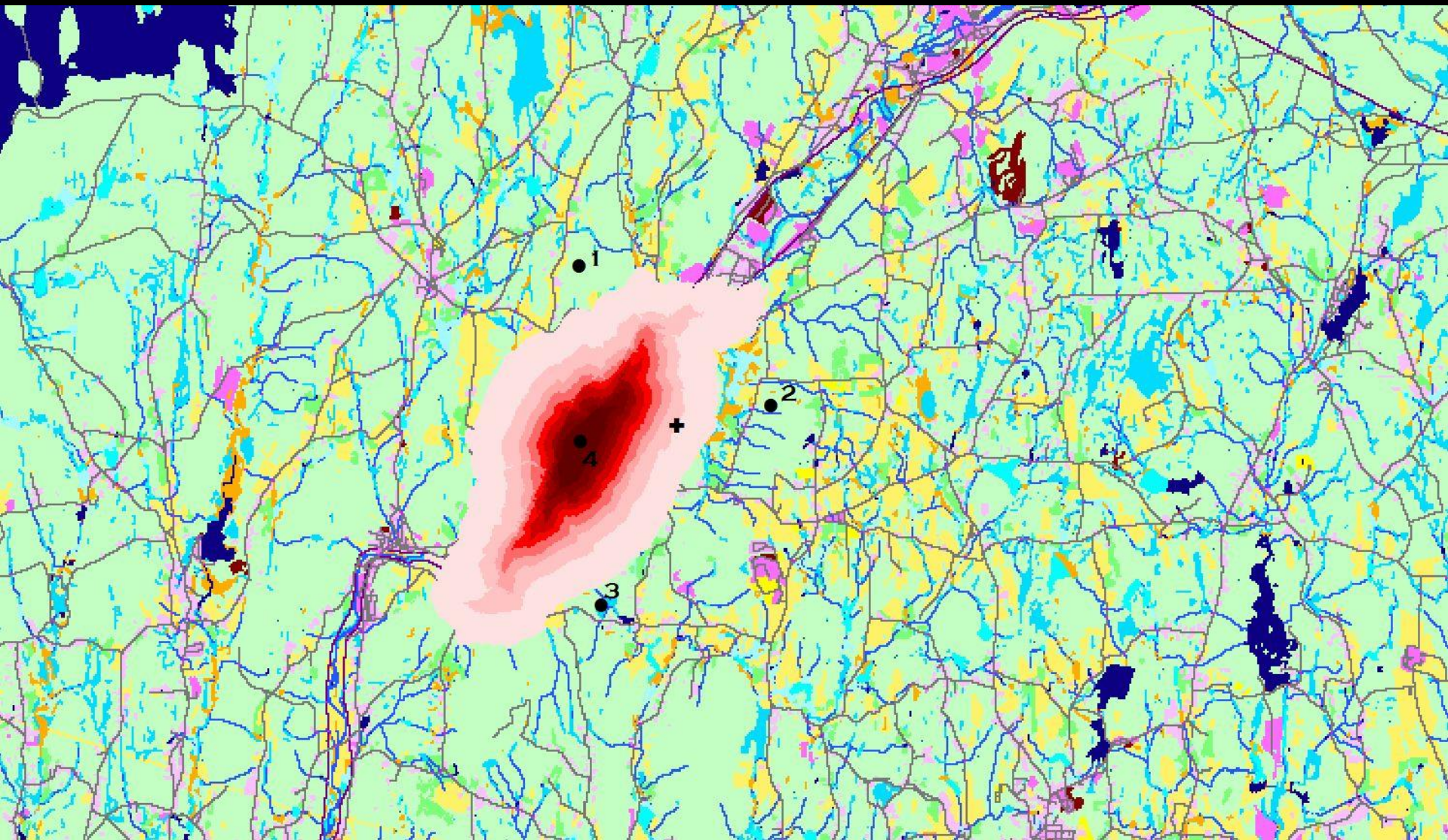
Resistant Surface

Cell #4: River

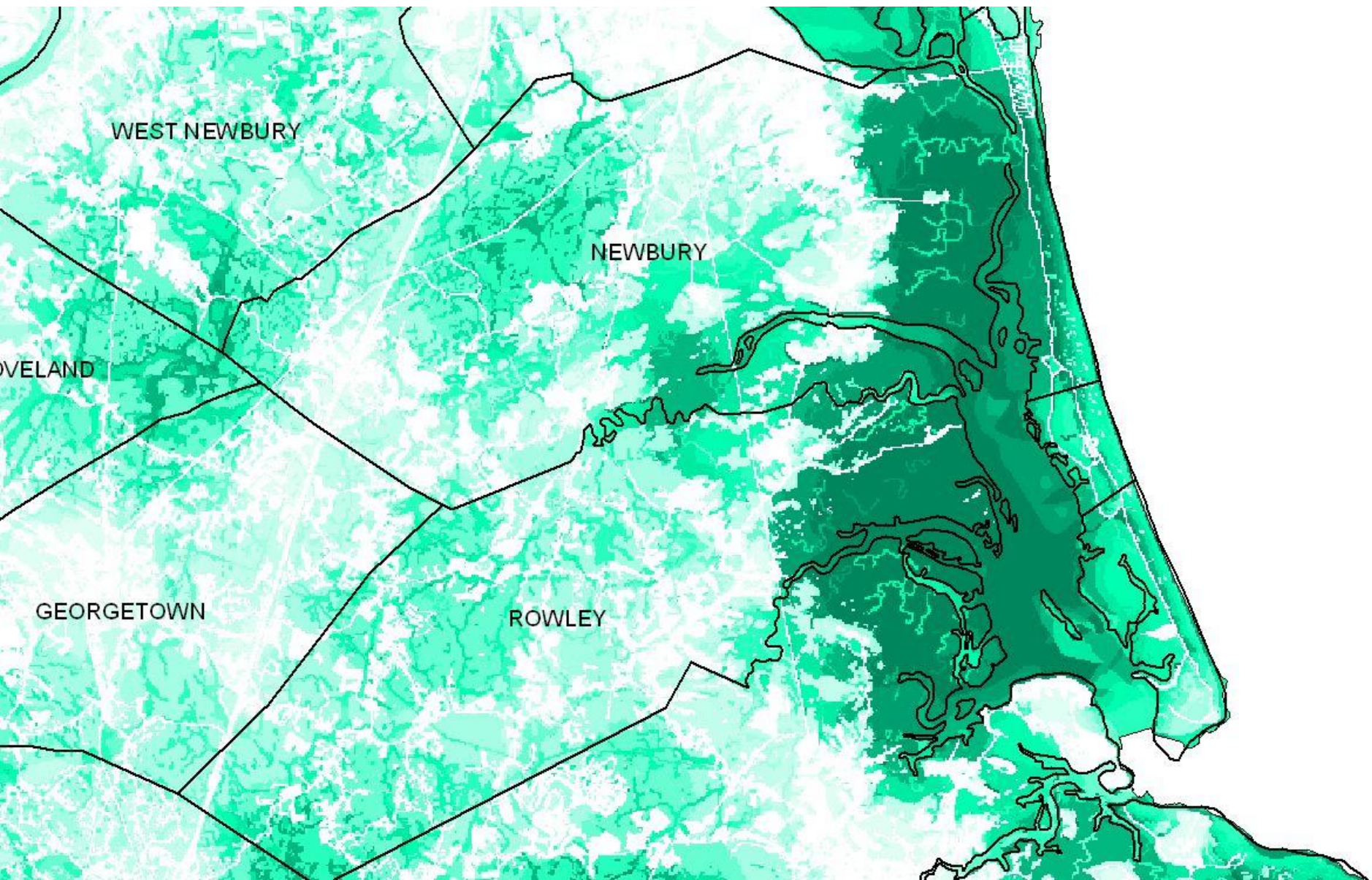




# Resistant Kernel

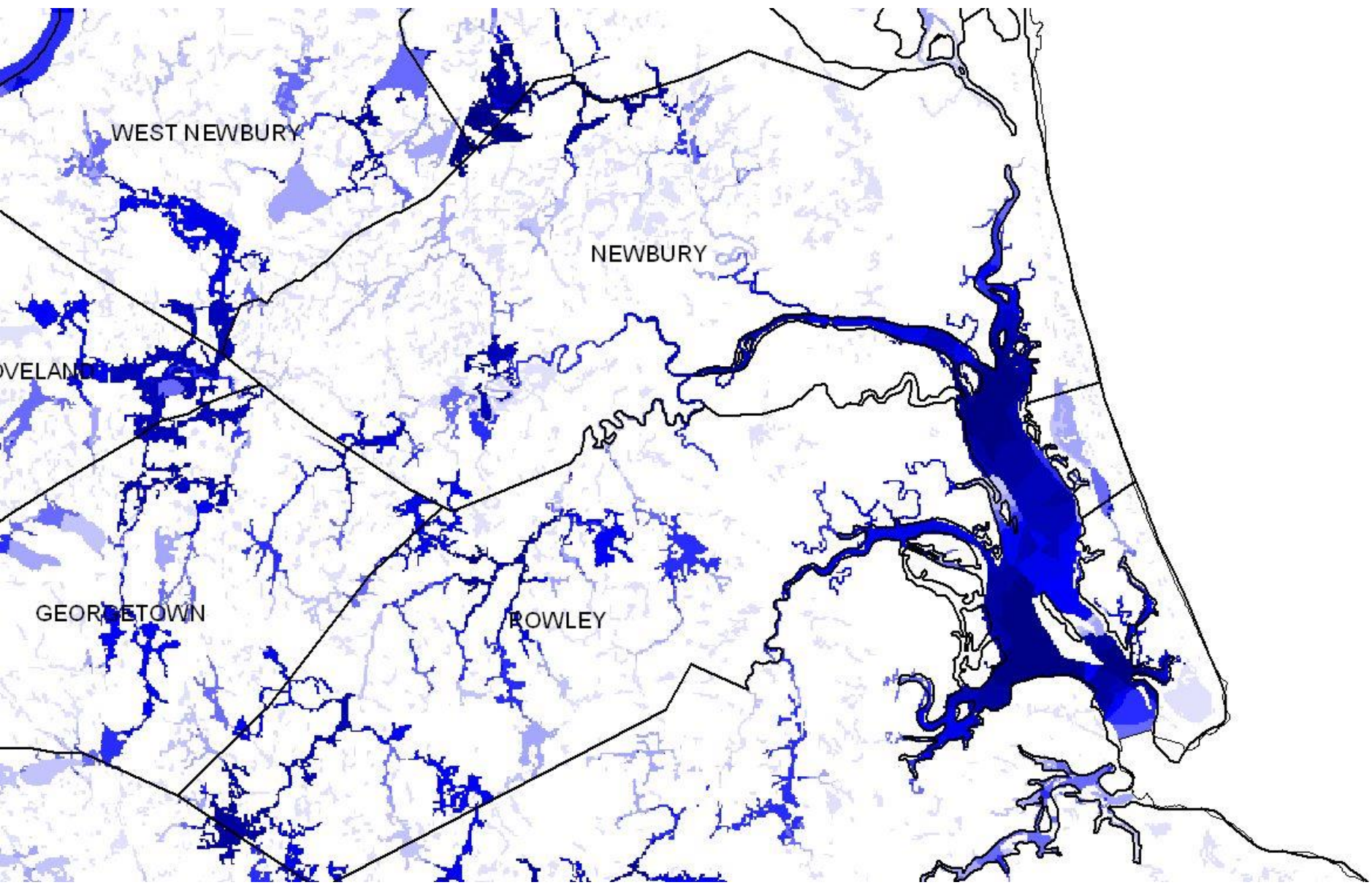






Connectedness





Aquatic Connectedness







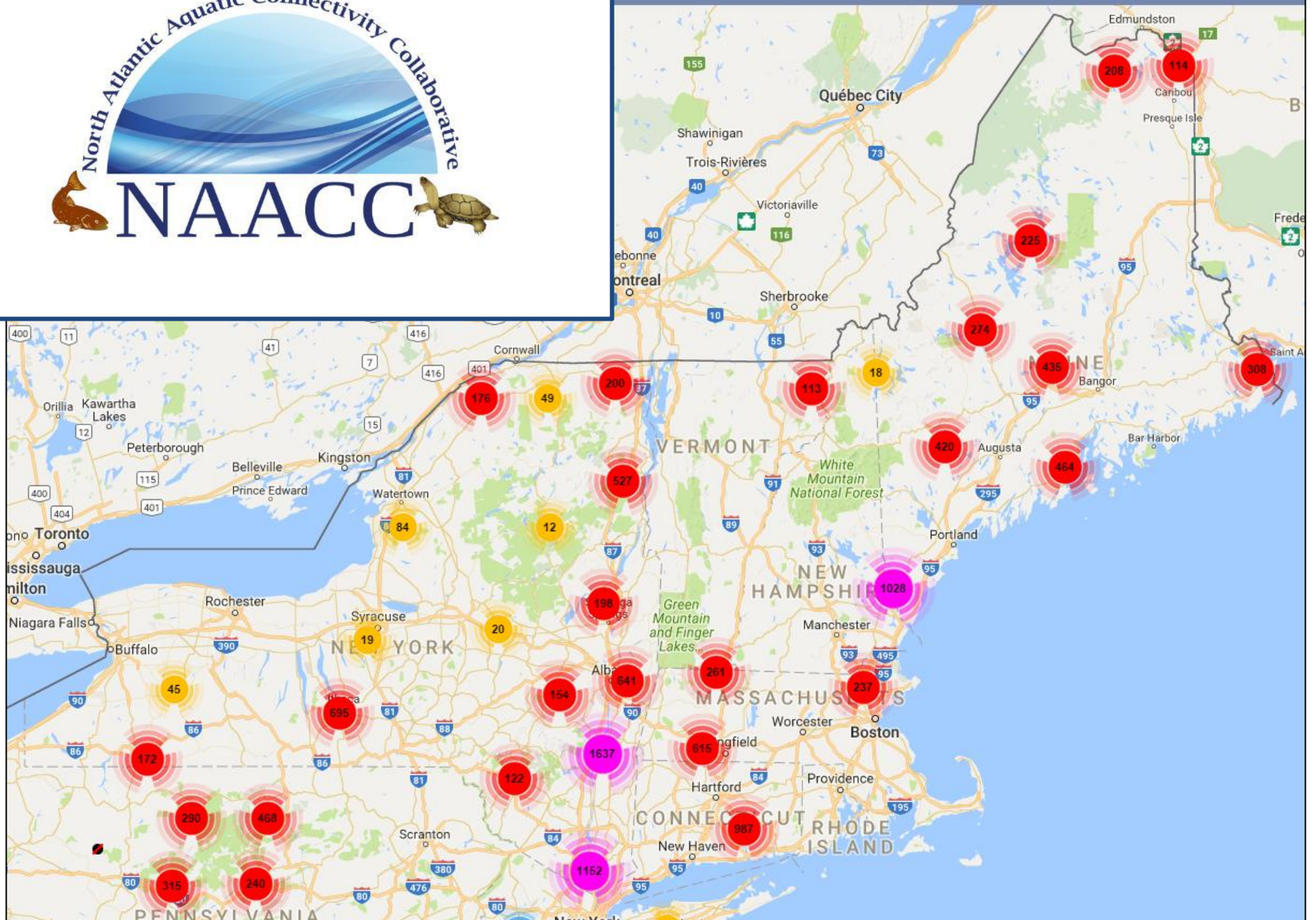






Welcome to our search results mapping page!

Records having valid xy crossing codes or GPS information can be mapped. Only one record of records



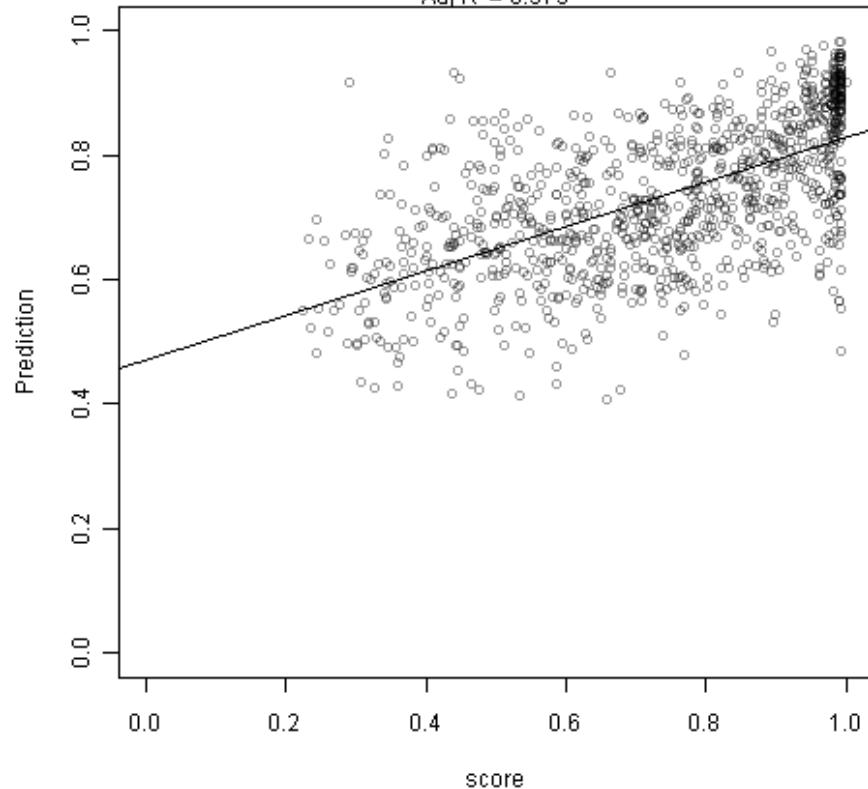


# Modeling crossing scores

Predictions of aquatic and terrestrial crossing scores from Stream Continuity Project from GIS data.

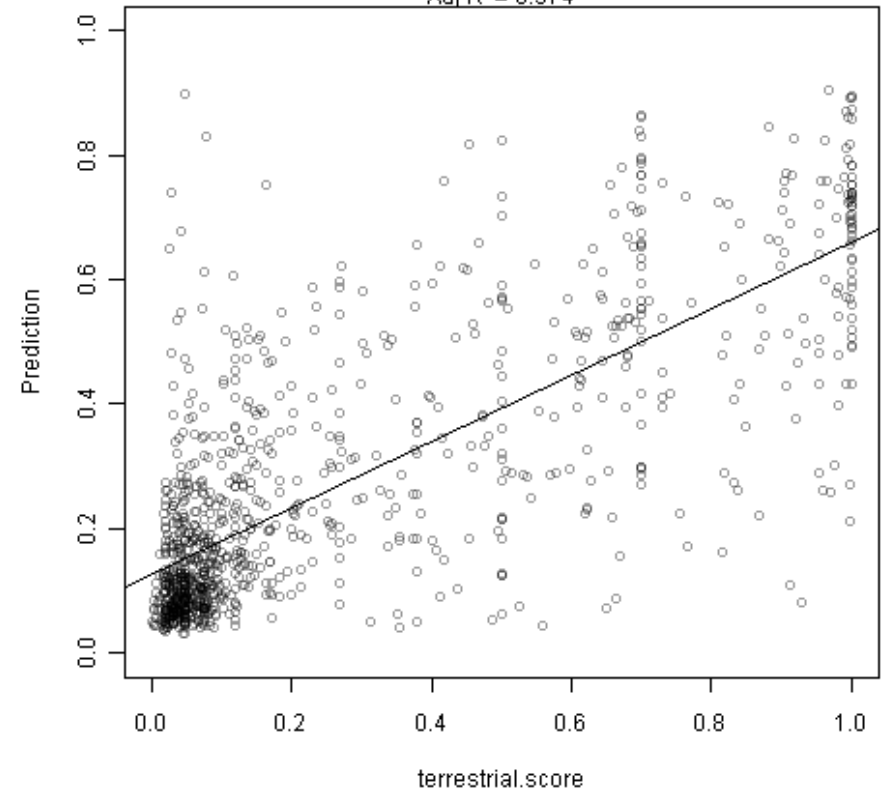
**Random forest score prediction**

Adj  $R^2 = 0.375$



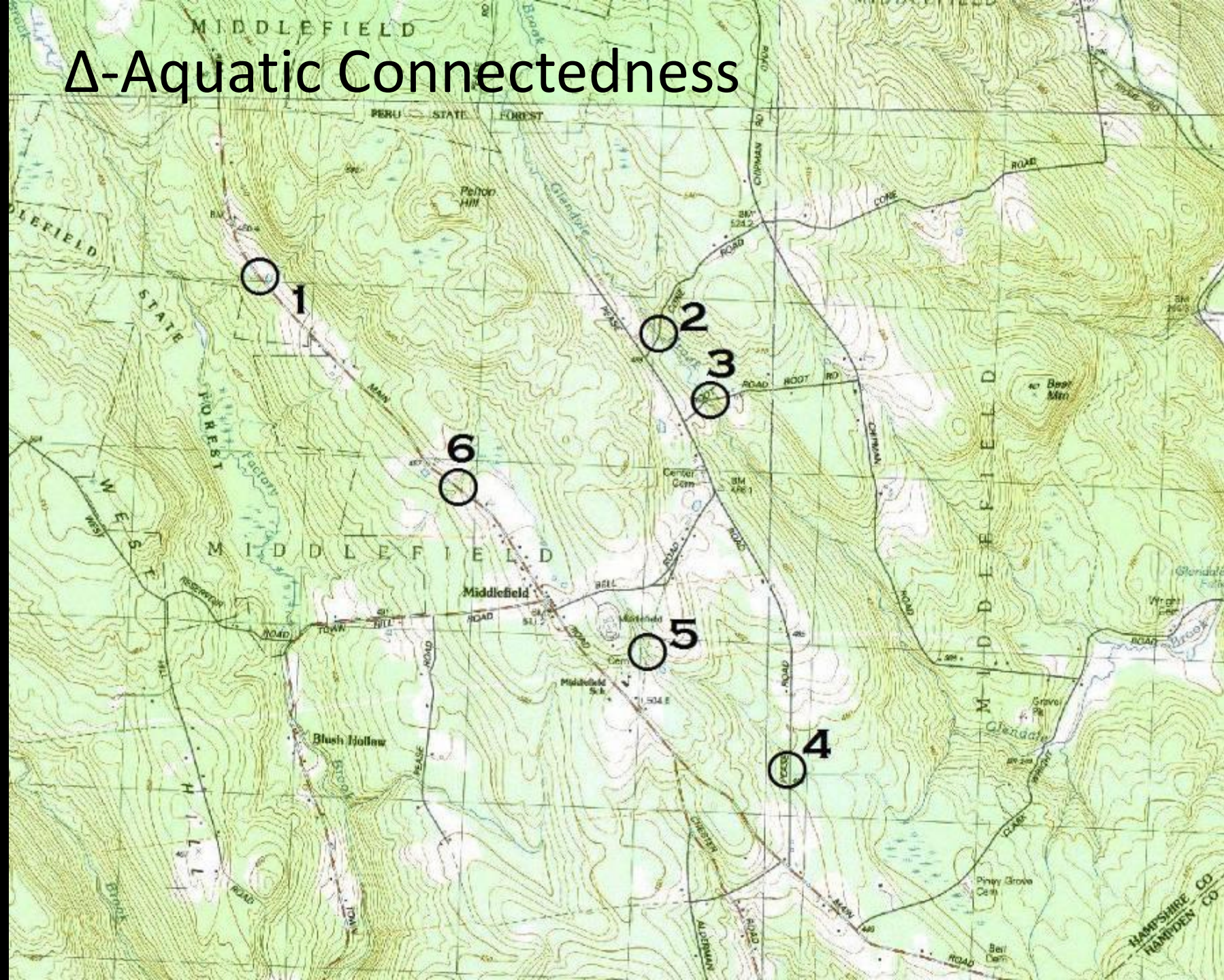
**Random forest terrestrial.score prediction**

Adj  $R^2 = 0.574$

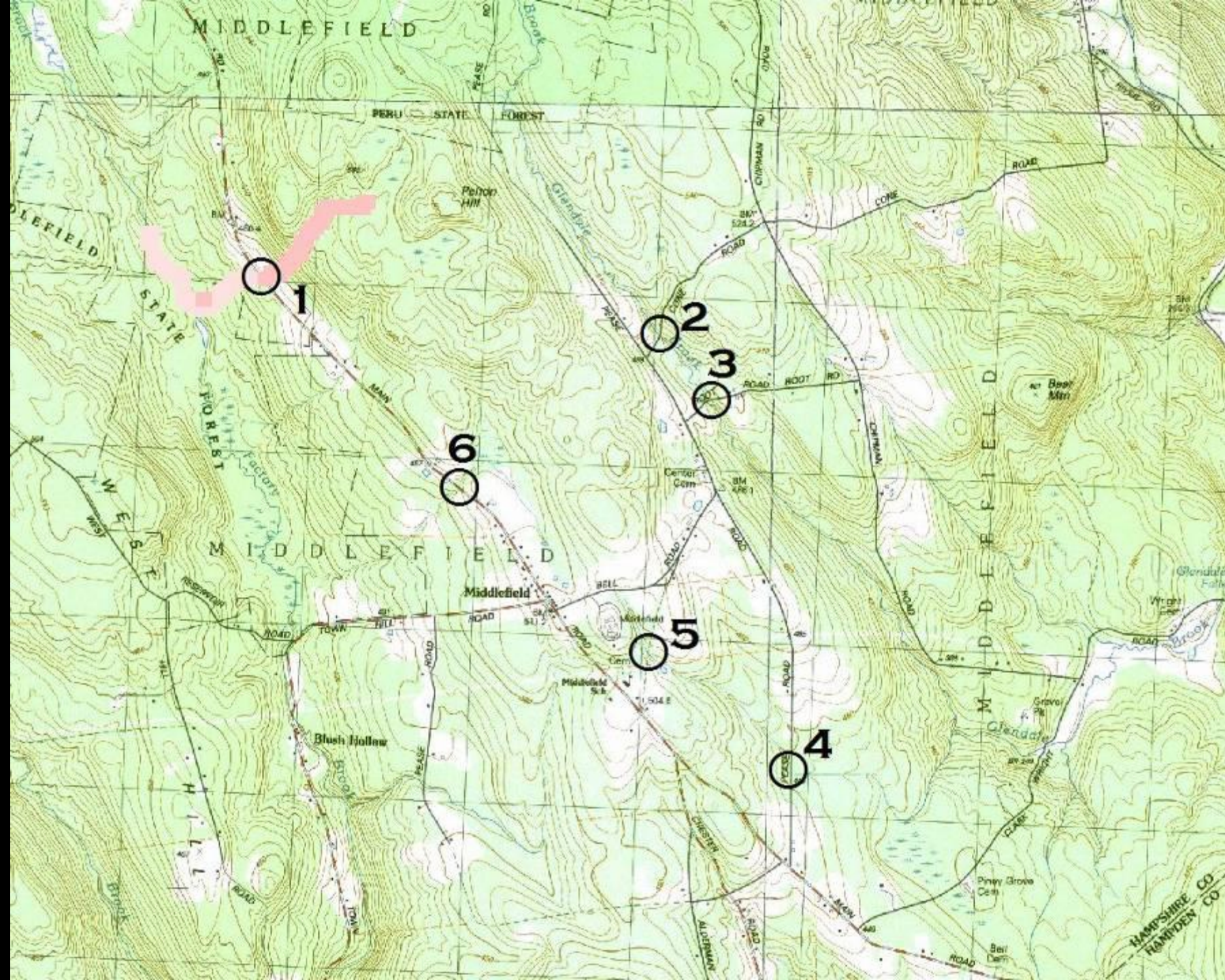




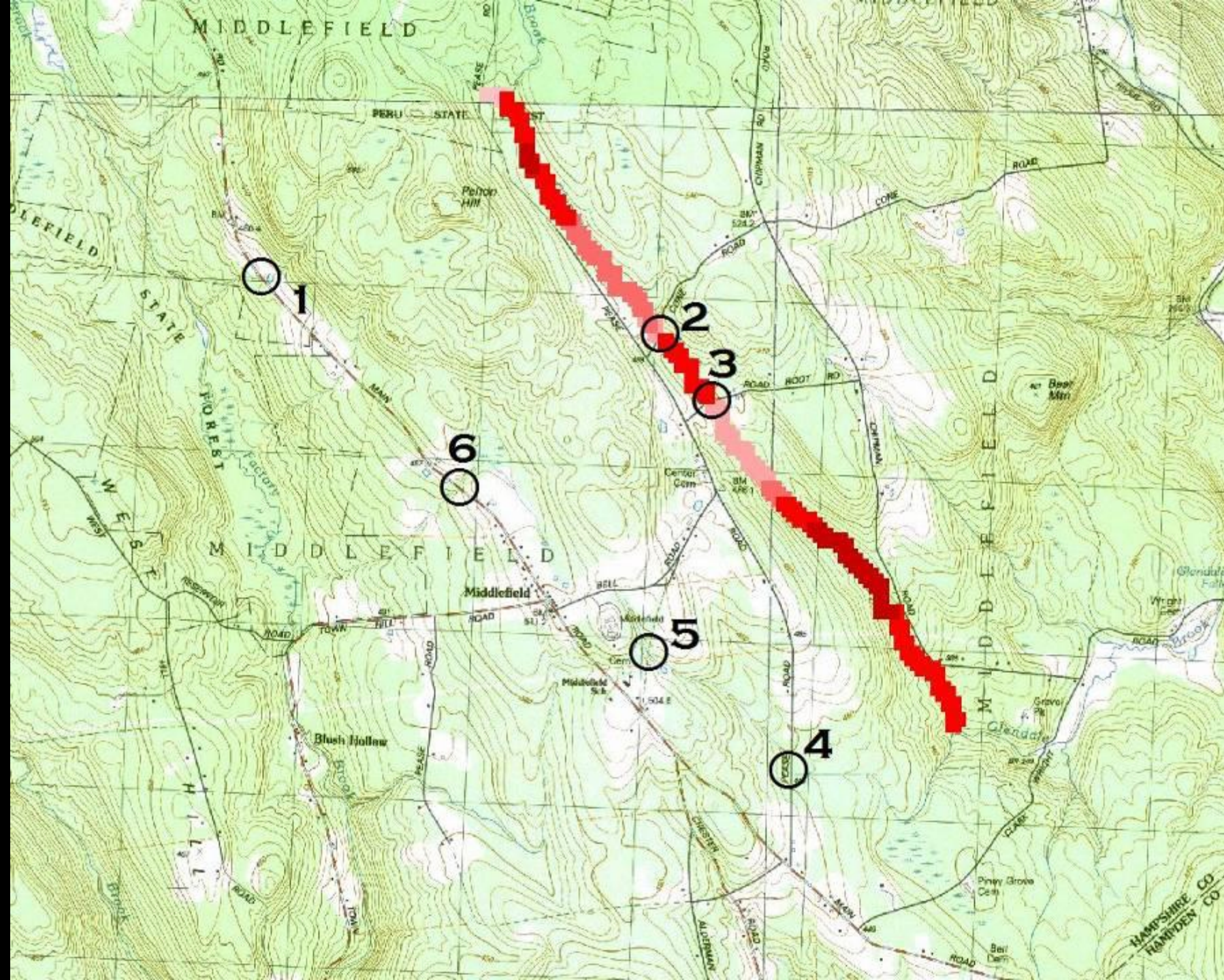
# $\Delta$ -Aquatic Connectedness



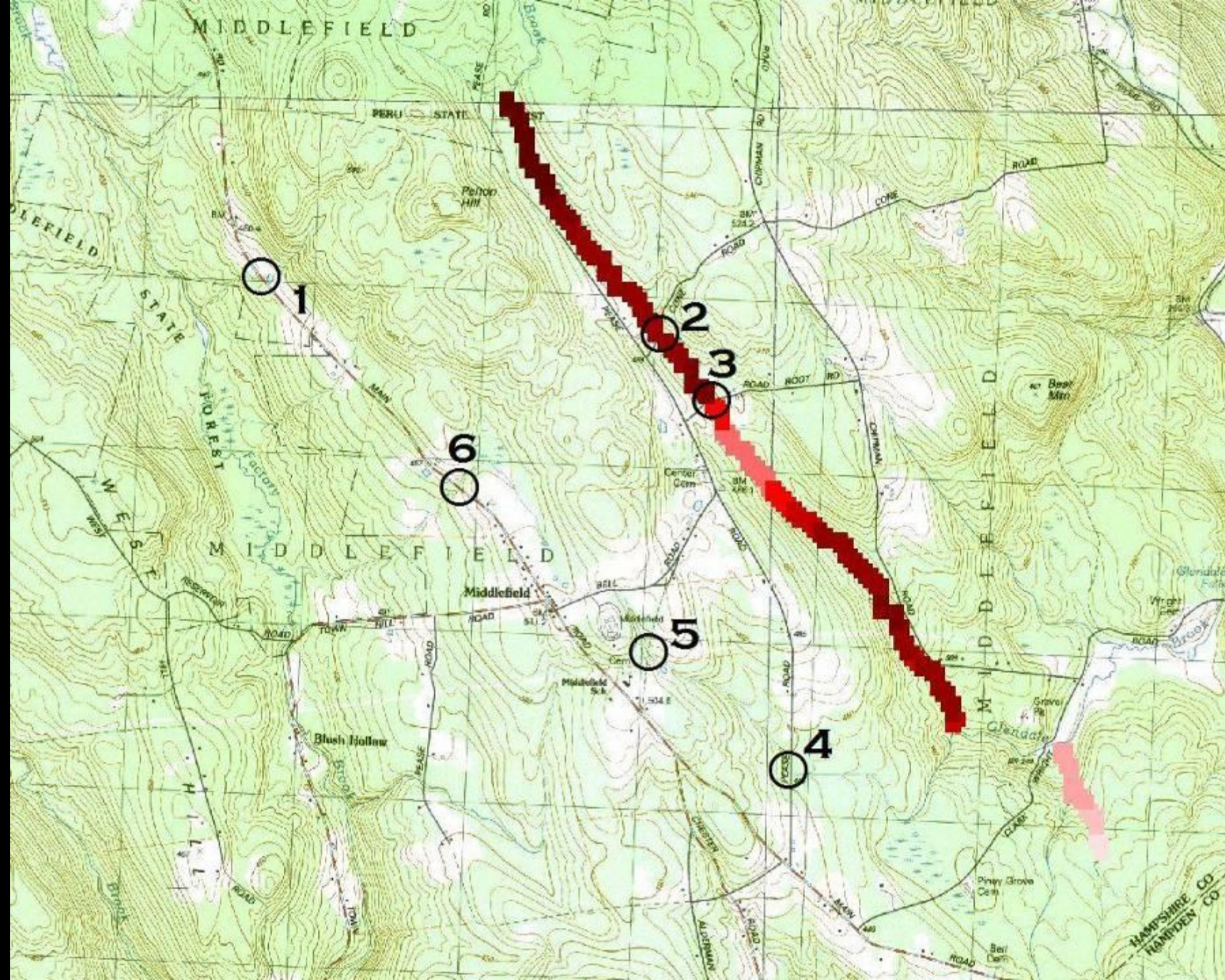




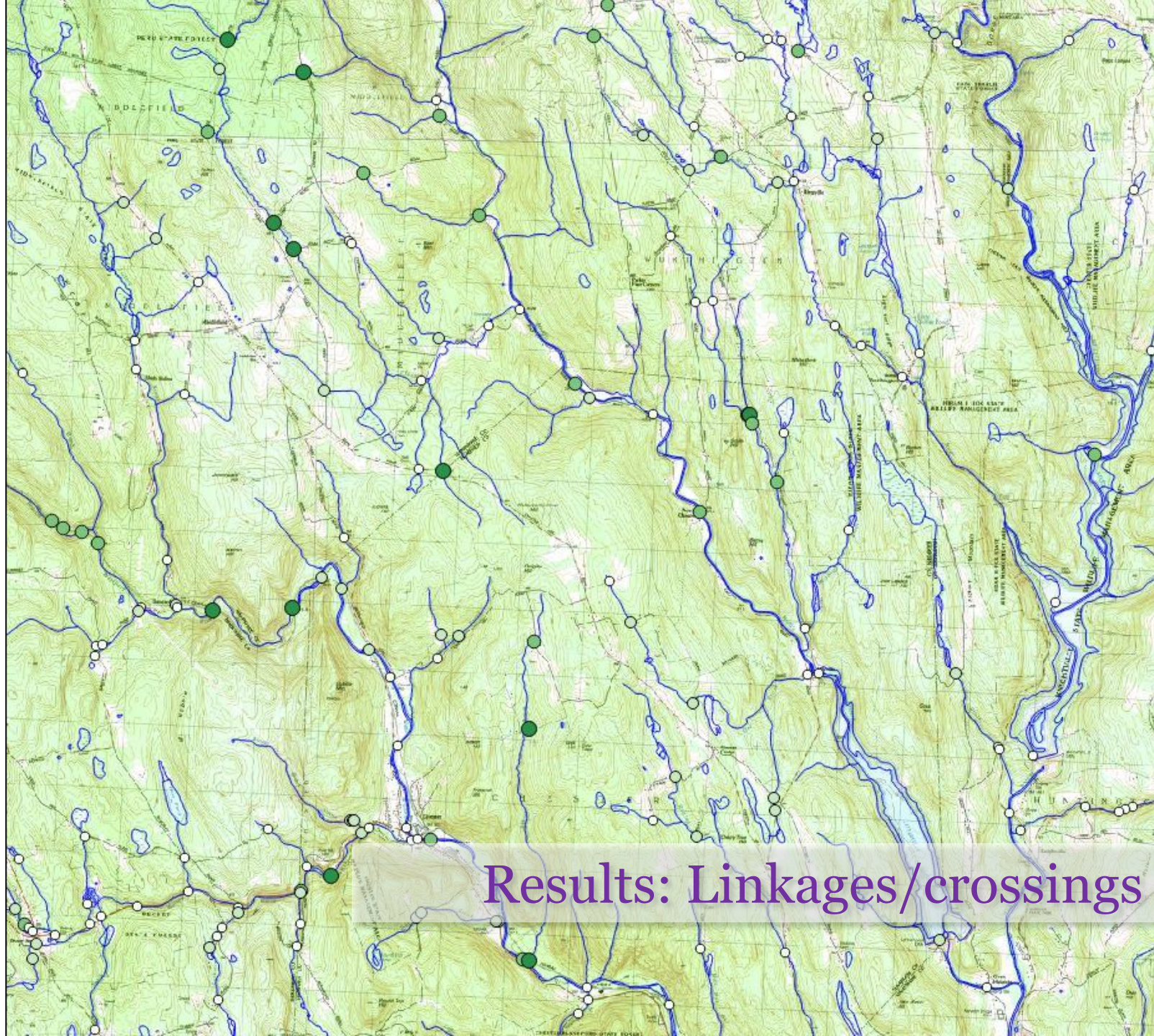








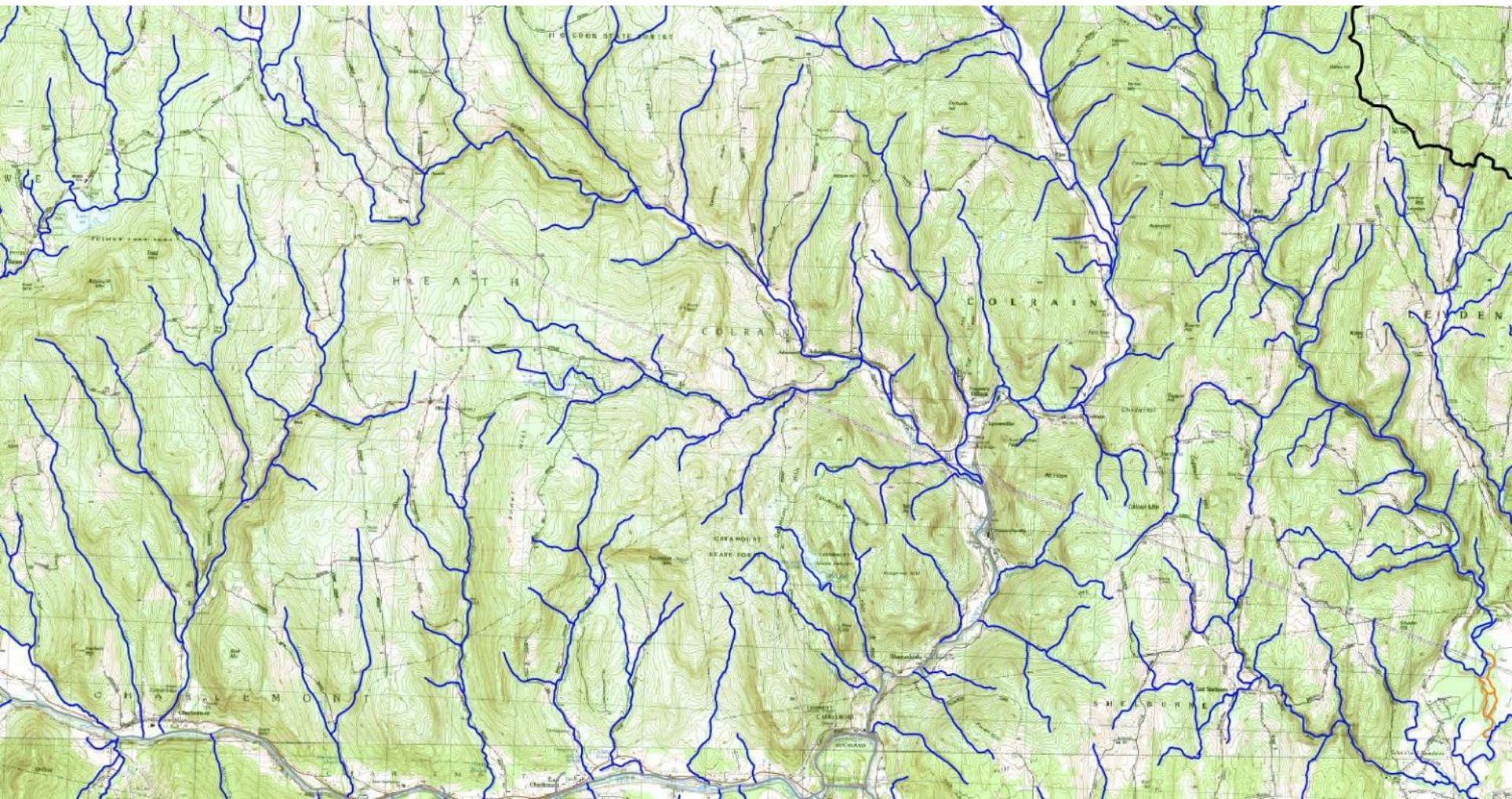




Results: Linkages/crossings

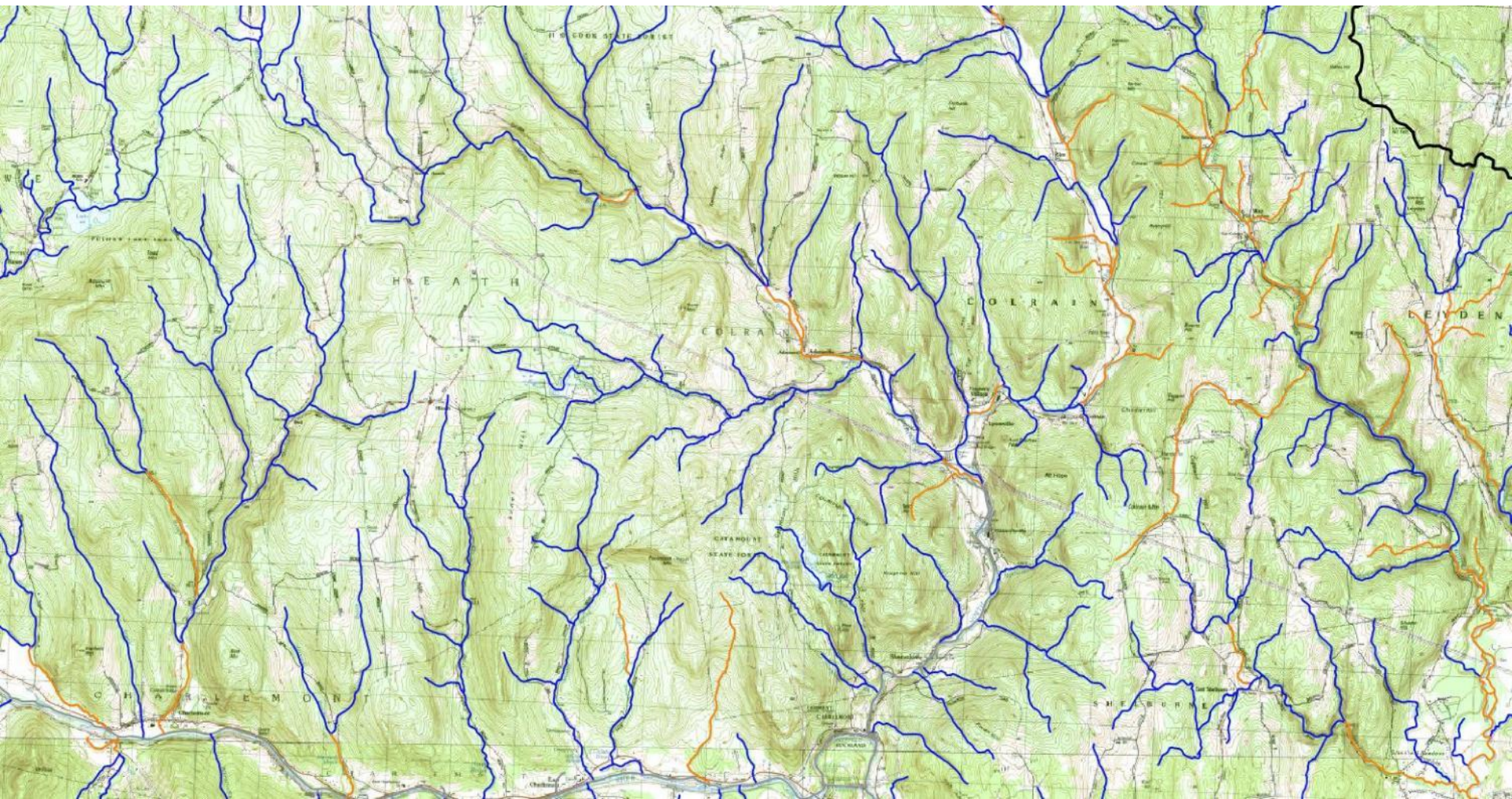


## All Streams



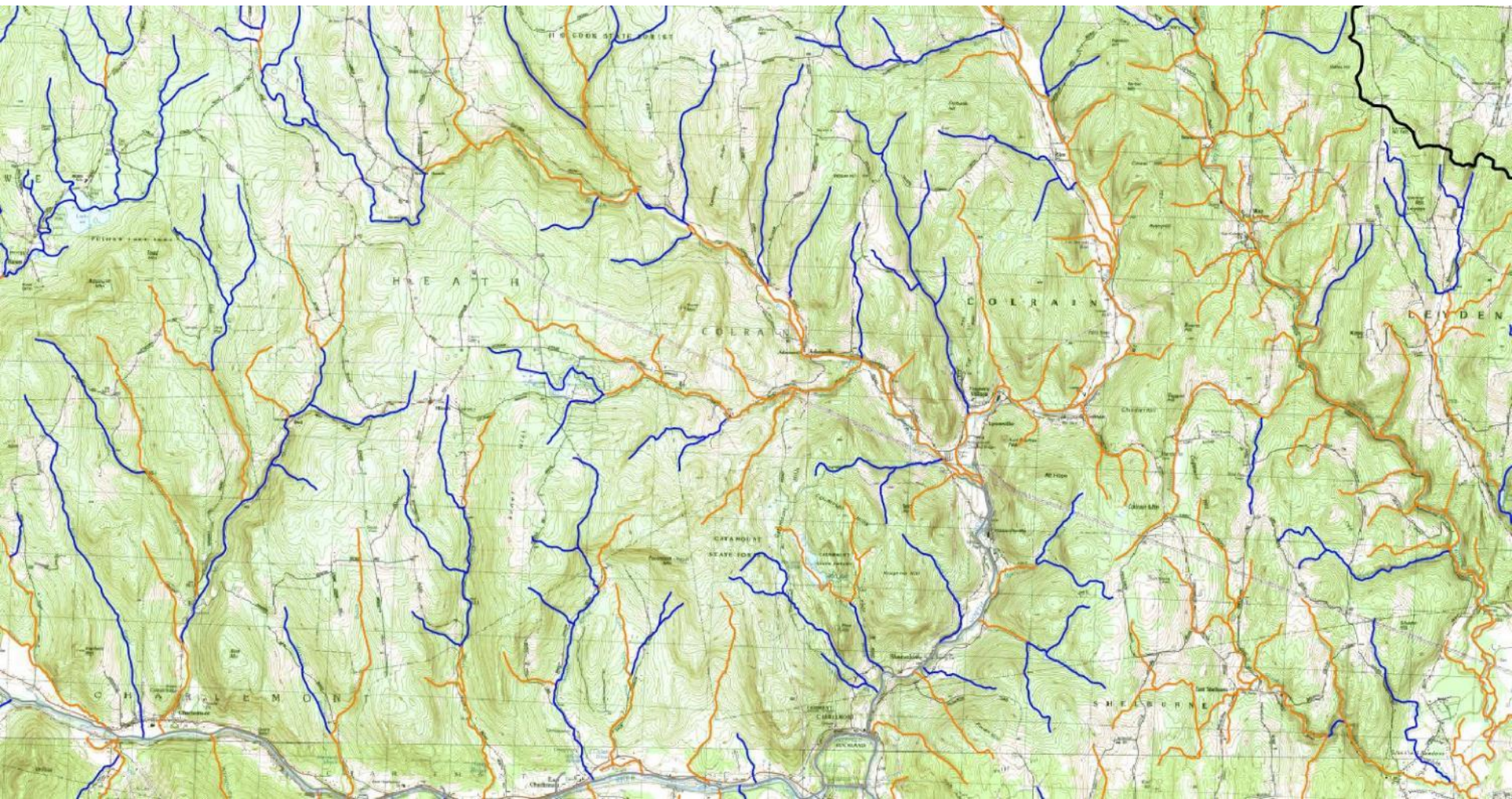


# Coldwater Streams, $T = 18^{\circ}\text{C}$





## Coldwater Streams, $T = 16^{\circ}\text{C}$

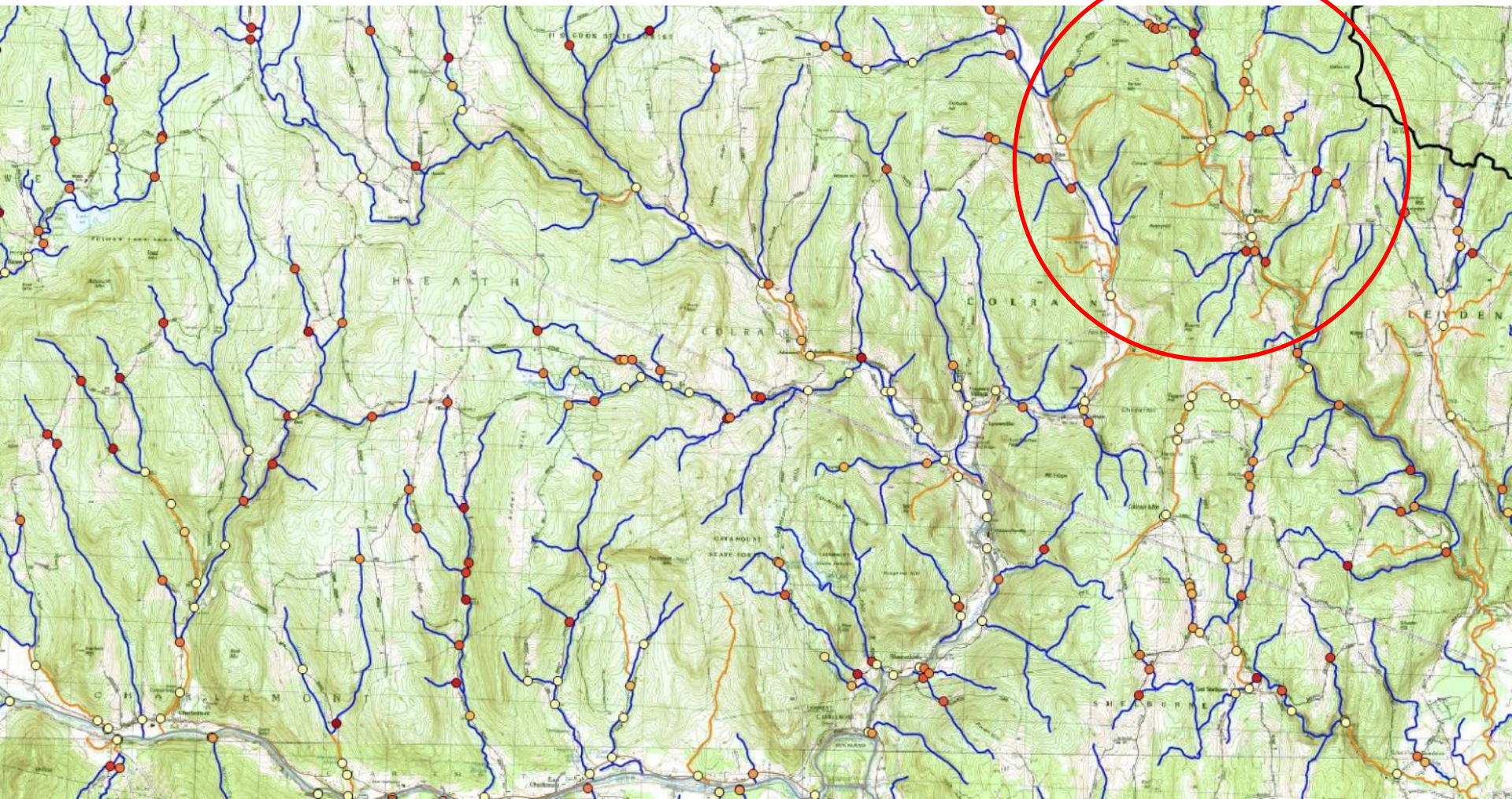




## A topographic map of the Colrain area in Massachusetts. The map shows the Colrain River and its tributaries, with towns including Heath, Colrain, and Leyden. A red circle highlights a specific area in the upper right quadrant of the map, which is the focus of the subsequent images. The map includes contour lines, roads, and various geographical features.



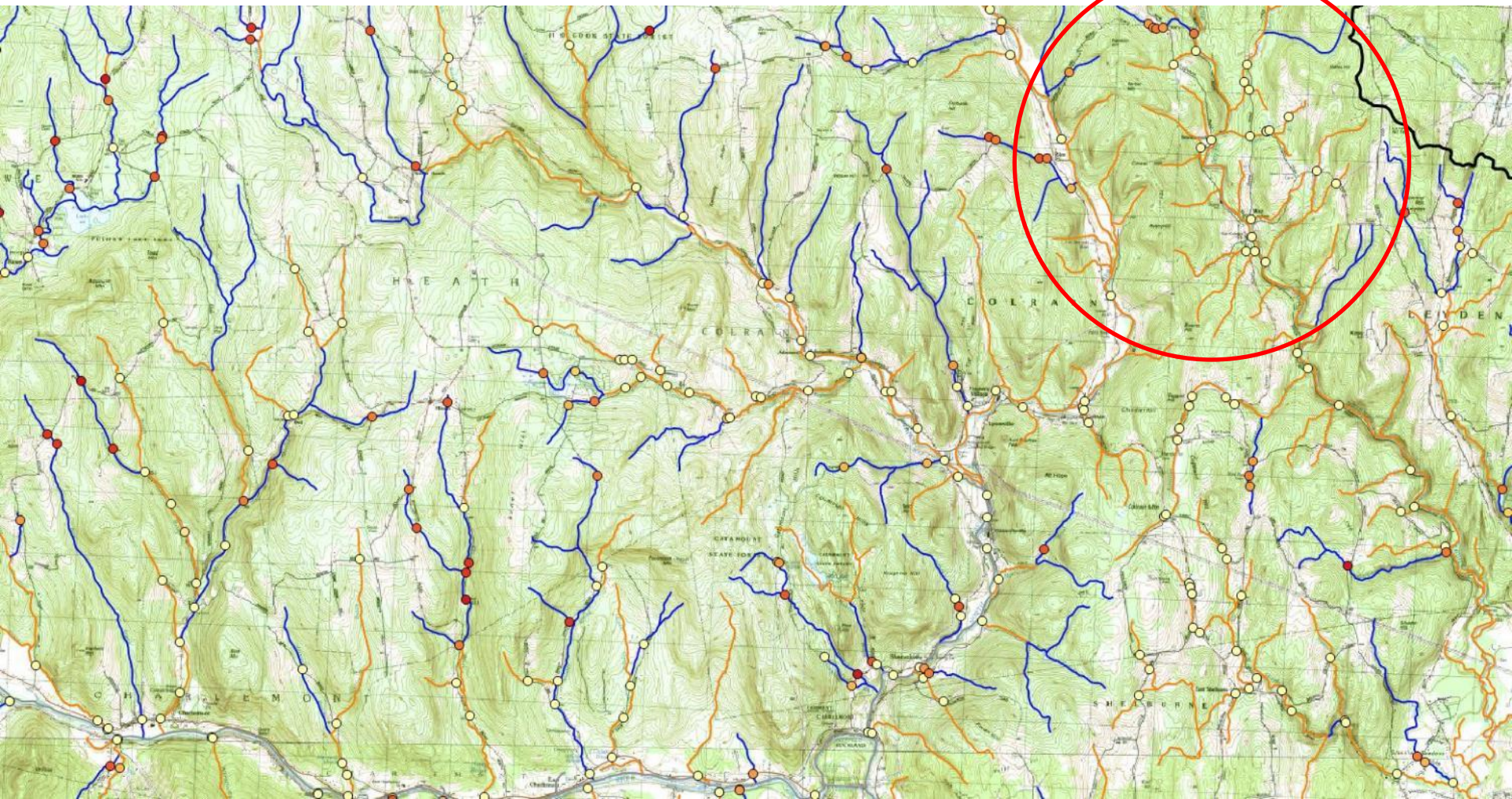
# Critical Linkages: Coldwater Streams, $T = 18^{\circ}\text{C}$





Critical Linkages: Coldwater Streams,  $T = 16^{\circ}\text{C}$

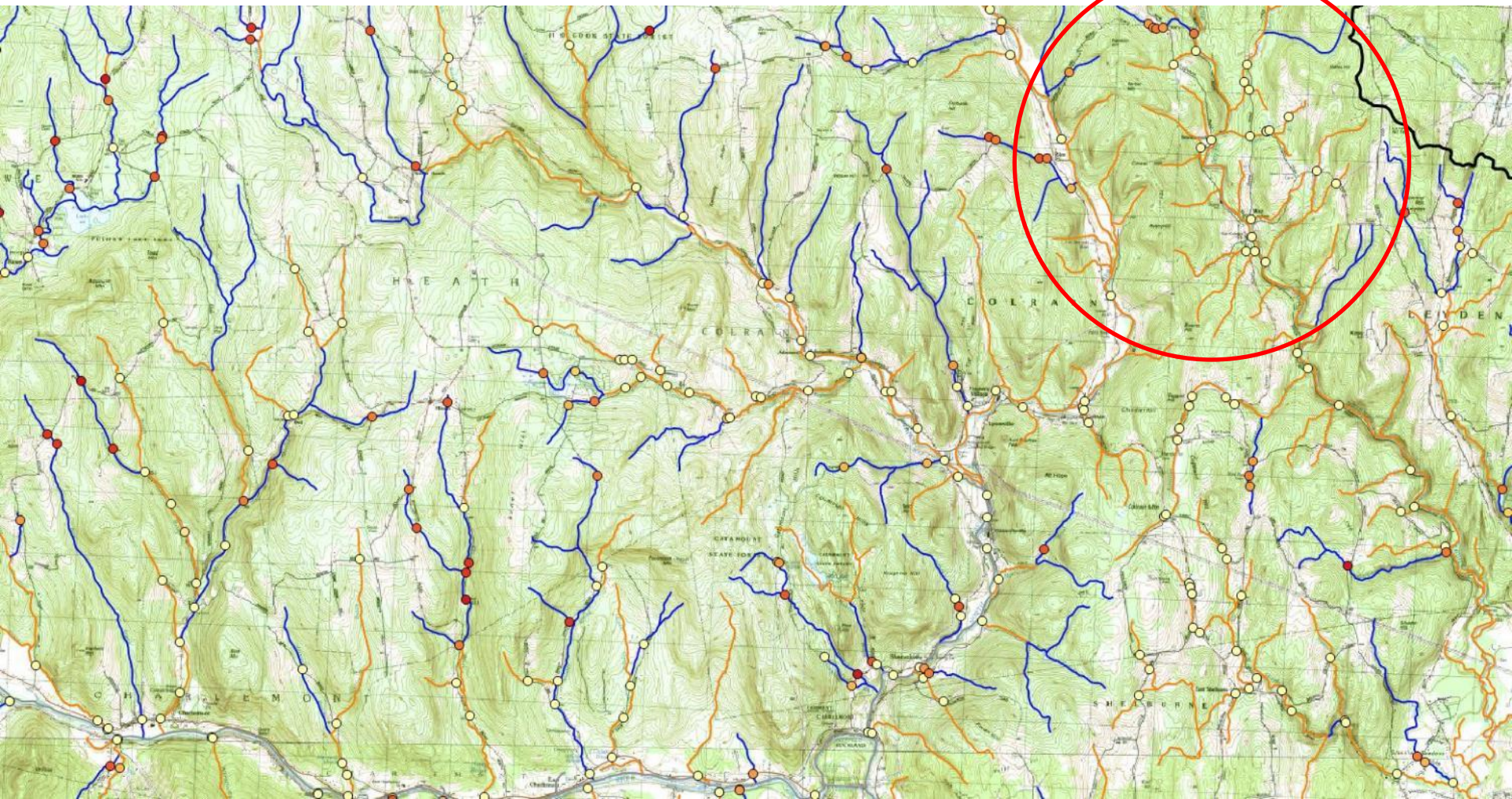
Or...





...in 2050

# Critical Linkages: Coldwater Streams, $T = 18^{\circ}\text{C}$





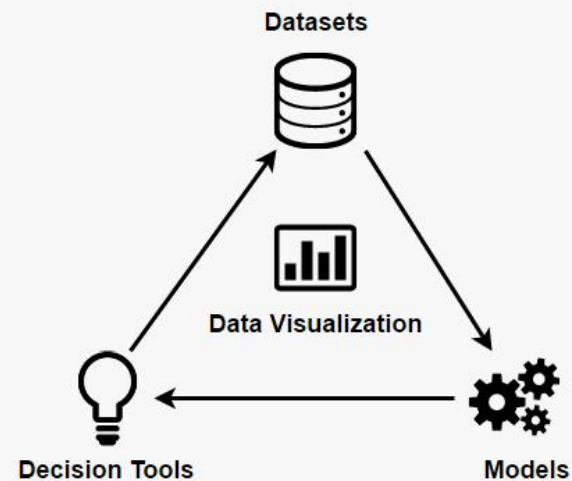
# Spatial Hydro-Ecological Decision System (SHEDS)

Seamlessly linking hydro-ecological datasets, models, and decision support systems

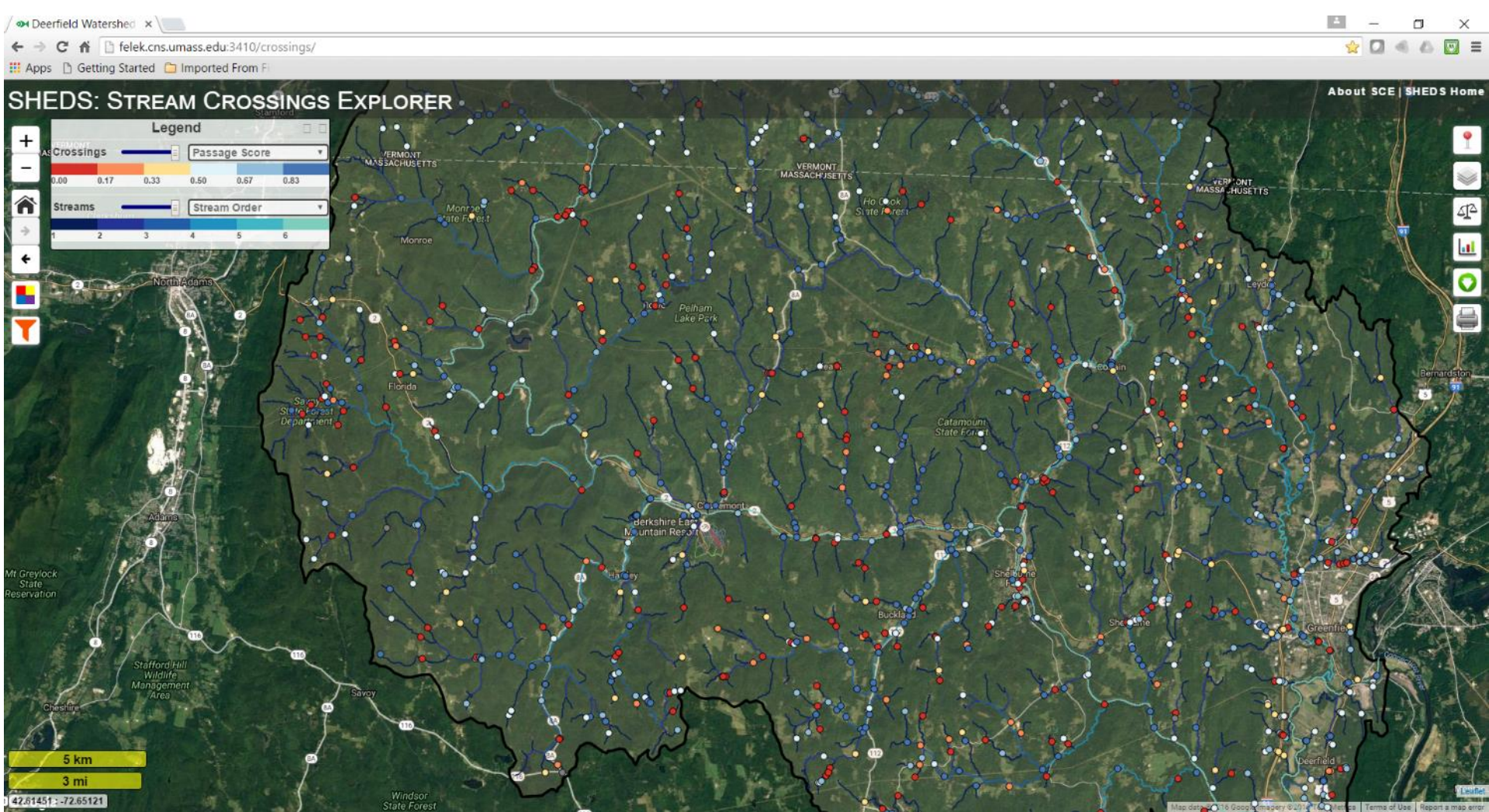
## What is SHEDS?

SHEDS is a collection of innovative data visualization and decision support tools for exploring and better understanding dynamic relationships in stream ecosystems.

SHEDS seamlessly links datasets, models, and decision support systems into a powerful platform for gaining insight, supporting transparent decision making, and improving management of hydro-ecological resources.







## Critical Linkages: Coldwater Streams

Choose a Temp Threshold

- 16C
- 18C
- 20C

Choose a Year

- 2015
- 2050
- 2080



# Funding and Other Support Provided by:



The Nature Conservancy  
Federal Highway Administration  
MA Department of Transportation



MA Department of Environmental Protection  
MA Natural Heritage & Endangered Species Program

MA Office of Energy & Environmental Affairs

US Environmental Protection Agency



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