

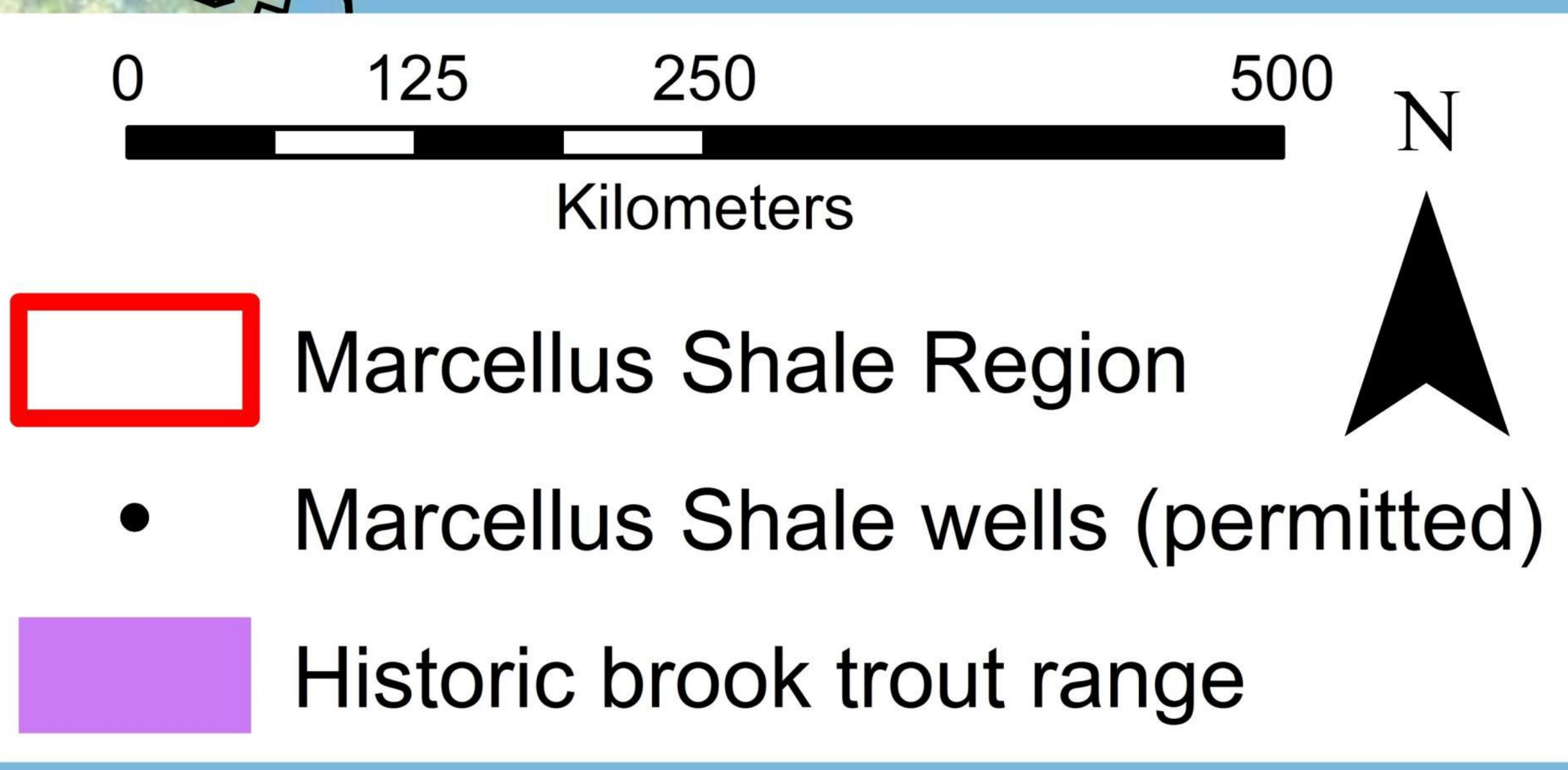
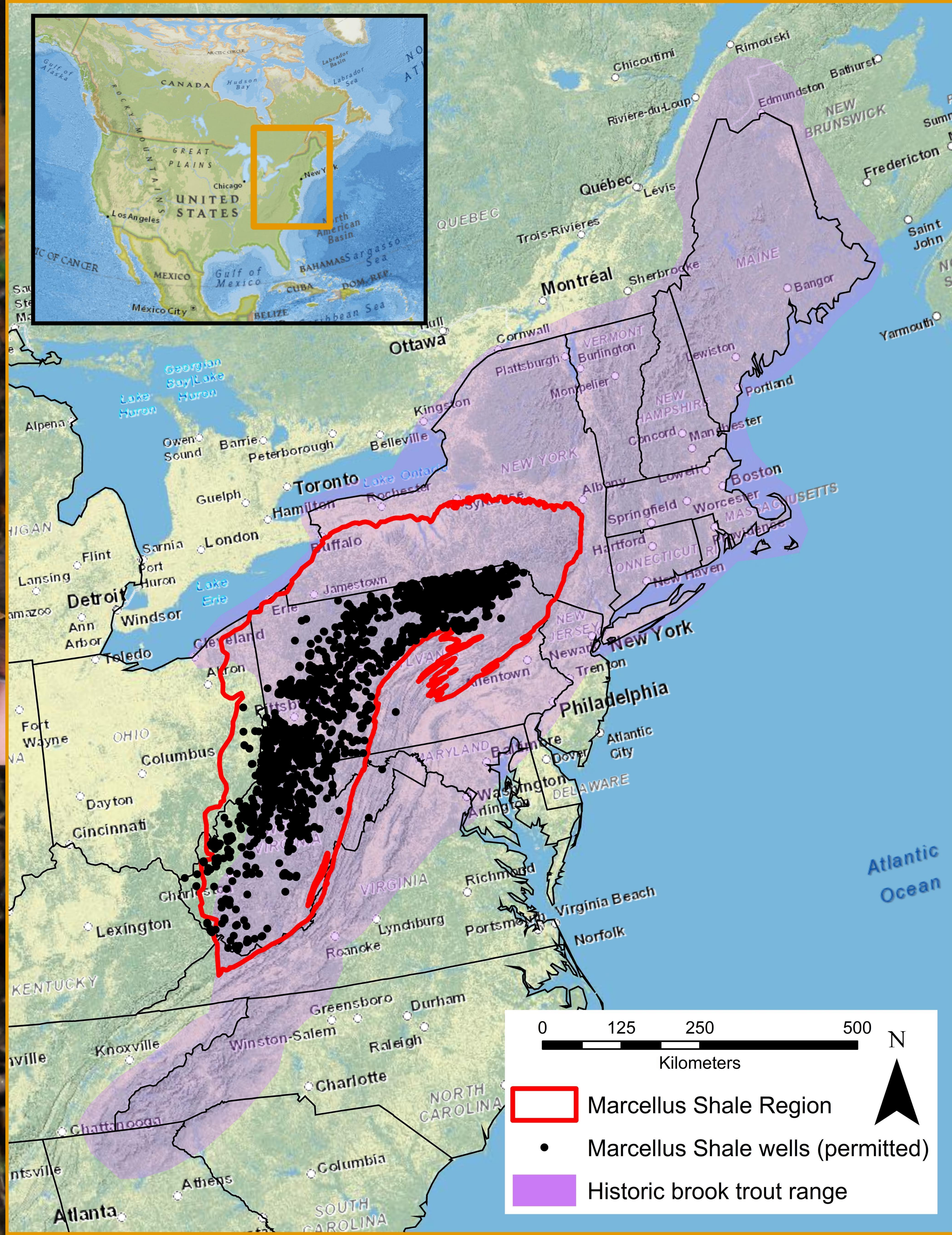
Development of a hydrologic foundation  
and flow-ecology relationships  
for monitoring riverine resources  
in the Marcellus Shale region

**William L. Fisher,<sup>1,2</sup> Jason M. Taylor,<sup>2</sup> and Maya Weltman-Fahs<sup>2</sup>**

<sup>1</sup>United States Geological Survey

<sup>2</sup>New York Cooperative Fish and Wildlife Research Unit and Department of Natural Resources, Cornell University, Ithaca, NY





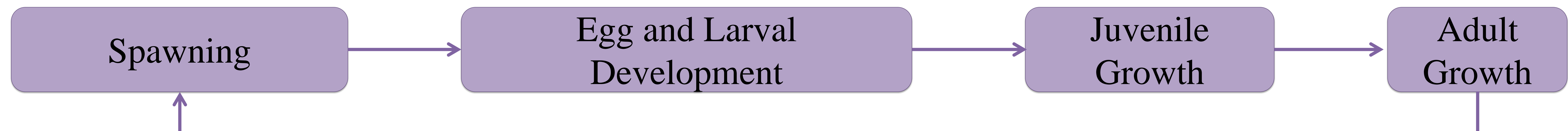
onomic value  
 ritage species  
 dicator species

Supporting  
Infrastructure

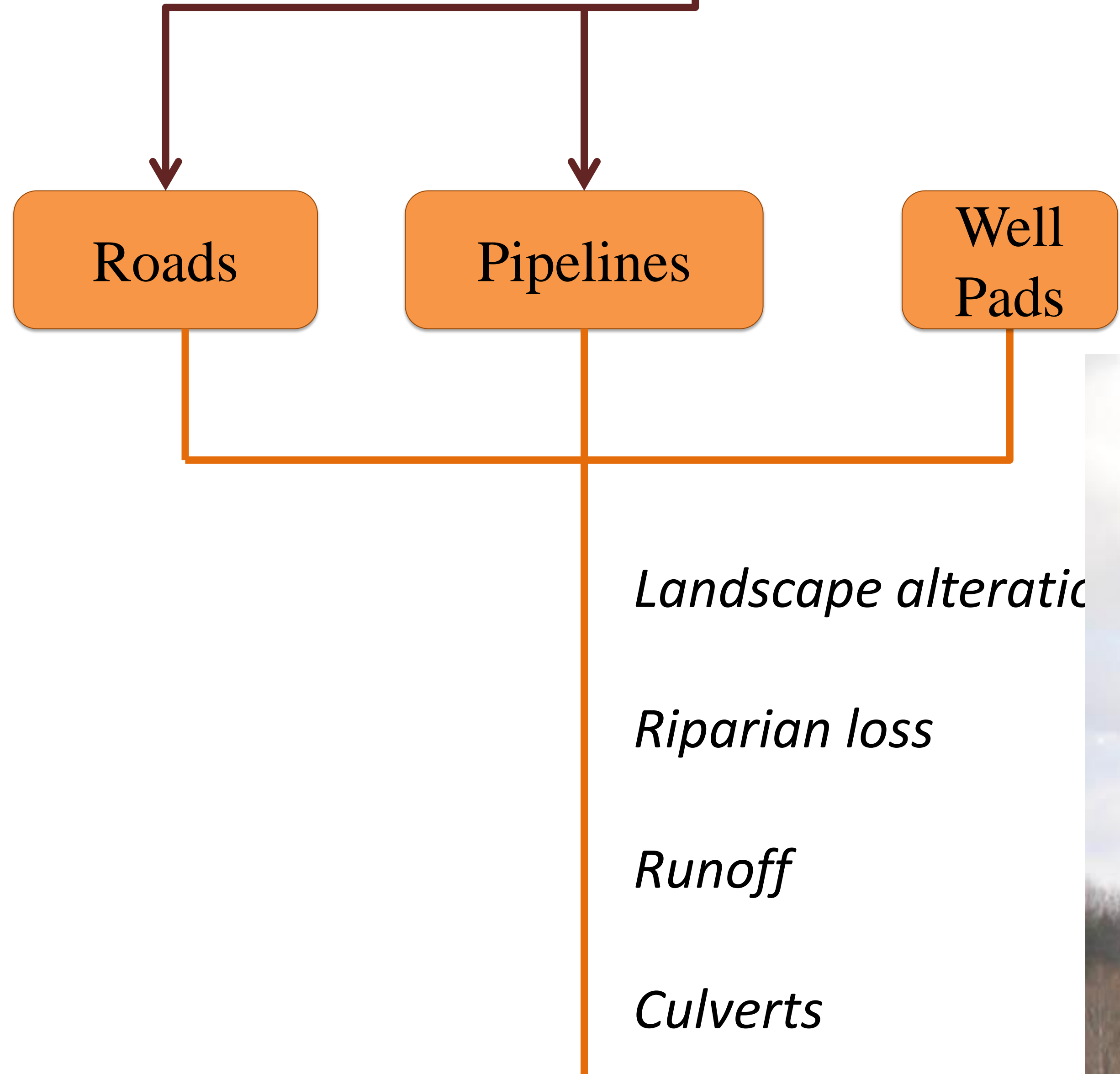
Drilling and  
Fracturing Process

Treatment/Waste  
Handling

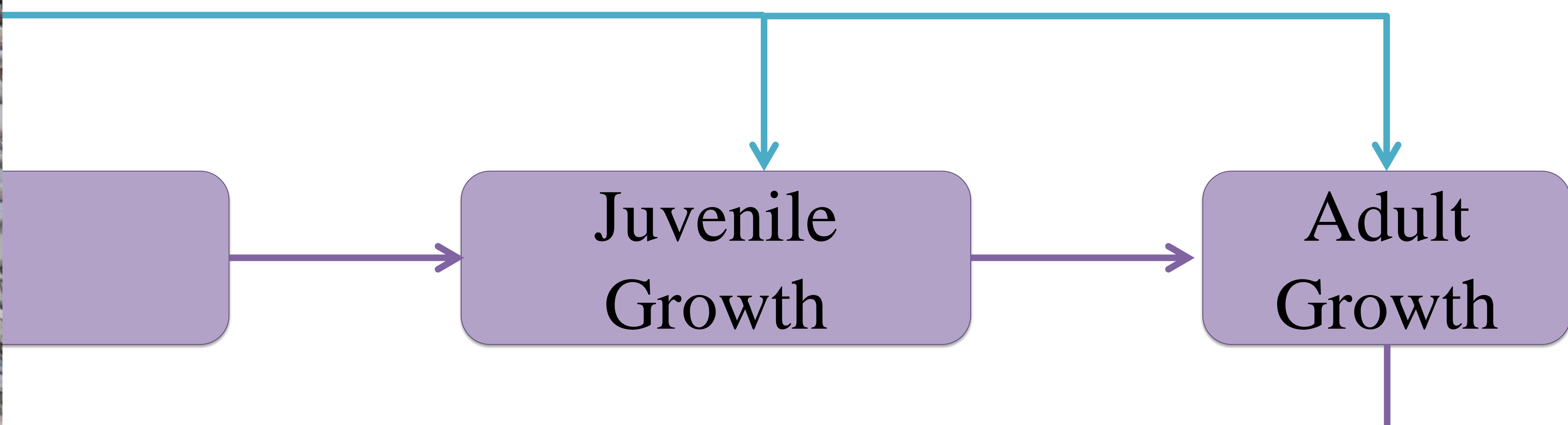
# Building influence pathways . . . .



Supporting Infrastructure



position,  
ft



# Ch Pa



Treatment/Waste Handling

Treatment Facilities

UIC

Land application/burial  
Runoff/leaching

Metals ↑

TENORM ↑

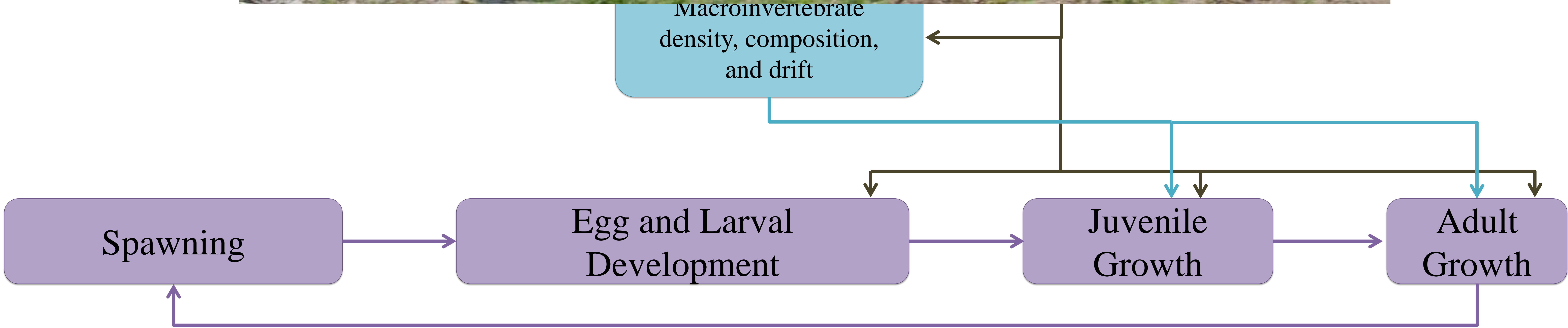
Macroinvertebrate density, composition, and drift

Spawning

Egg and Larval Development

Juvenile Growth

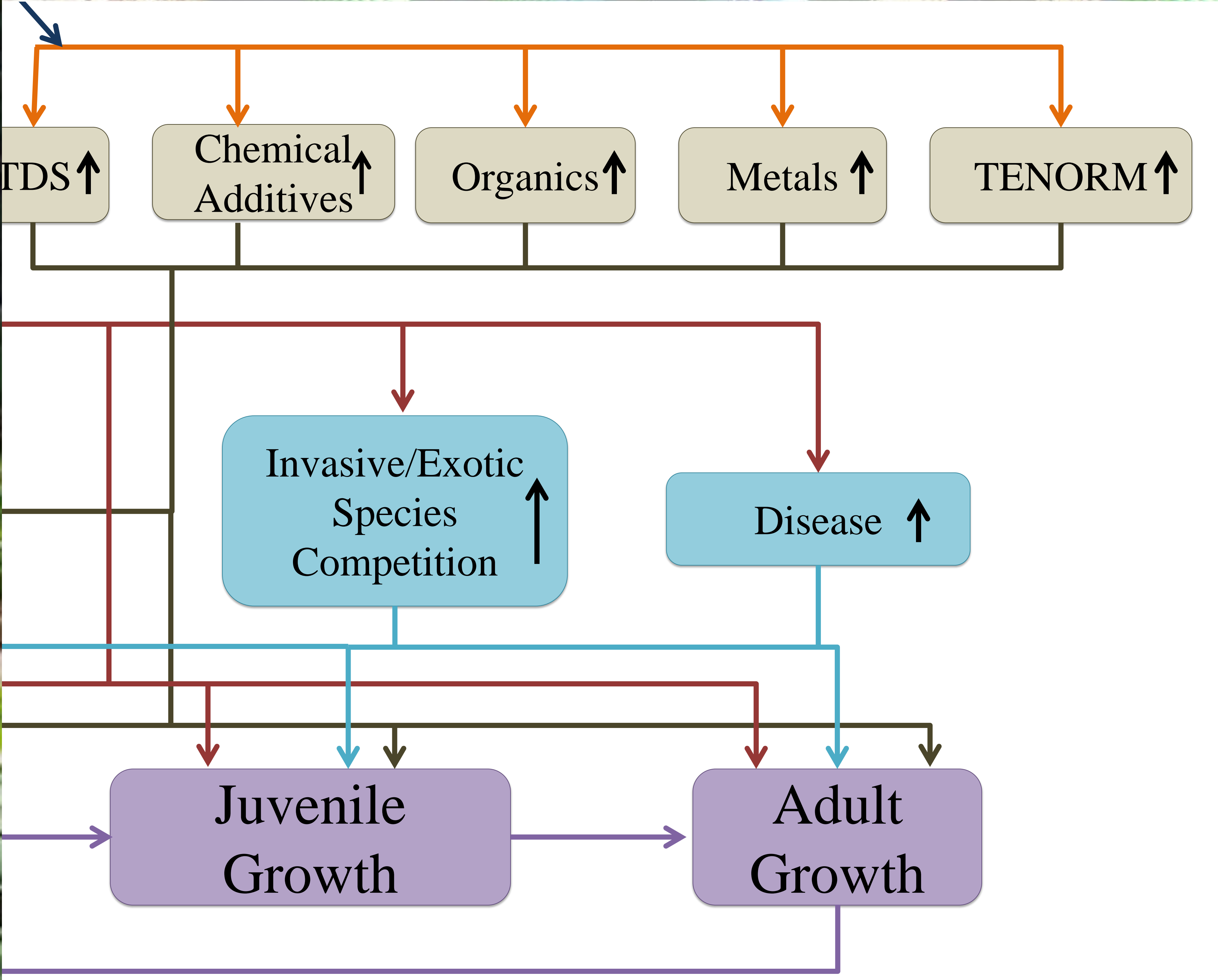
Adult Growth

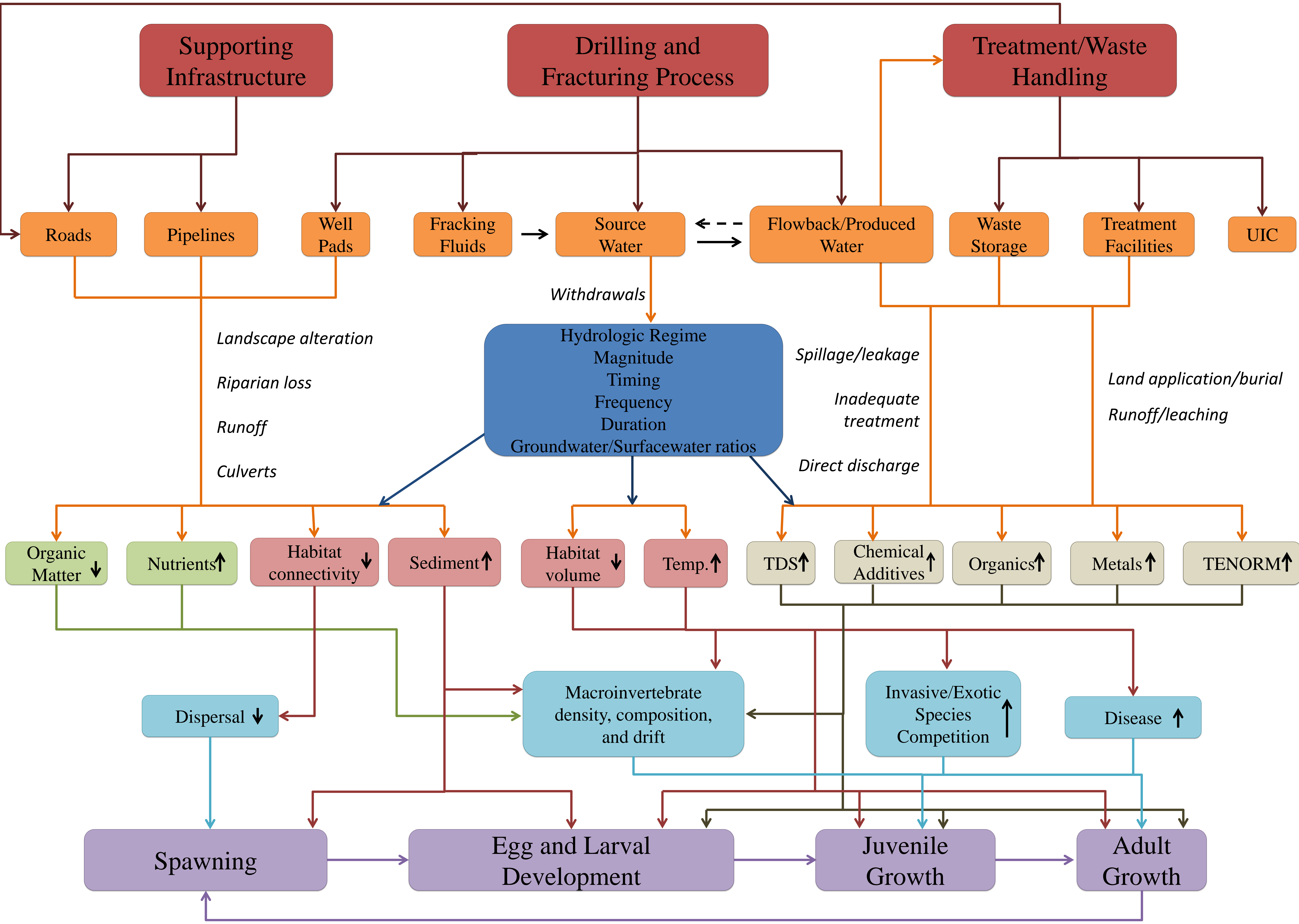


Fracking  
Fluids

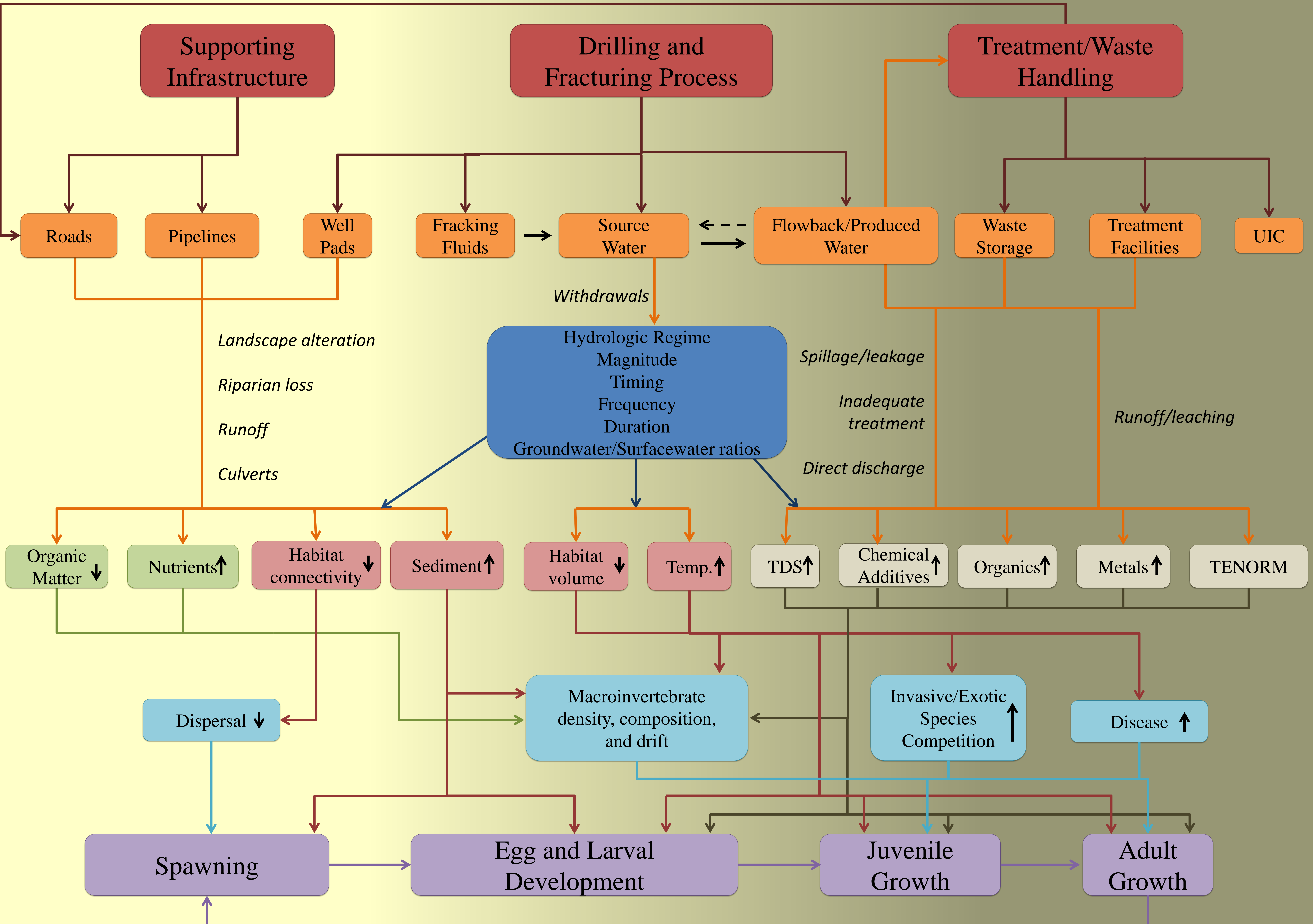


Shenandoah River Basin Commission



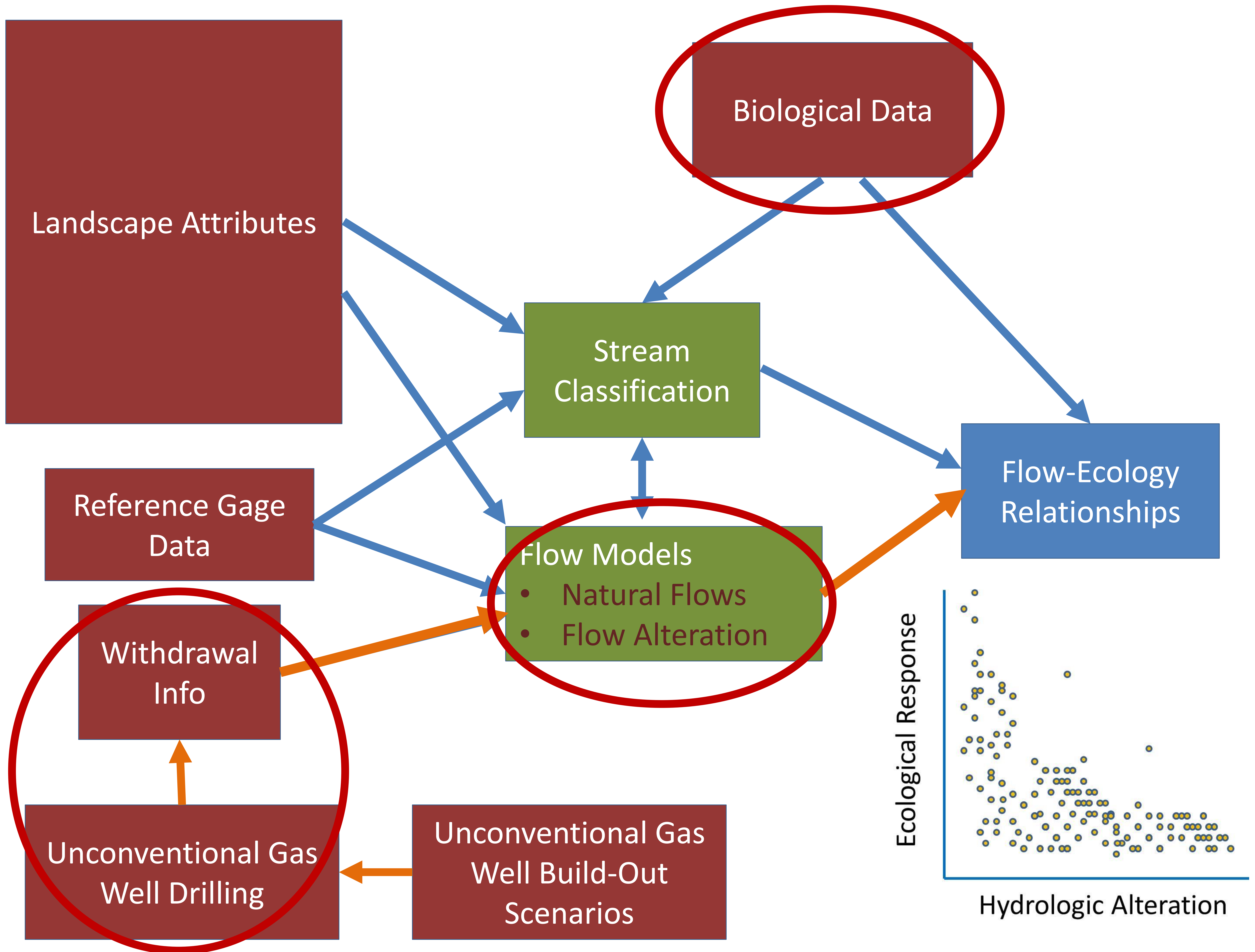






# Project Goals

1. Determine what flow modeling tools are applicable to the Marcellus Shale Region and identify the best tool for predicting flow statistics at un-gaged sites.
2. Develop empirical relationships between flow alteration and biological responses based on existing biological data.
3. Forecast changes in hydrology and associated predicted biological responses in relation to expanding water withdrawals from unconventional natural gas drilling.



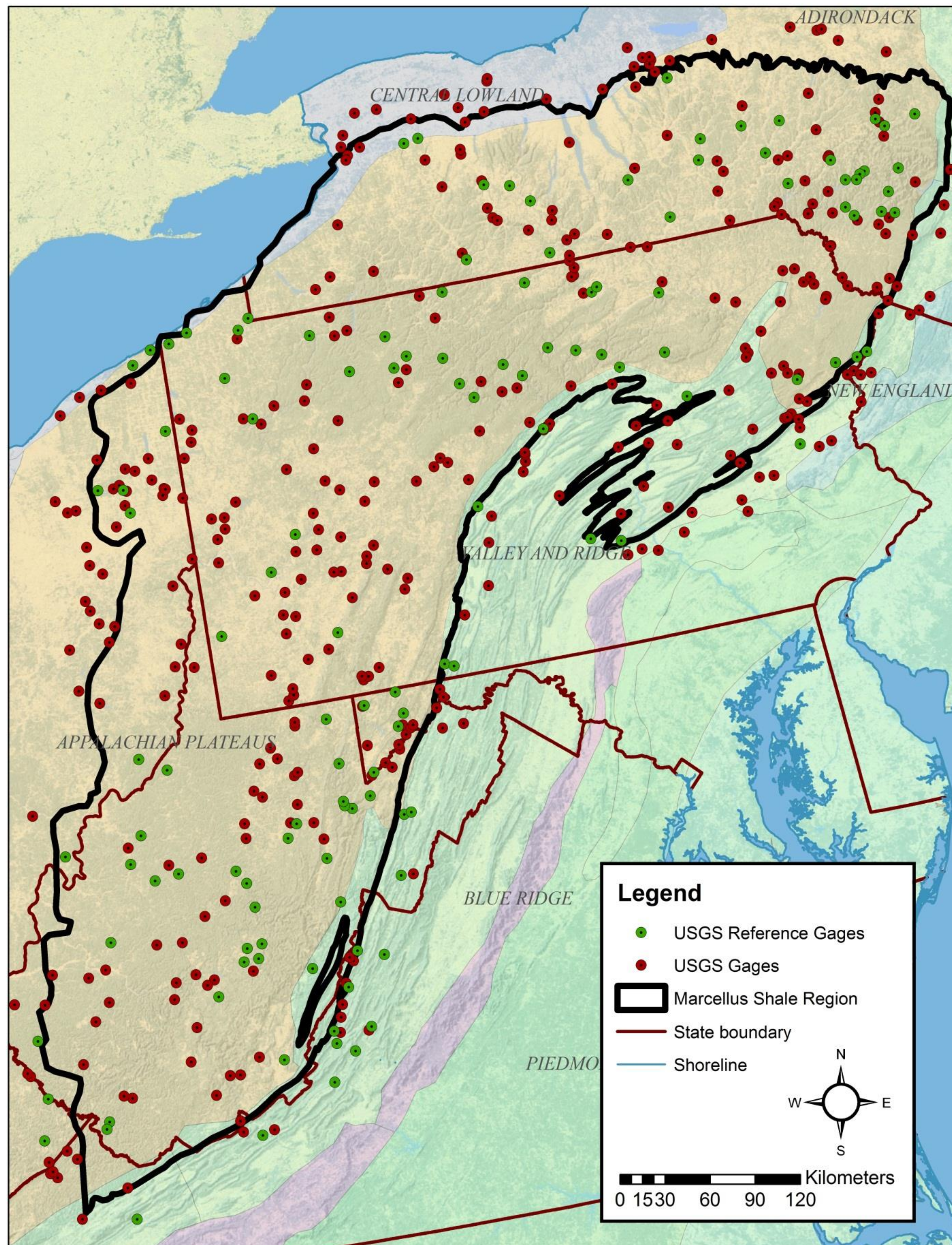
# What are your primary data sources and how can data be shared across project teams

- NHD attributes
  - Climate, Landform, Soils, Geology
  - Coordinating with Arlene and Mark on generating spatial datasets
- USGS Reference Gage dataset
  - Expanding GAGES dataset using State Water Office Reference gages and collaborating with Ryan McManamay on putting together an expanded “least altered” gage dataset for flow models and classification

# What are your primary data sources and how can data be shared across project teams

- State Fish and Macroinvertebrate databases (NY, PA, WVA, OH)
  - Considering using the MARIS database as a platform for fish data, updating participating state's data (NY, WVA, PA), and adding eastern Ohio data
  - Also plan to incorporate EPA and USGS NAWQUA data
- State Water Withdrawal info. Have developed a good relationship with NY, established contacts with PA, and have leads for WVA and OH.

# Important technical challenges?



- Biological data collected across a wide region with diverse methods
- Flow Models
  - PA and NY have developed SYE tools to facilitate regulating flow
  - Put together a long list of candidate models for modeling flow regimes across 4 state region.
  - Challenge is to identify, calibrate and use a model that will work across the entire region, but also integrate well with the SYE tools in PA and NY



**Temporal complexity related to Marcellus shale  
withdrawals verses permitting time scales:  
Monthly/Daily vs. subdaily withdrawals**

# **What opportunities do you see for collaboration and model integration?**

- Established collaboration with TNC project regarding developing spatial datasets and stream classification
- Exploring overlap between Marcellus project and other flow modeling efforts in NE projects.
- Exploring opportunities to integrate flow-ecology relationships across projects for shared target species (Brook trout).