The Role of River-Floodplain Connectivity in Nutrient Removal

Durelle Scott & Nathan Jones, Virginia Polytechnic Institute and State University

Collaborators: Richard Keim, Brandon Edwards, Robert Cook, Andy Naiman, Louisiana State University; Judson Harvey, Dan Kroes, Greg Noe, U.S. Geological Survey

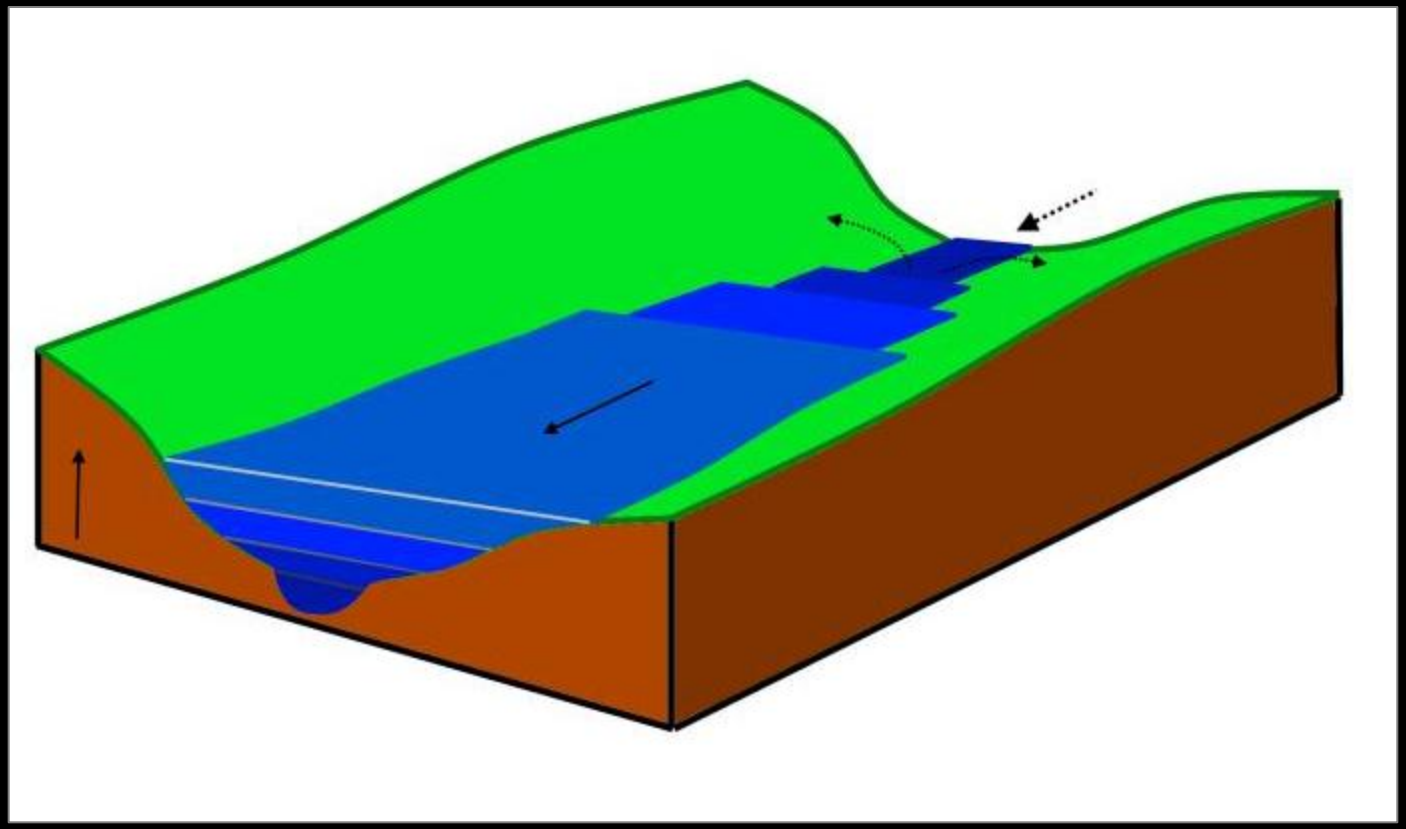
National Science Foundation
WHERE DISCOVERIES BEGIN

LSU
LOUISIANA STATE UNIVERSITY

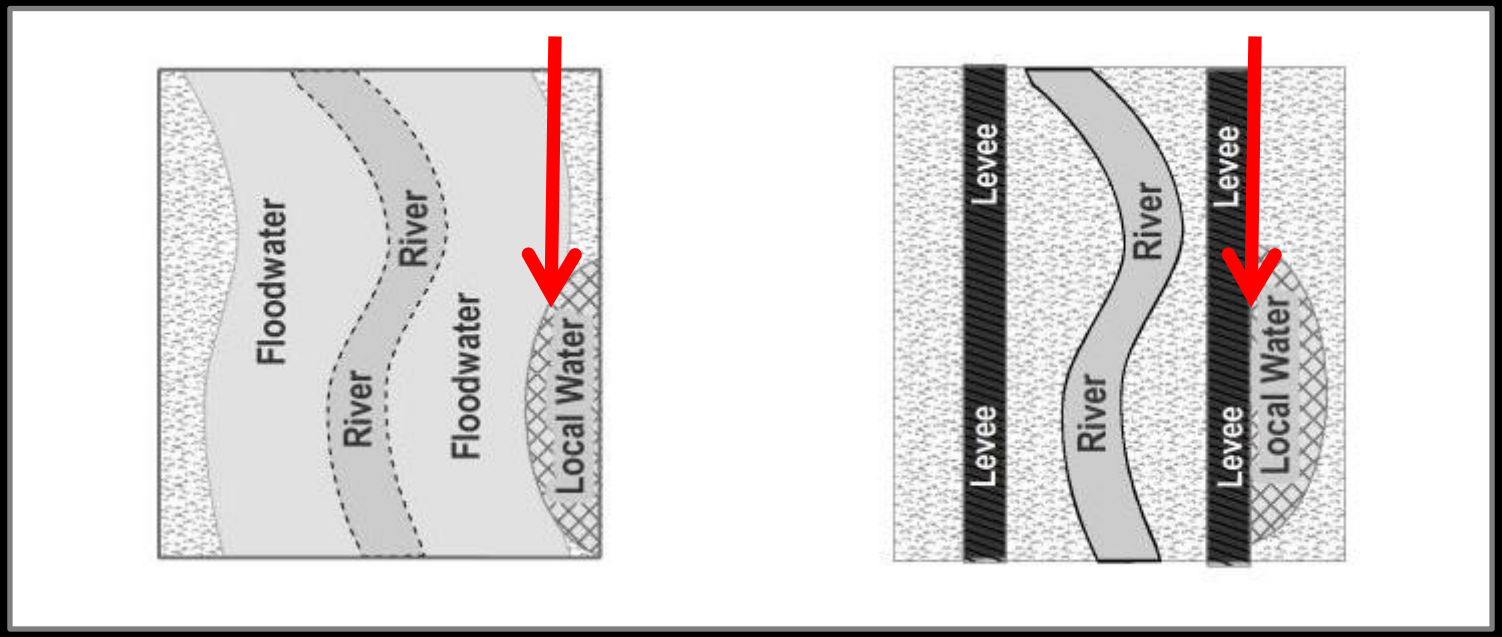
USGS
science for a changing world

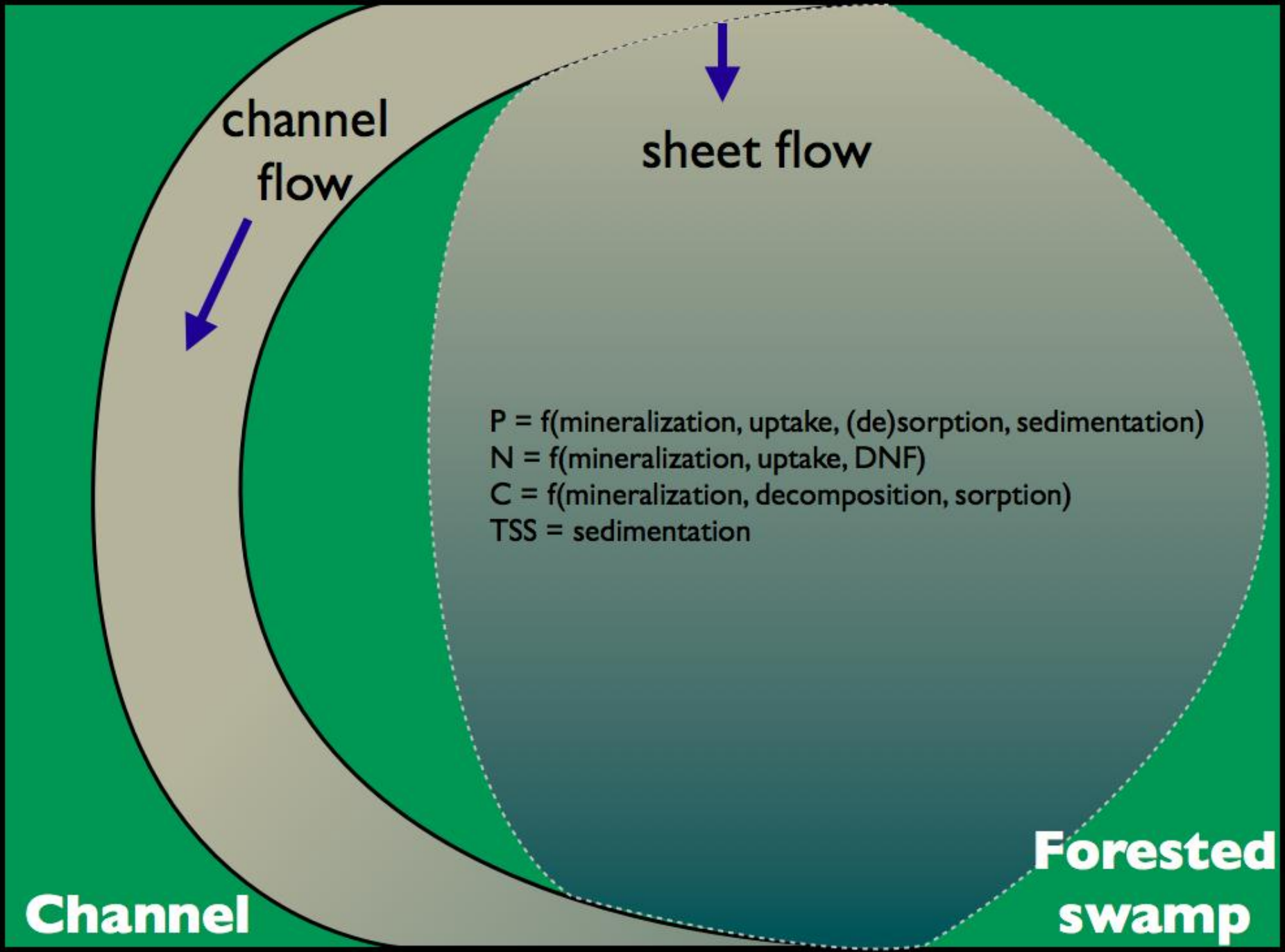
CENTER for WATERSHED STUDIES at VIRGINIA TECH

Riverine Floodplains



Connected vs. Disconnected Floodplain




channel
flow
sheet flow
P = f(mineralization, uptake, (de)sorption, sedimentation)
N = f(mineralization, uptake, DNF)
C = f(mineralization, decomposition, sorption)
TSS = sedimentation
Channel
Forested
swamp

Primary Questions:

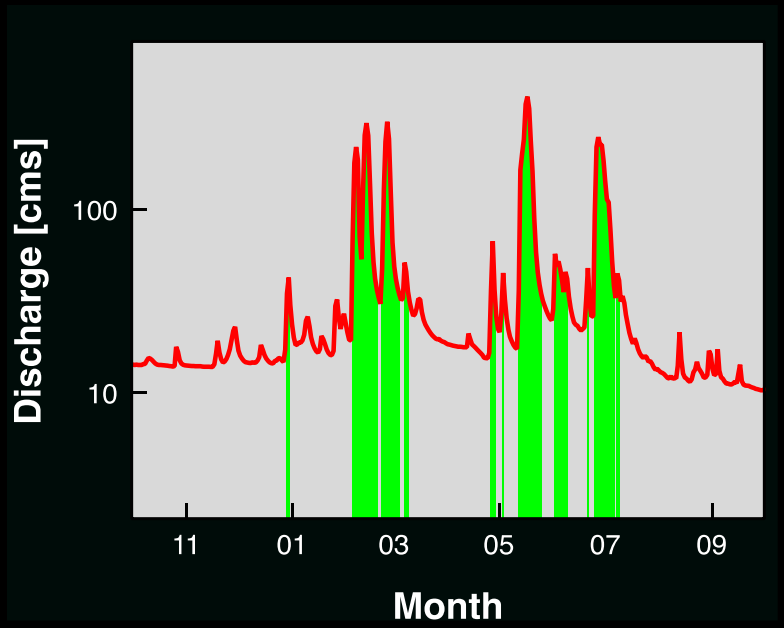
- How does connectivity change temporally?
- How does floodplain connectivity change spatially?
- What does this mean for reactive nutrients?

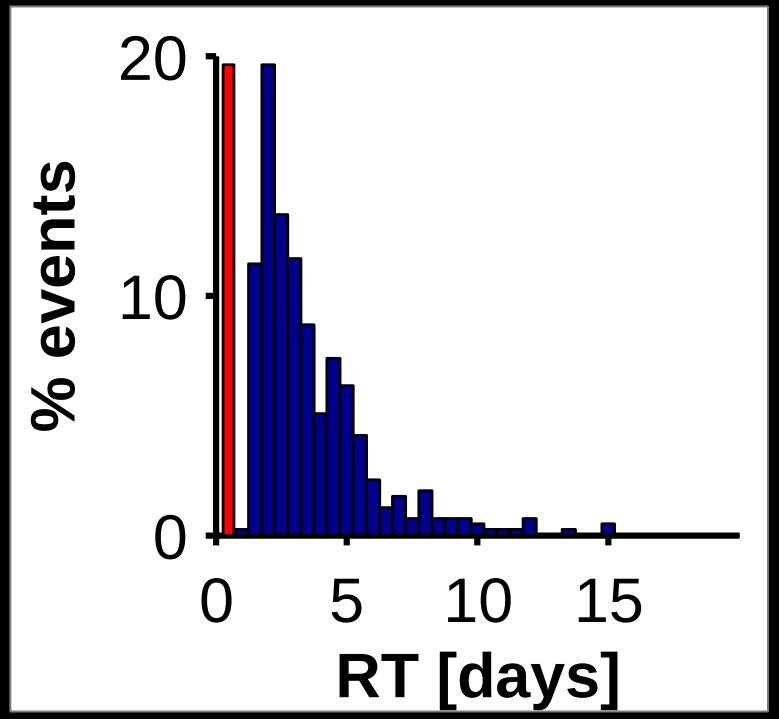
201  asin

Frequency of Connection

How frequently does inundation occur?
f(topography, climate, soils and human impacts)

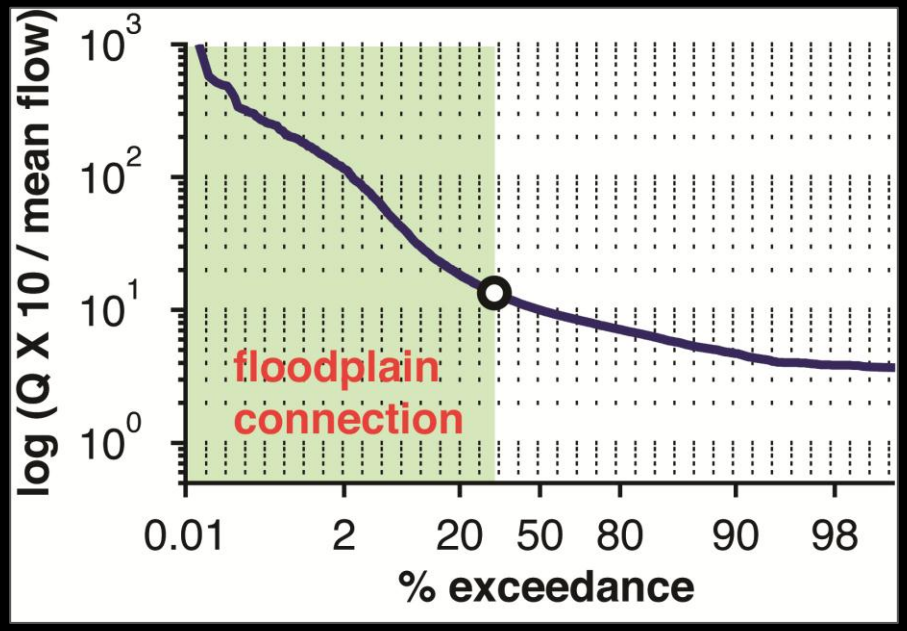
Length of Connection
(i.e. Residence Time)



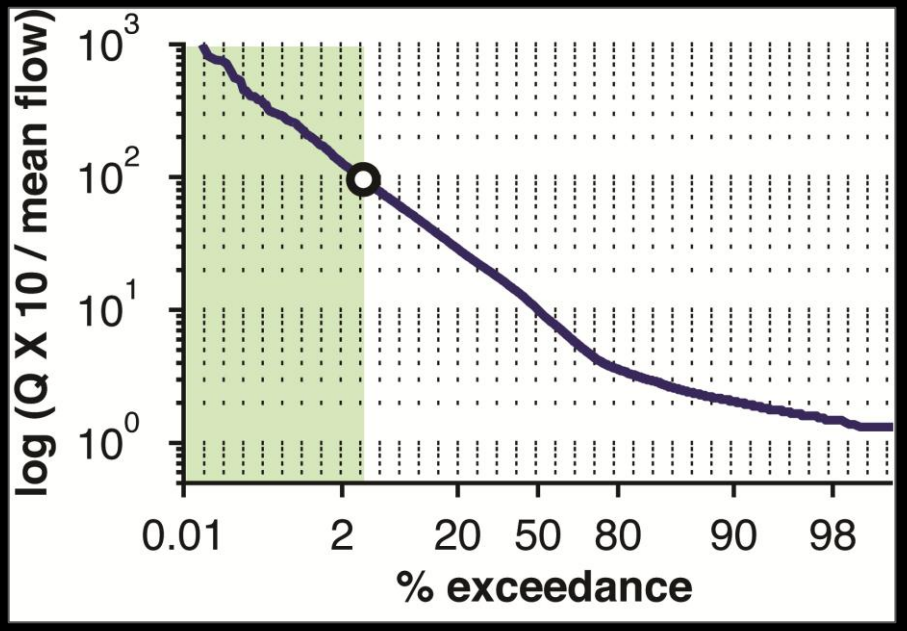


Frequency of connection

Southeastern Coastal: Tangipahoa

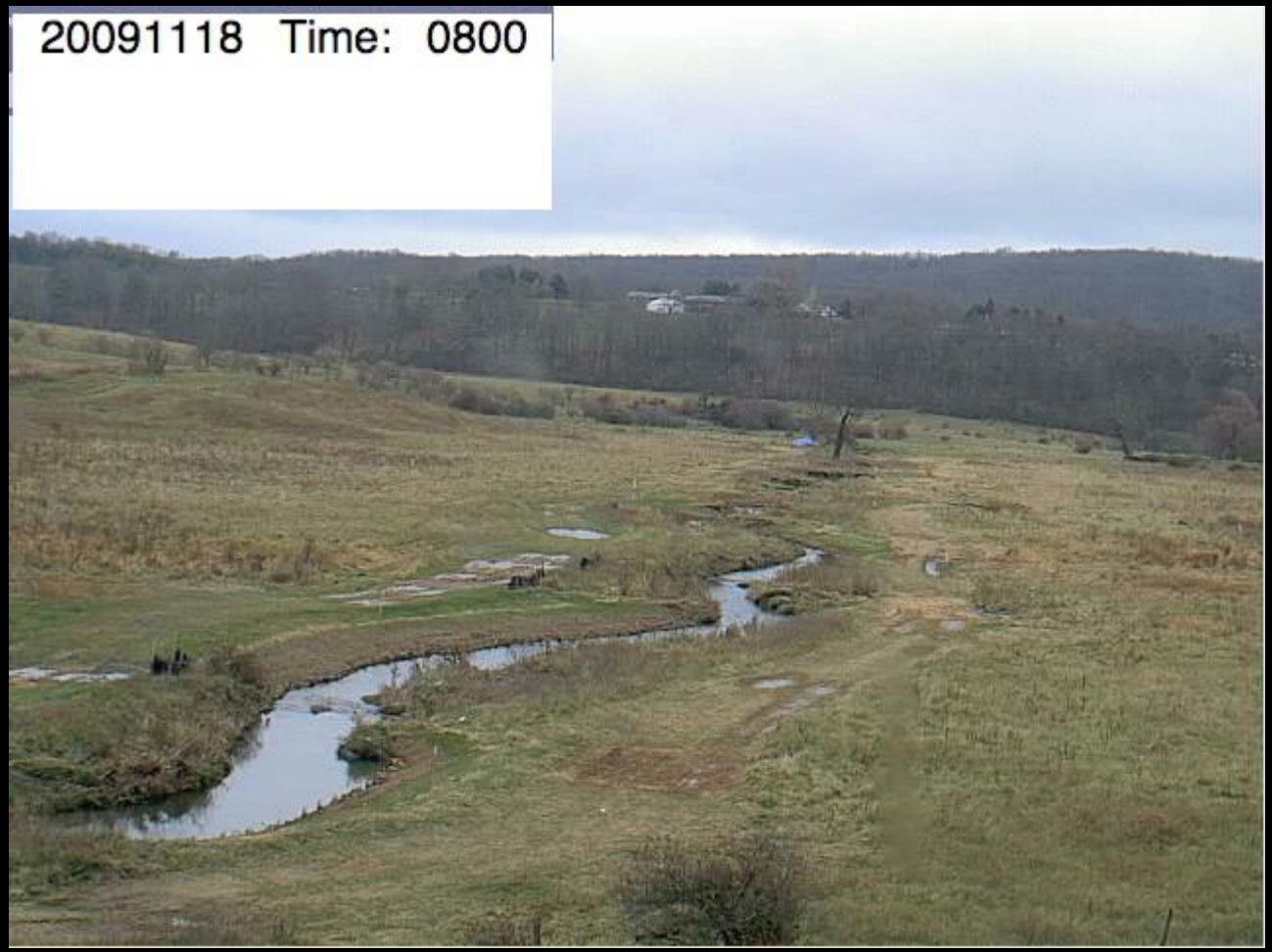


Ridge & Valley: Craig Creek



Frequent connectivity (>30%) vs. Infrequent connectivity (< 3%)

Temporal Variation



Spatial Variation

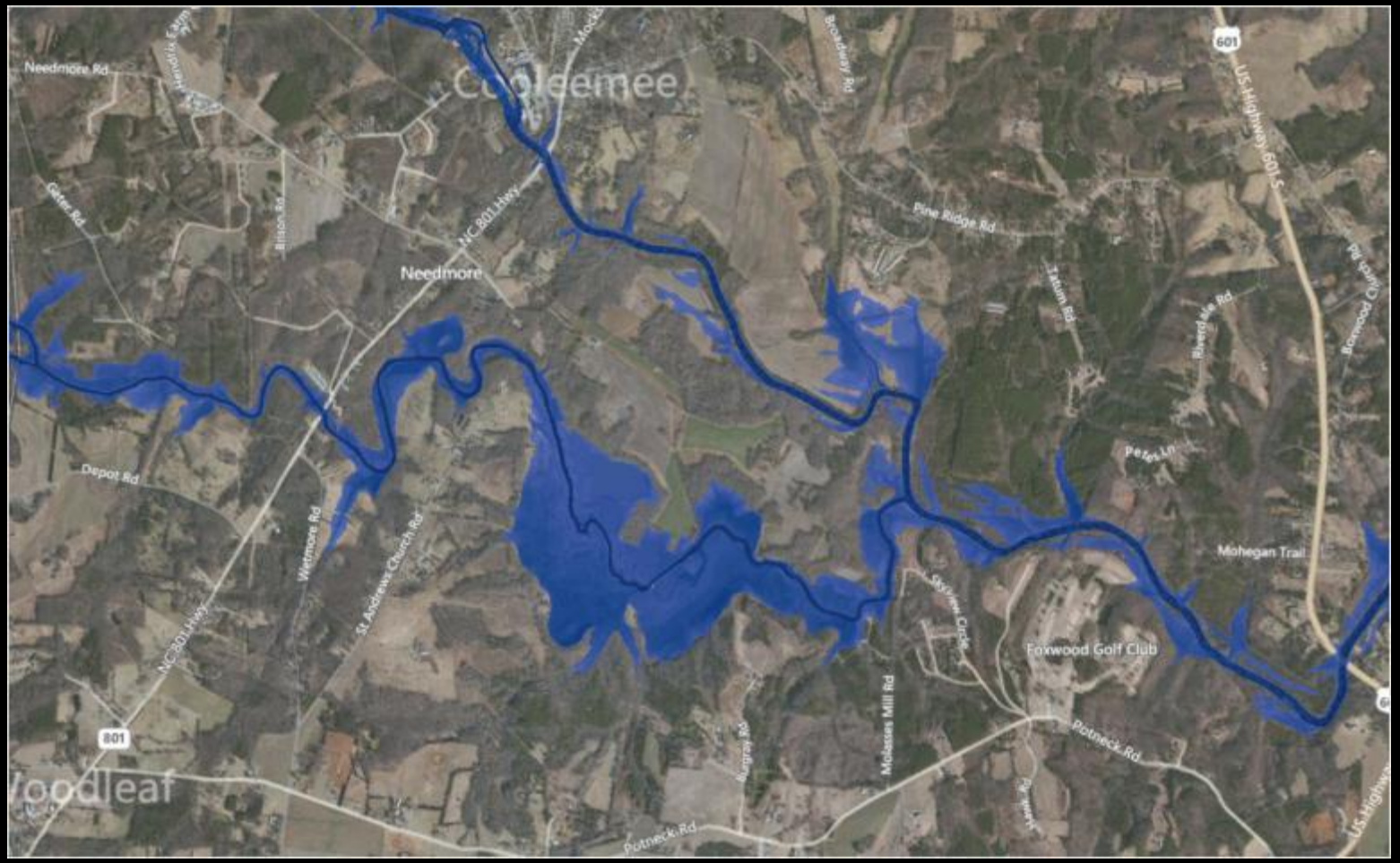
Spatial Variation

Spatial Variation

Spatial Variation

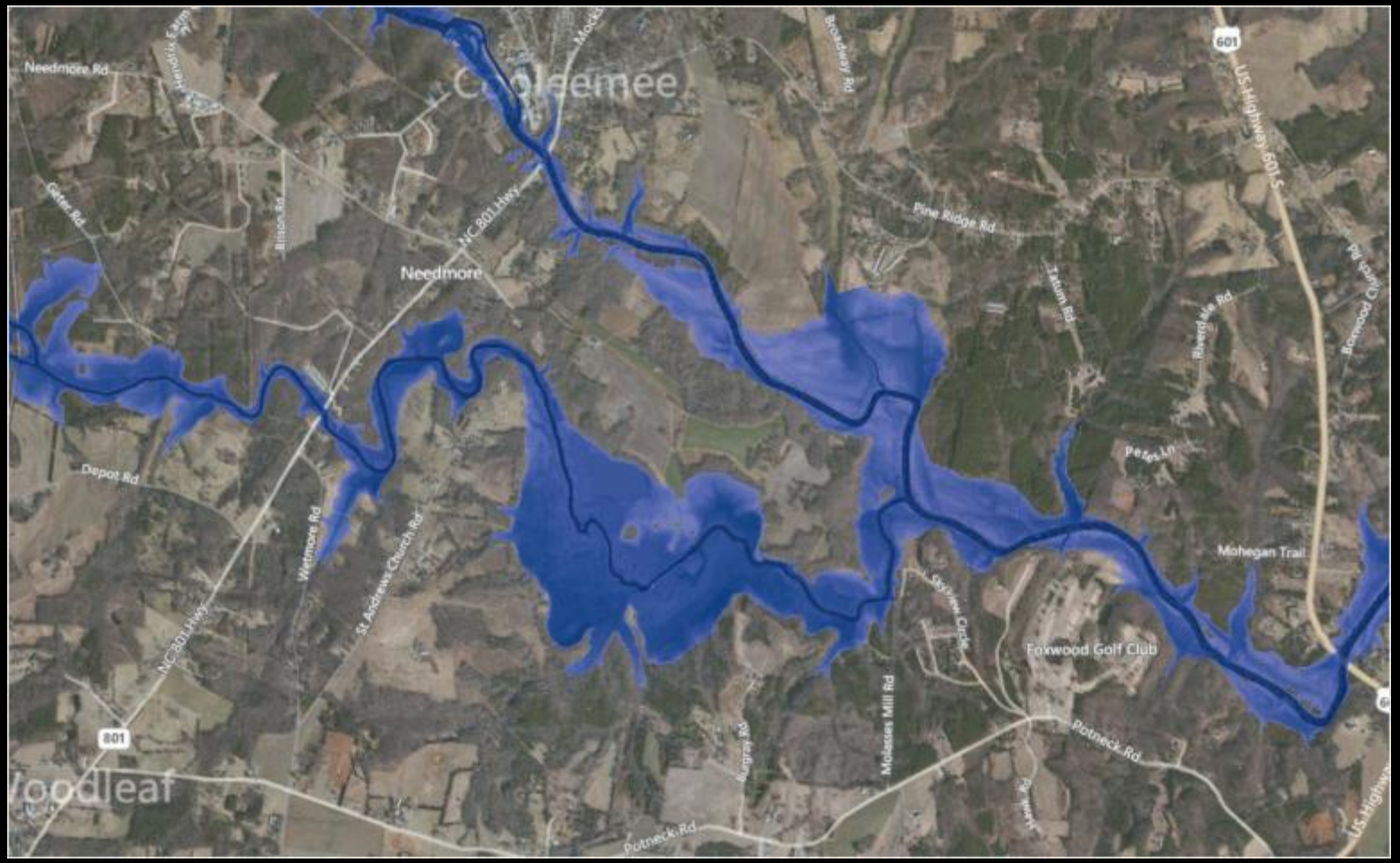
Spatial Variation

Spatial Variation

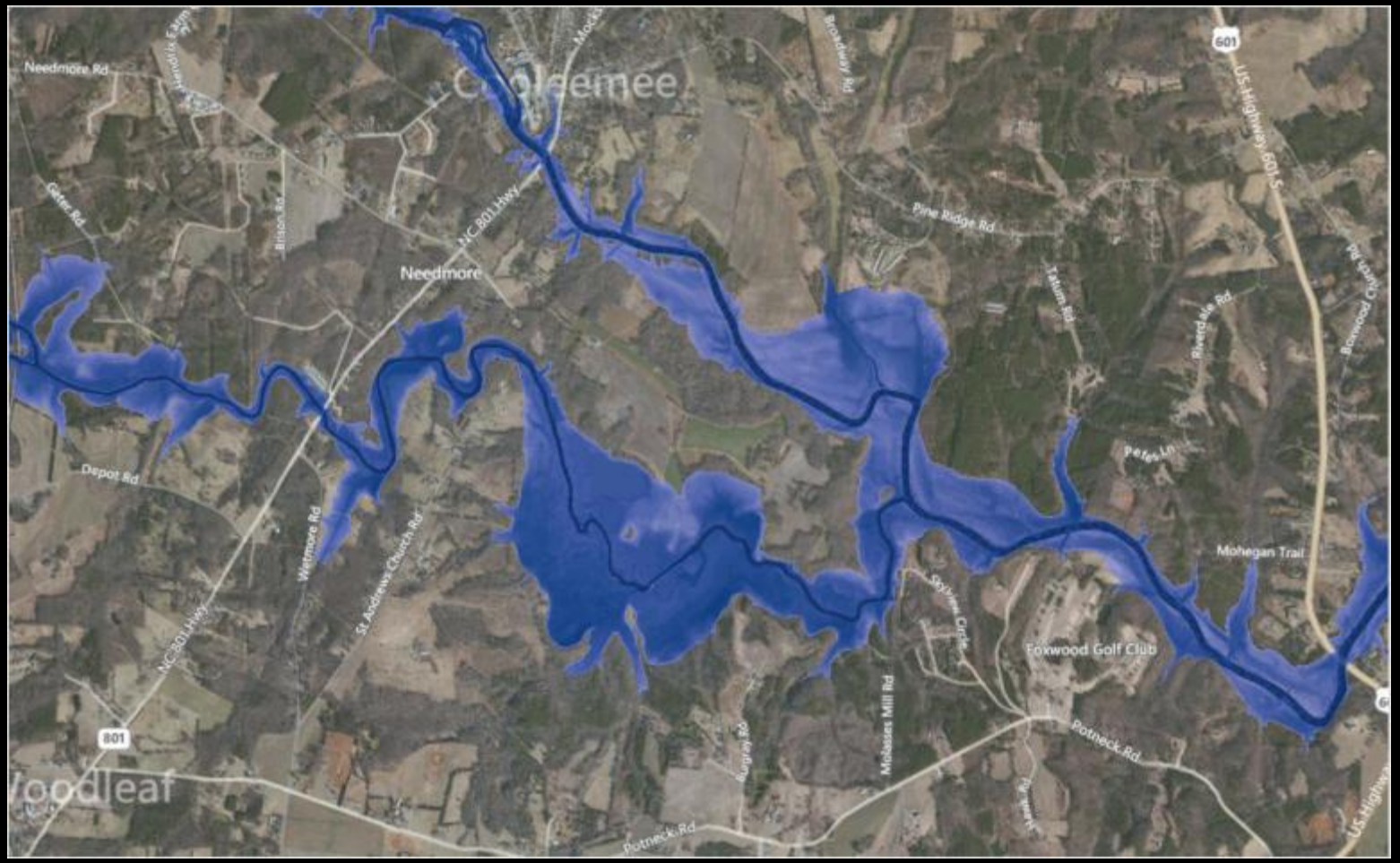


Spatial Variation

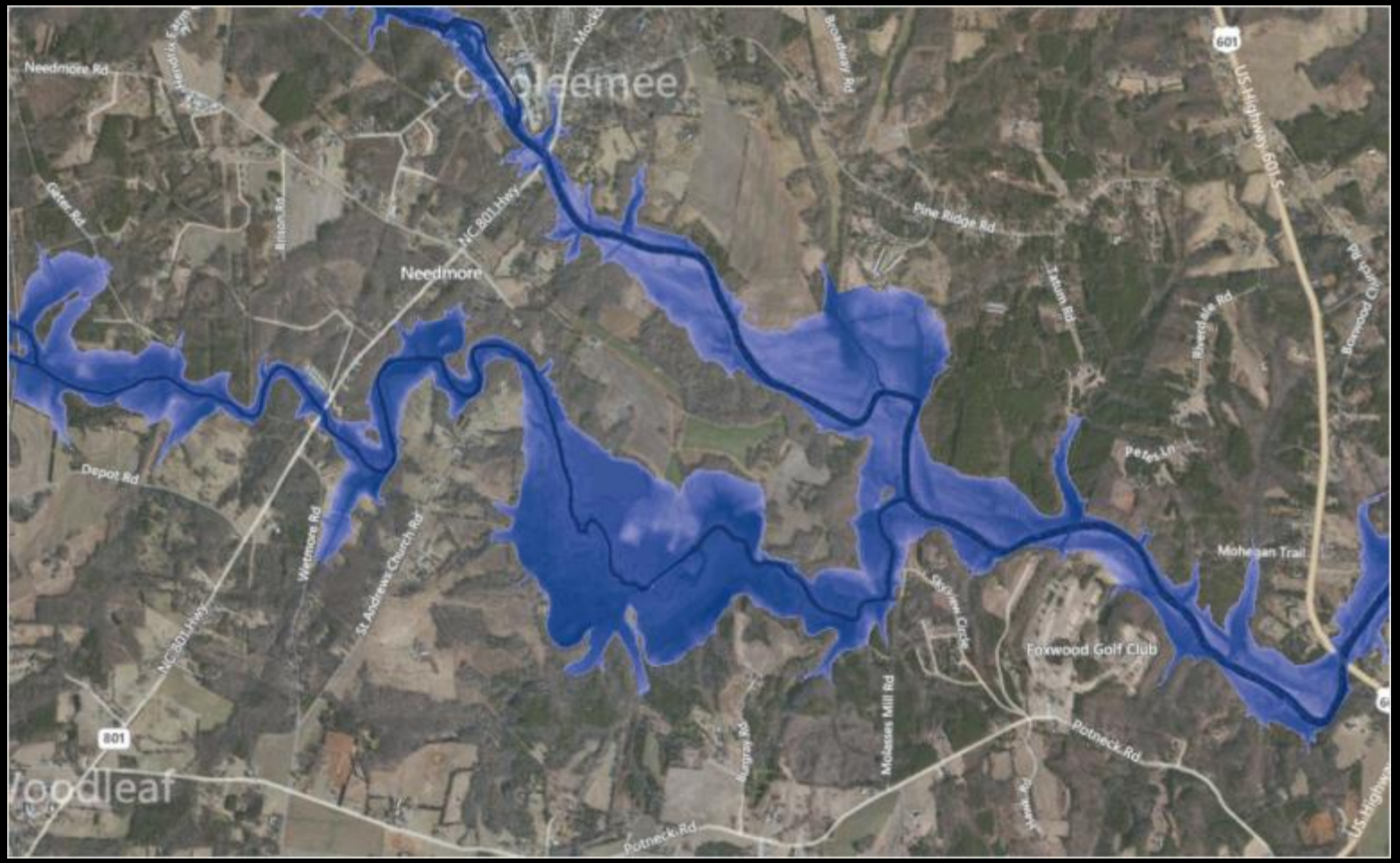
Spatial Variation



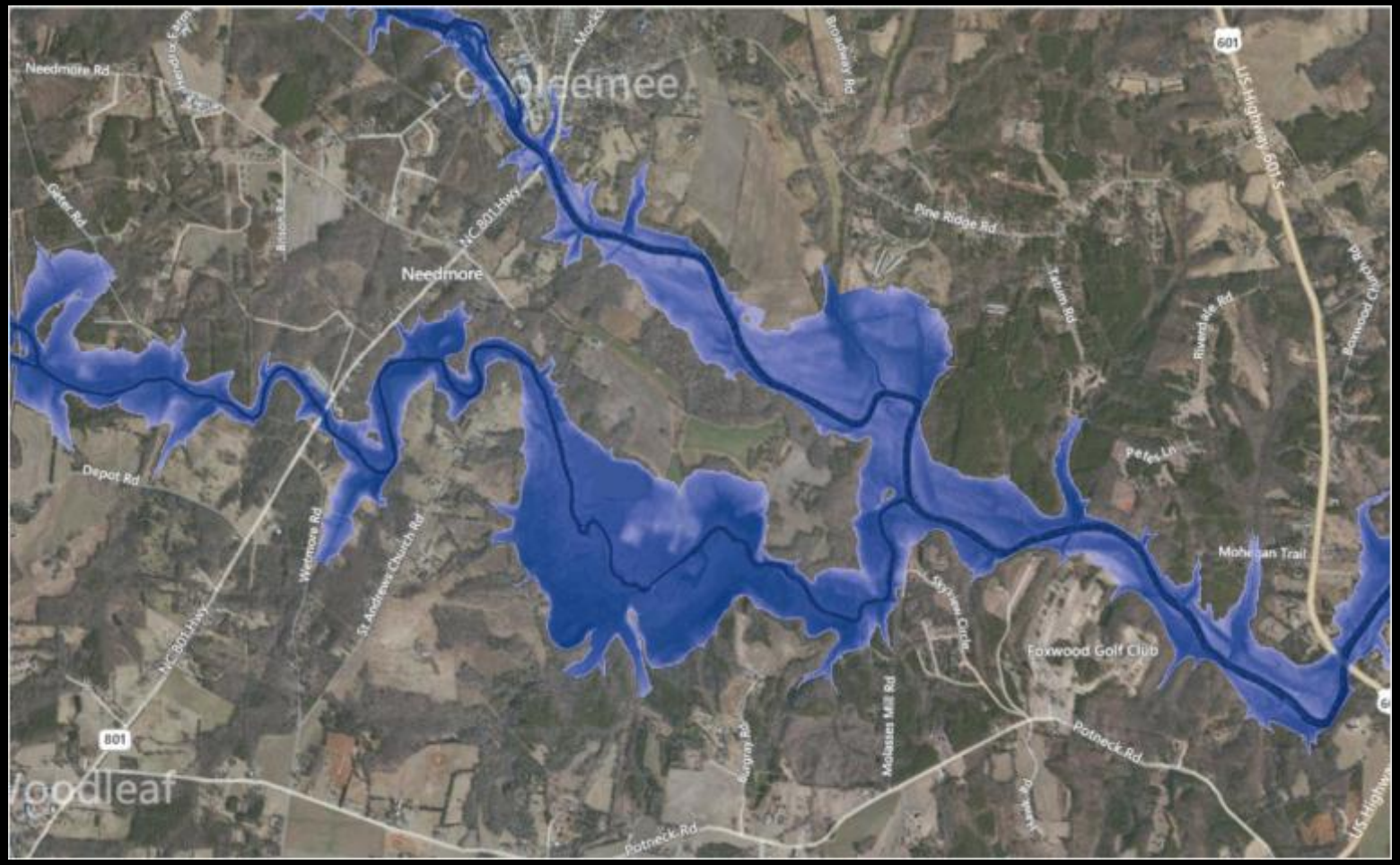
Spatial Variation



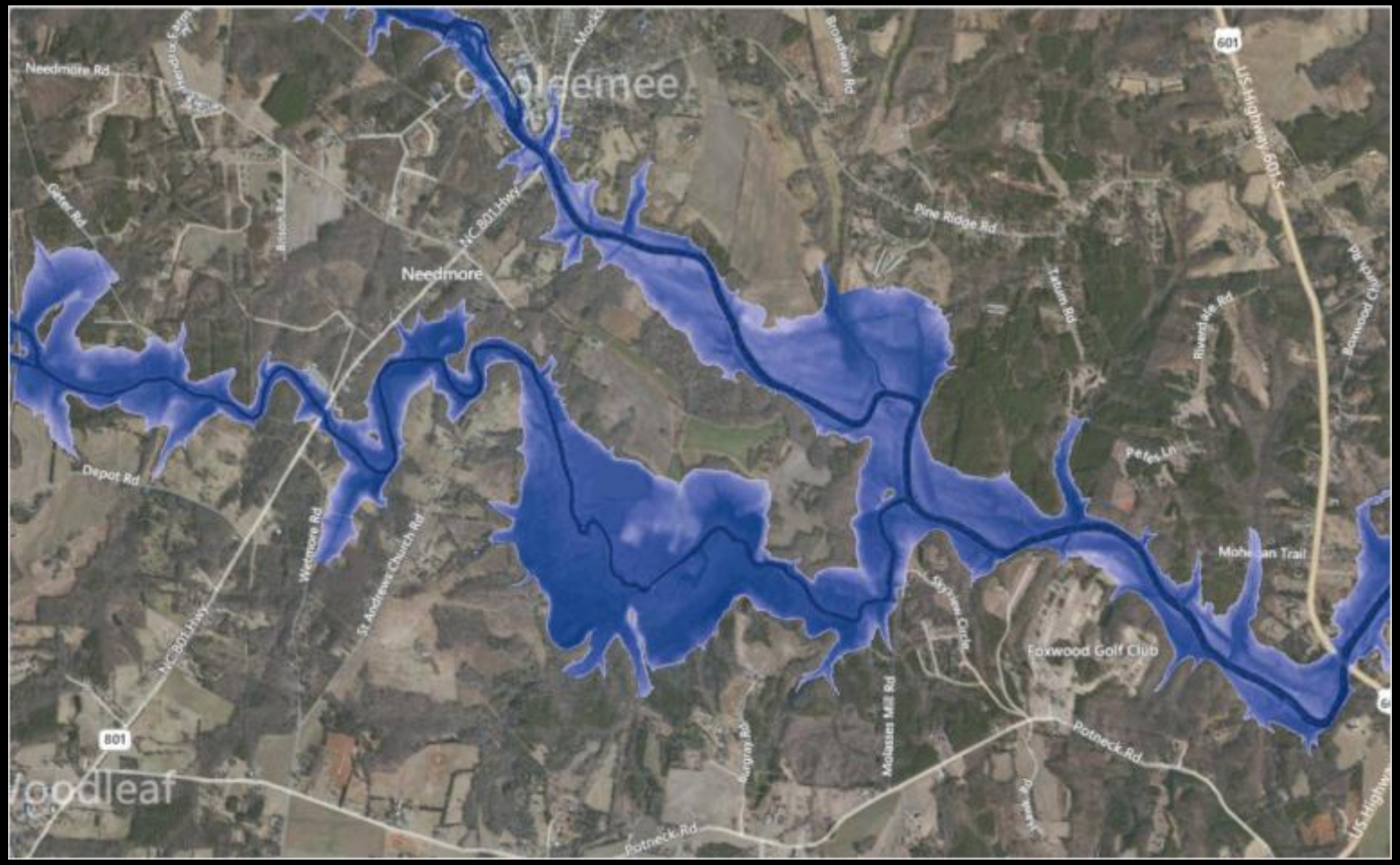
Spatial Variation



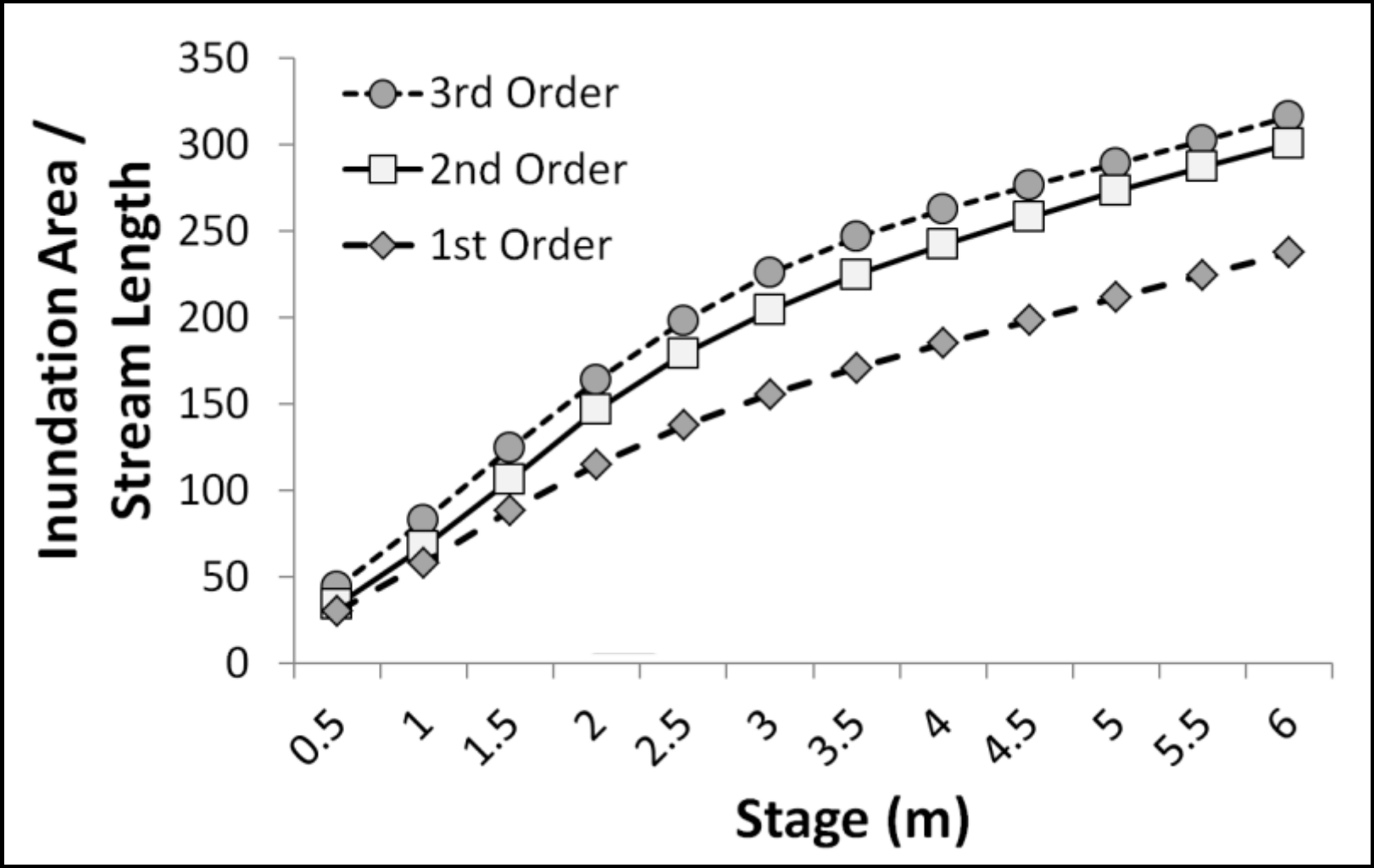
Spatial Variation



Spatial Variation



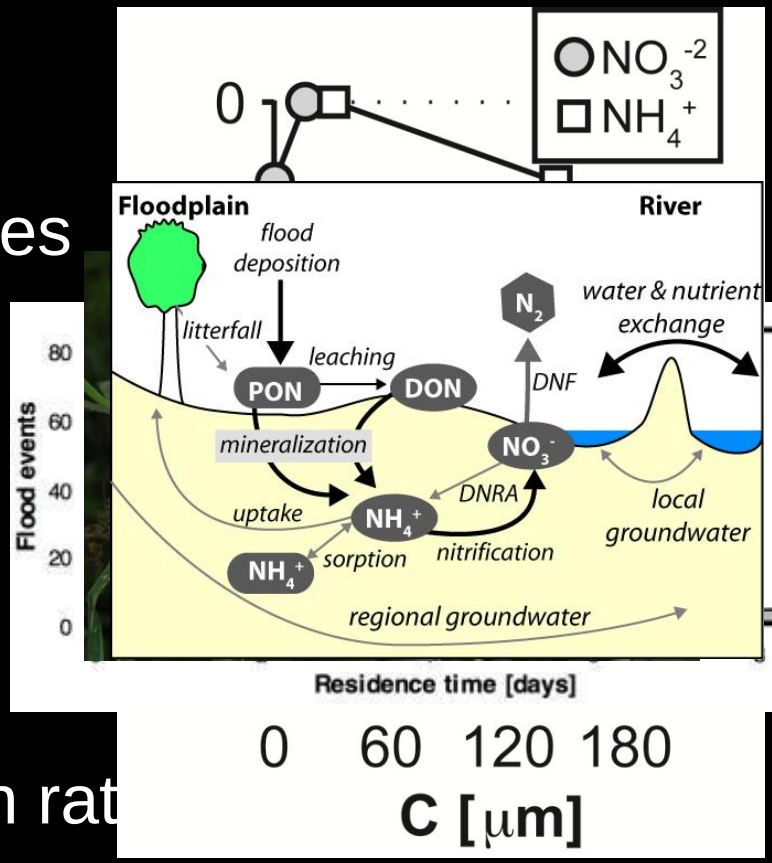
Spatial Variation in Inundation



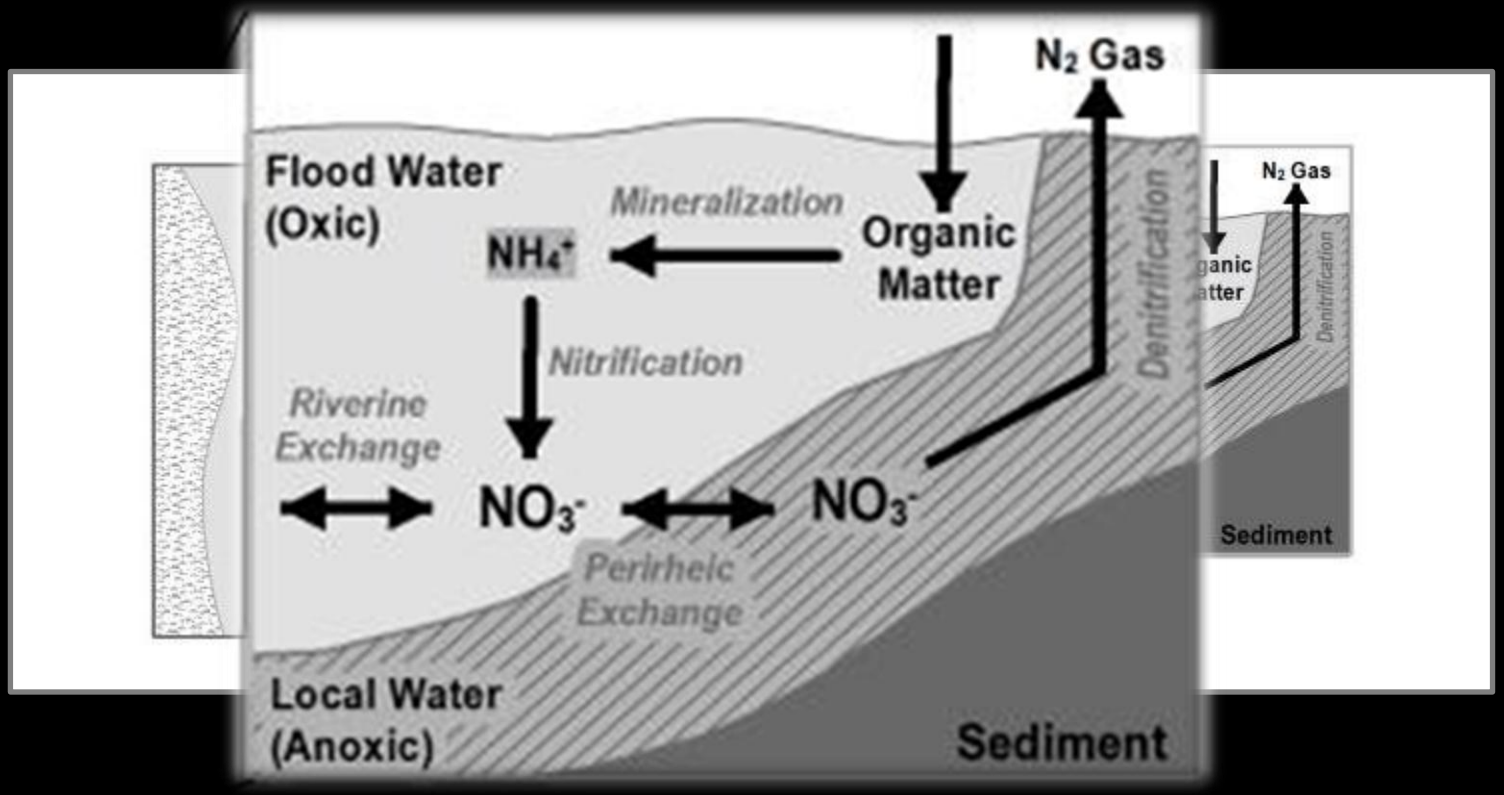
In-situ nutrient processing

- Sediment Deposition
- Increased contact with sediment and microbial surfaces
- Development of redox gradients:
  - DNF
  - Mineralization

- Residence time >denitrification rat

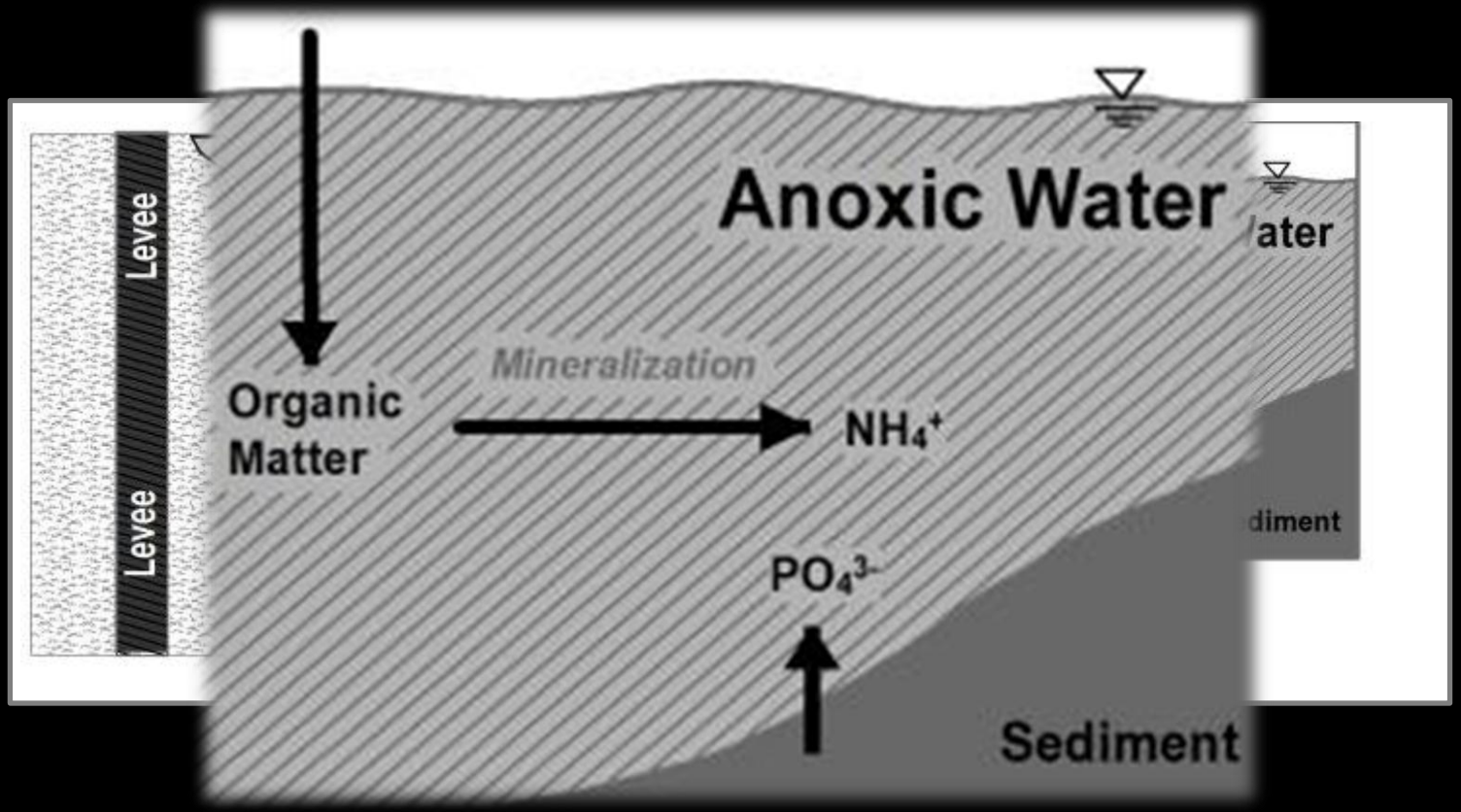


Connected Floodplain




River
Water
Perirheic Zone
Local
Water

Disconnected Floodplain



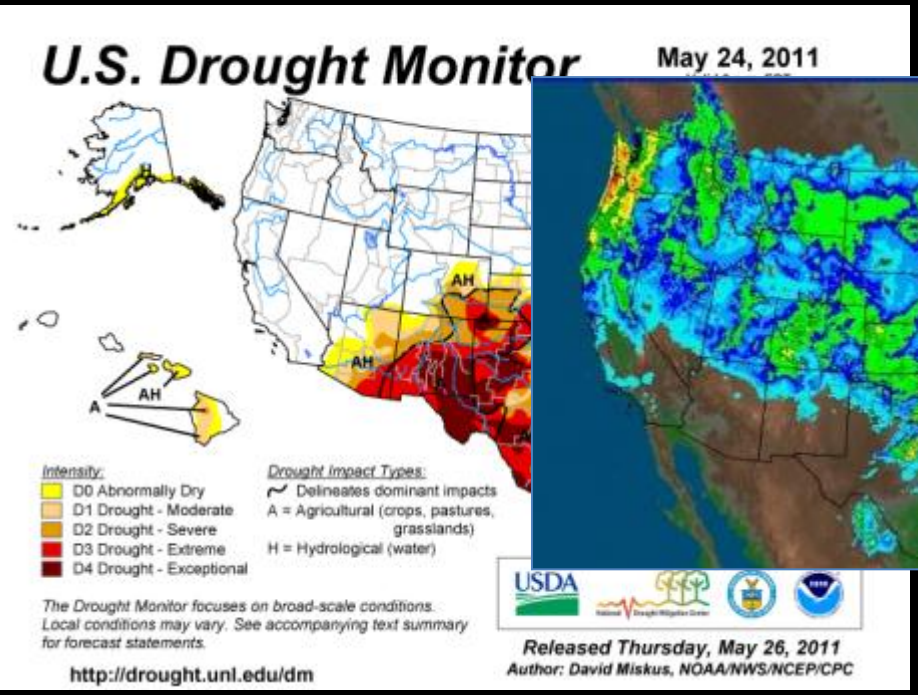
Riverine Floodplains

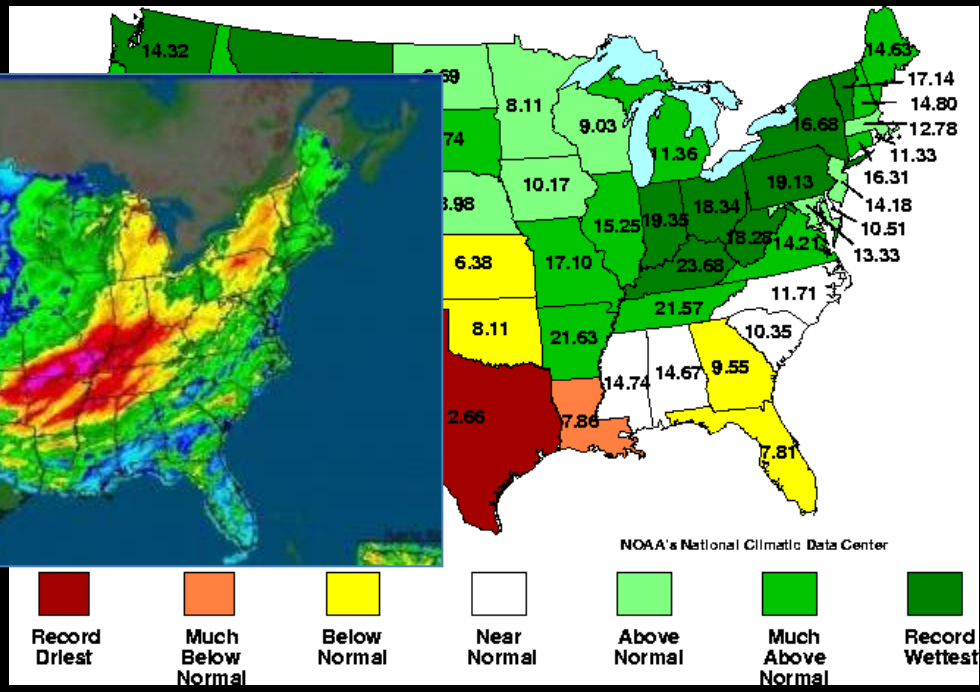
- Temporal Variability
- Spatial Connectivity
- Biogeochemical Importance

- Example: 2011 Flood in the Atchafalaya Swamp

2011 Lower Mississippi

- Drought in southwest
- High rain in midwest (> 20inches) resulted in one of highest floods on record!

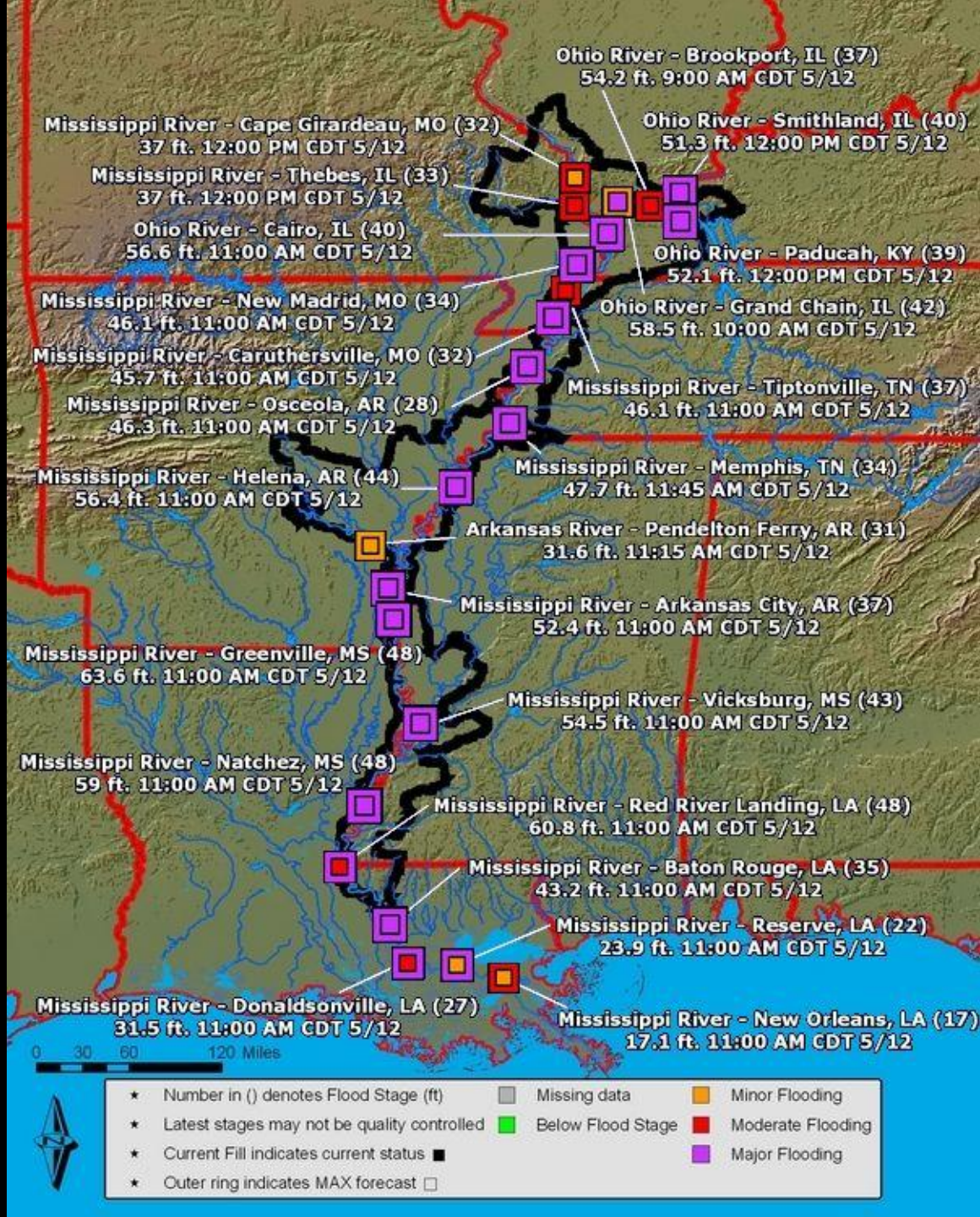




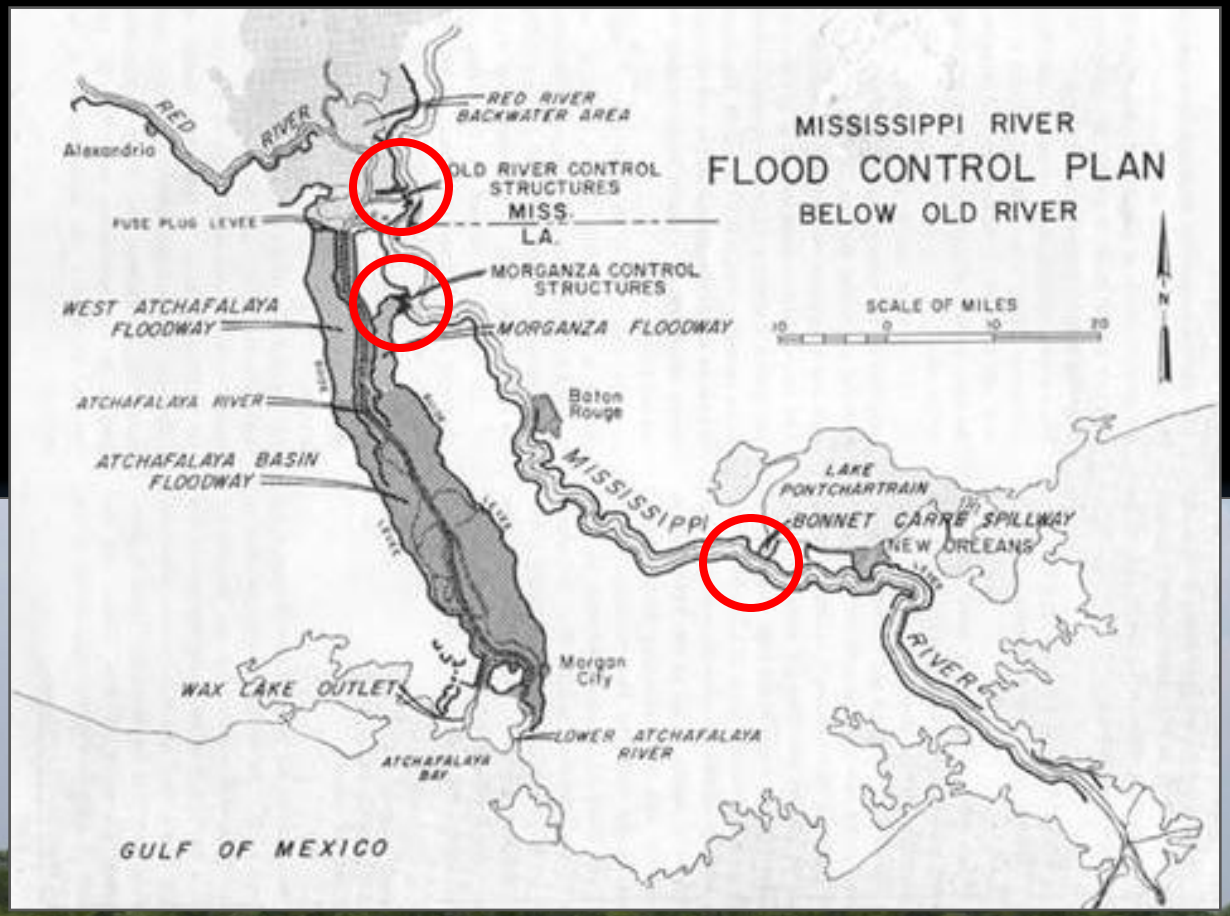
Vicksburg Stage:
57.06’ in 2011
Previous Record:
56.2’ in 1927

The Great Mississippi River Flood of 1927, photographed in Illinois on March 25.

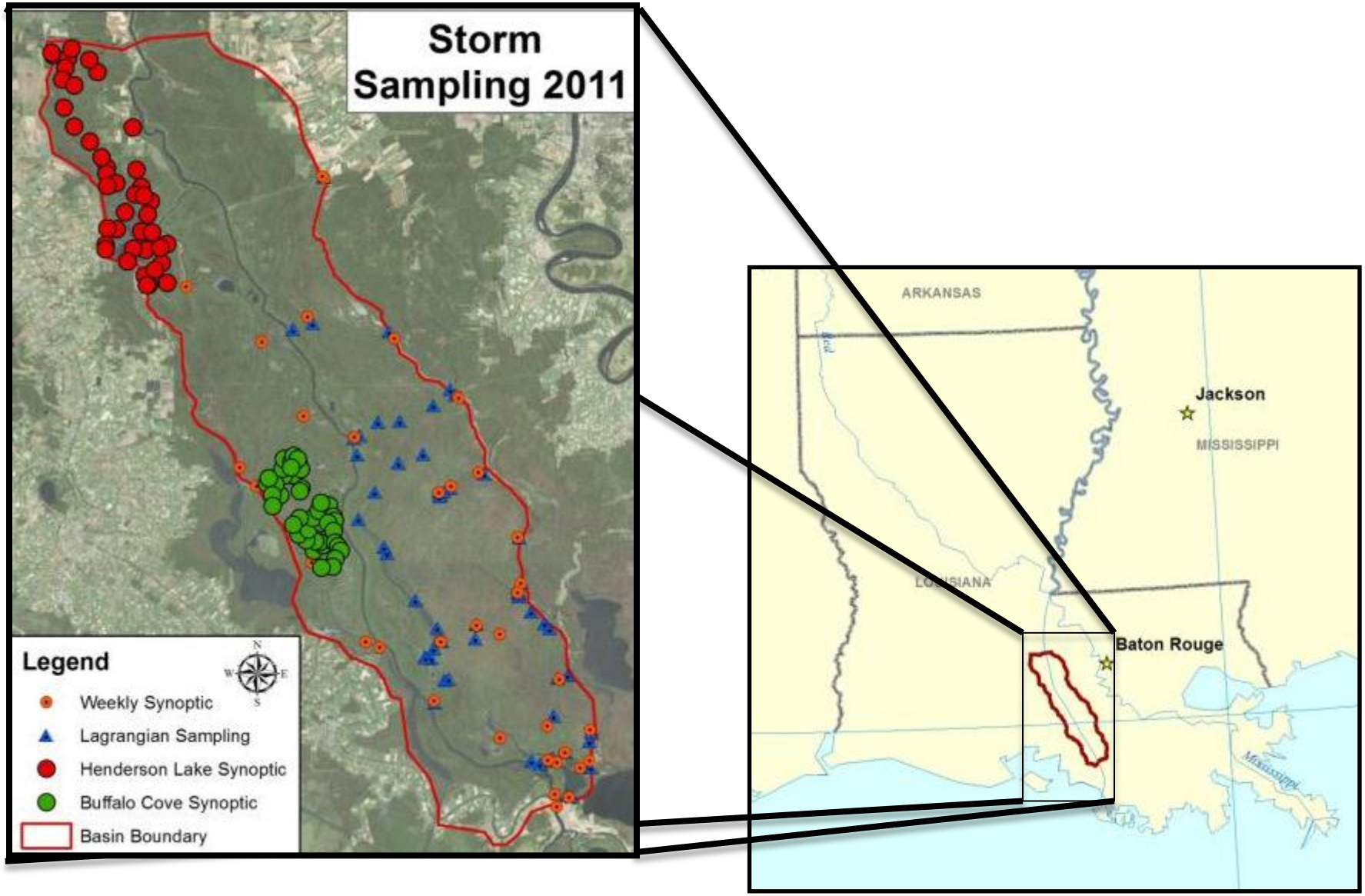
"The Floods of 1927 in the Mississippi Basin," Frankenfeld, H.C., 1927 Monthly Weather Review Supplement No. 29

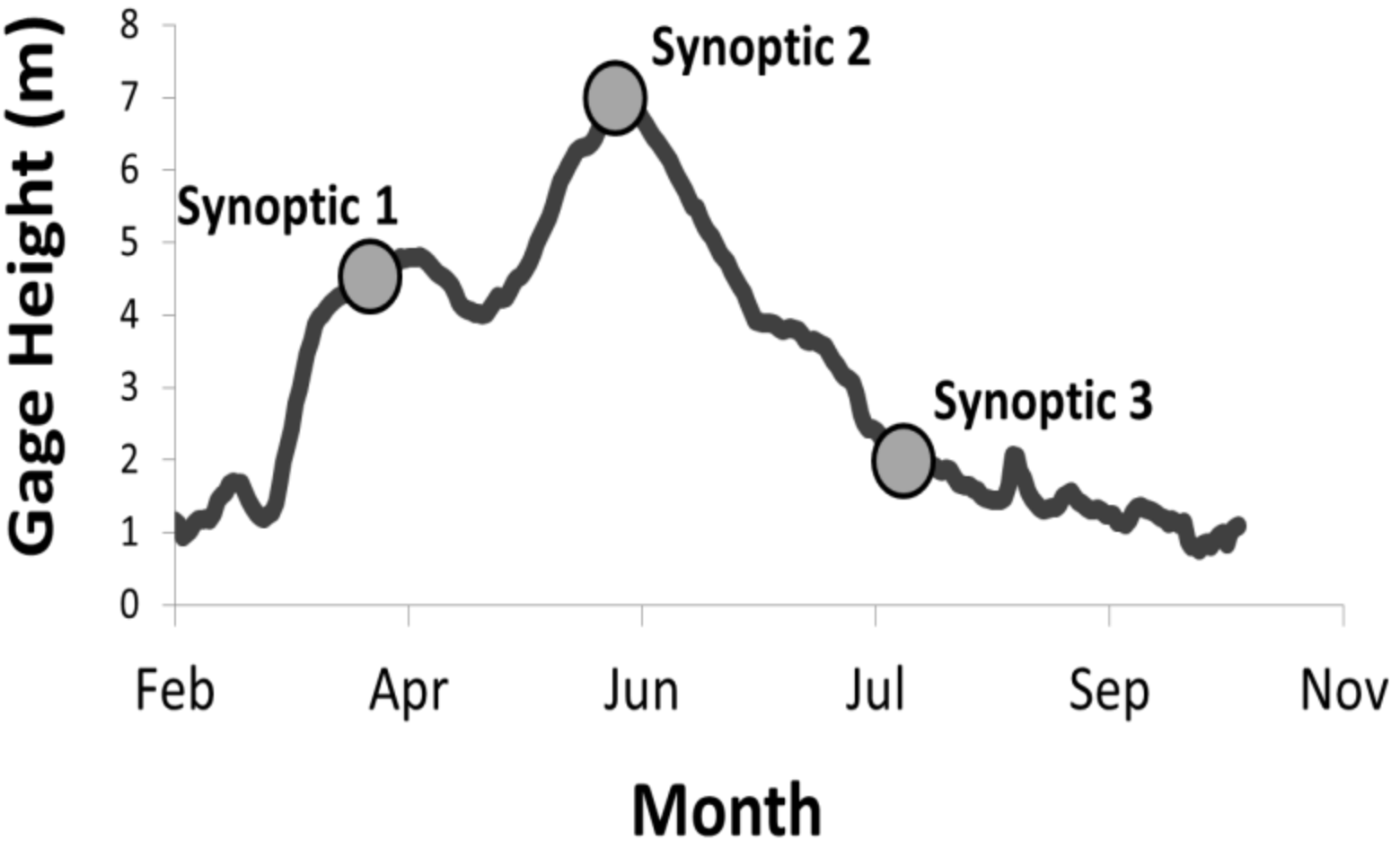


Atchafalaya River

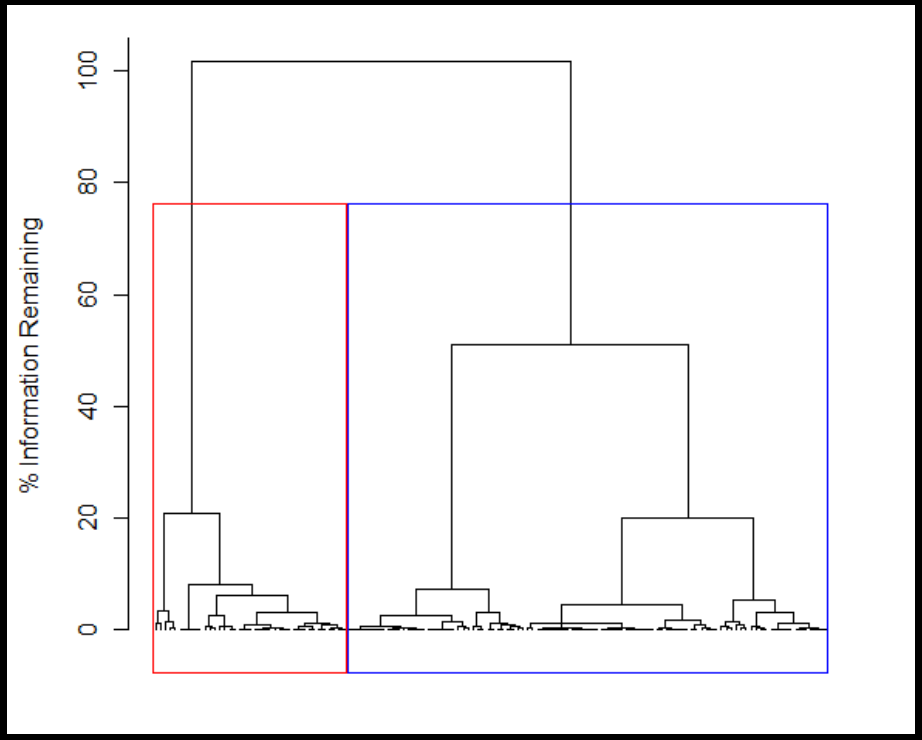


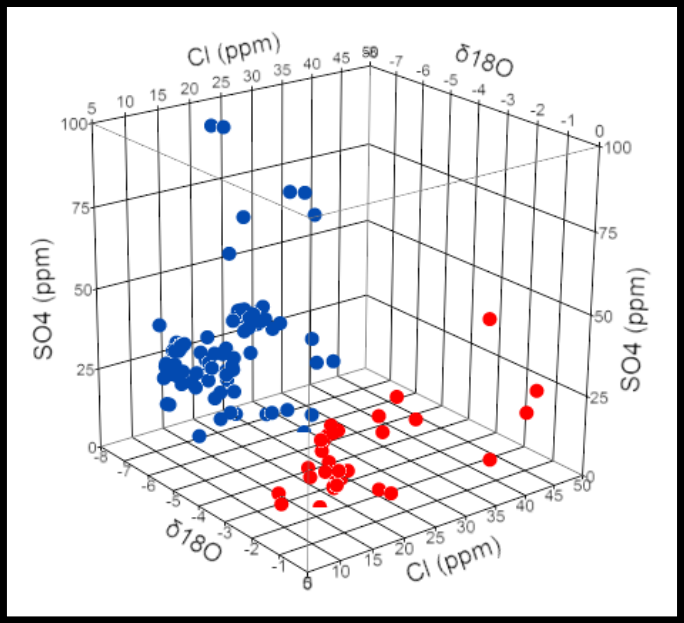
Flood Protection (or experimental Freshwater Diversion?)


Storm Sampling 2011
Legend
Weekly Synoptic
Lagrangian Sampling
Henderson Lake Synoptic
Buffalo Cove Synoptic
Basin Boundary
ARKANSAS
Jackson
MISSISSIPPI
LOUISIANA
Baton Rouge
Mississippi

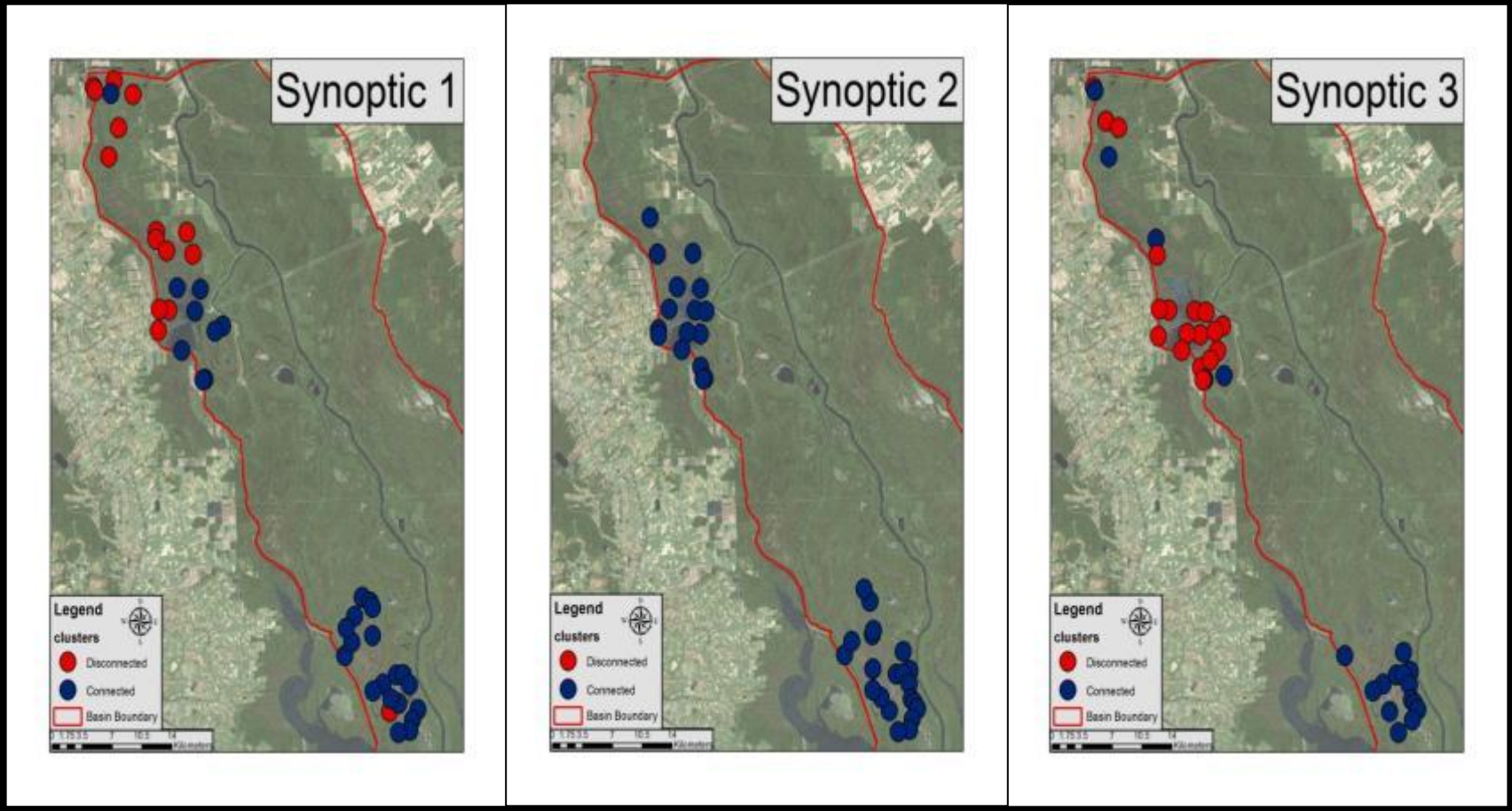

Gage Height (m)
8
7
6
5
4
3
2
1
0
Synoptic 1
Synoptic 2
Synoptic 3
Feb
Apr
Jun
Jul
Sep
Nov
Month

Distinct Chemical Signature

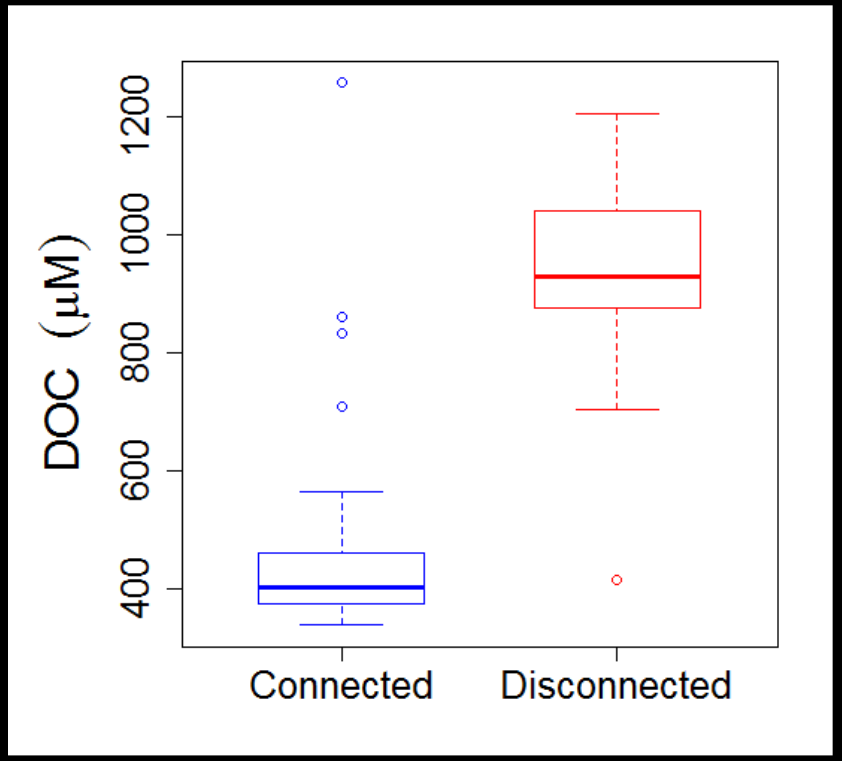


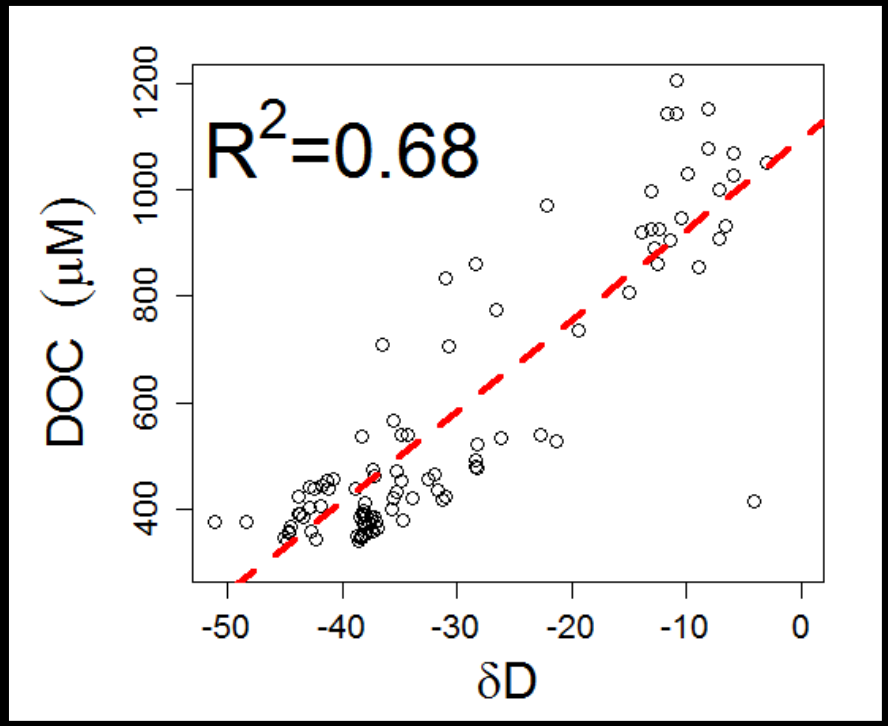


Spatial and Temporal Pattern

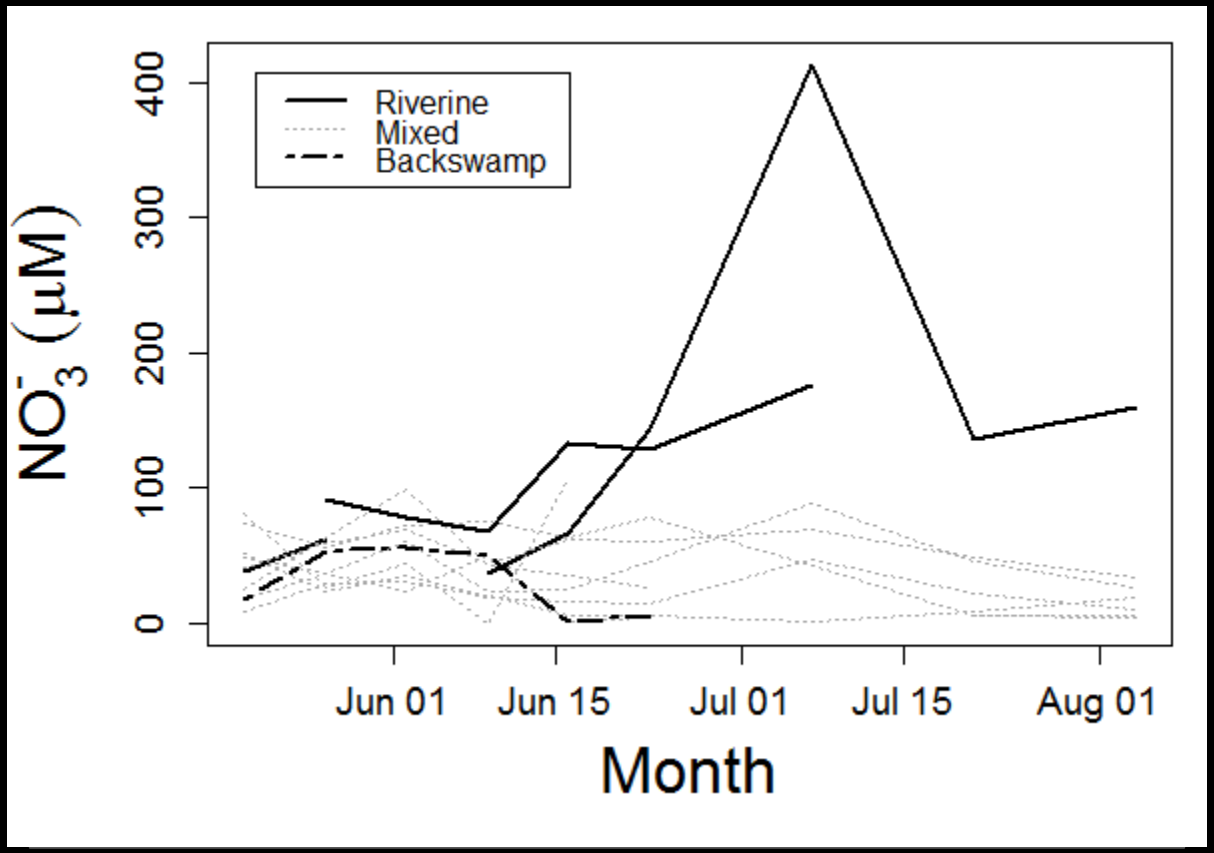


Accumulation of Organic Matter

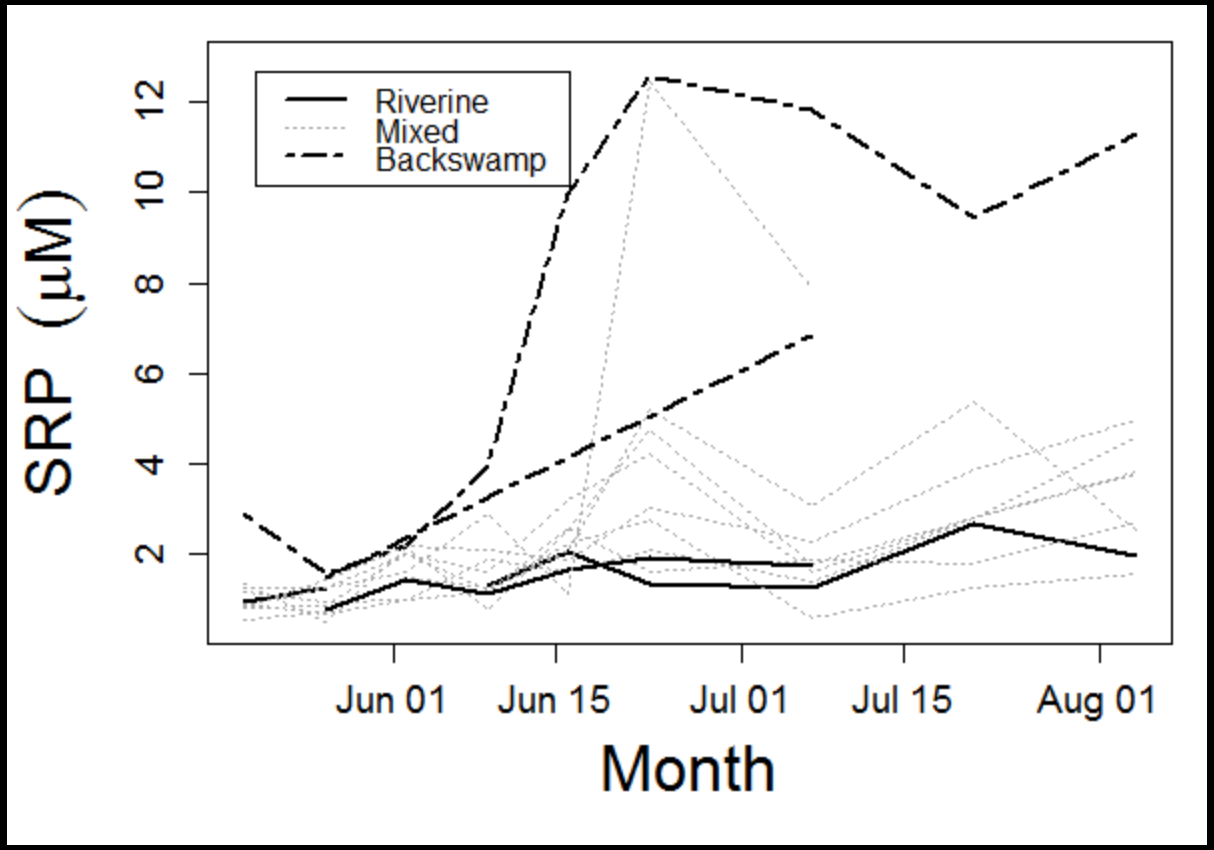




Dissolved Nitrogen Species



Soluble Reactive Phosphorus (SRP)



Initial Atchafalaya Findings

- Distinct connected vs. disconnected chemical signatures
- Accumulation of OM in disconnected regions
- DNF is a dominant process in floodplain systems
- Floodplain was a source of SRP during flood

Conclusions: Riverine Floodplains

- Biogeochemical Importance
- Spatial Connectivity
- Temporal Variability