# Benefits of Compensatory Stream Mitigation in Southern West Virginia

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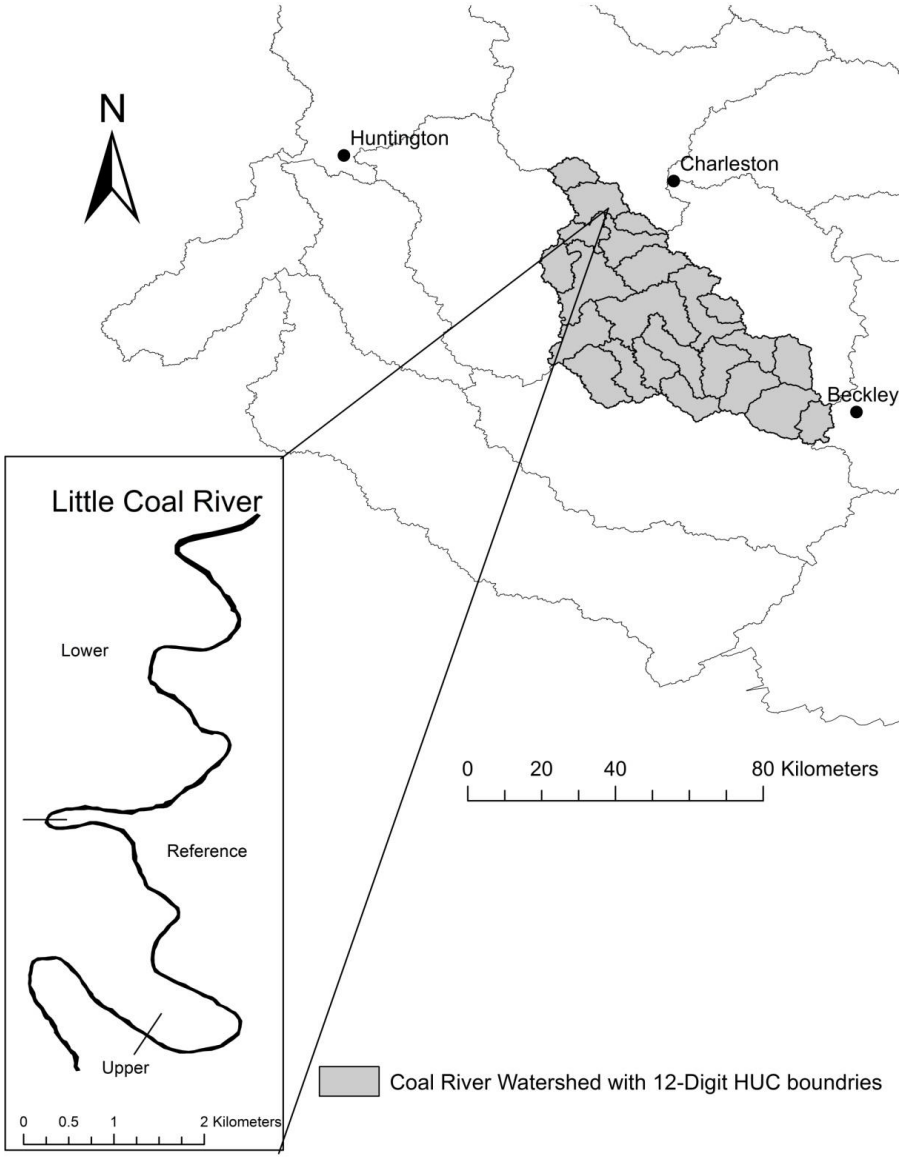
# Overview

- Little Coal River Study Design
- Little Coal River Results
- Little Coal River Conclusions

- Mitigation Project Study Design
- Mitigation Project Results
- Mitigation Project Conclusions

- Future Work

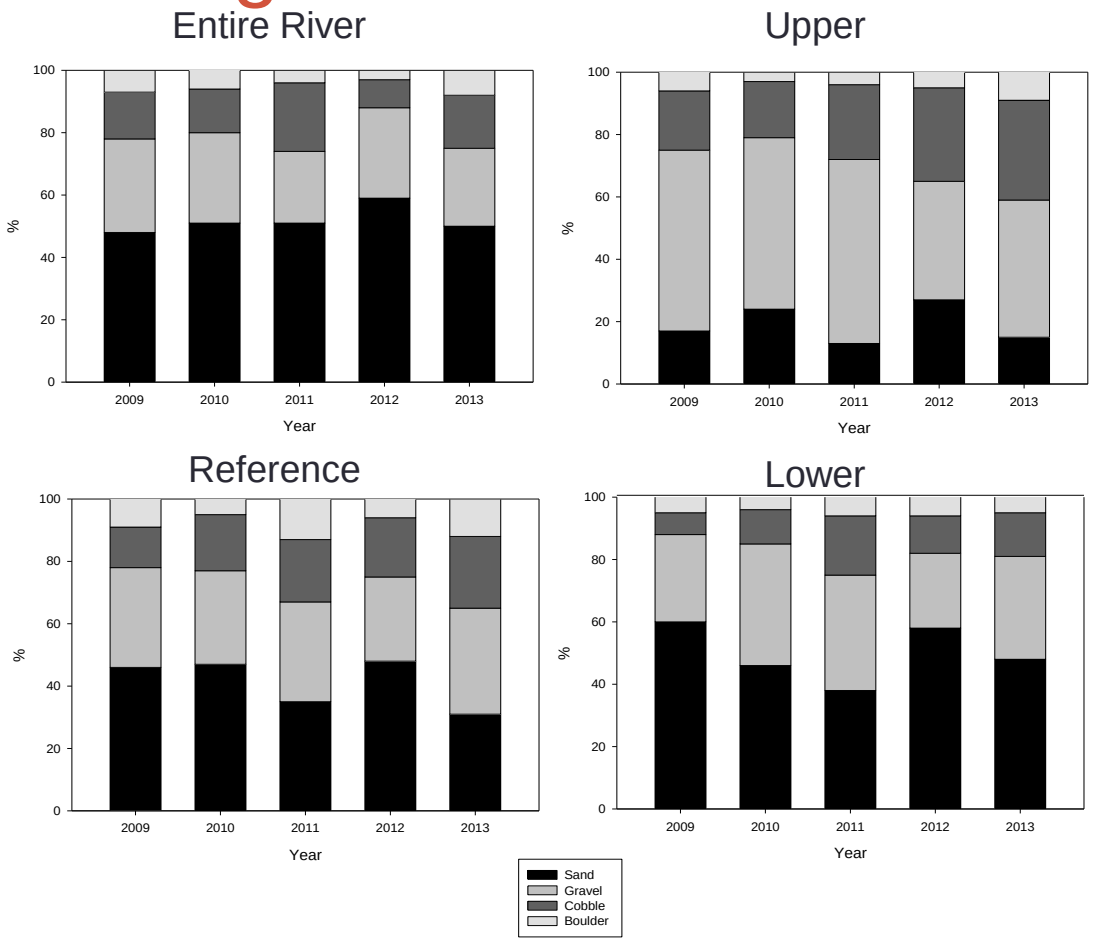
# Study Design




- Lower Reach
  - 15 structures constructed in June of 2010
- Reference Reach
  - No structures
- Upper Reach
  - 15 structures have been in place for 3-5 years

- Within each Reach we have Representative Sub-Reaches

# Change in Substrate

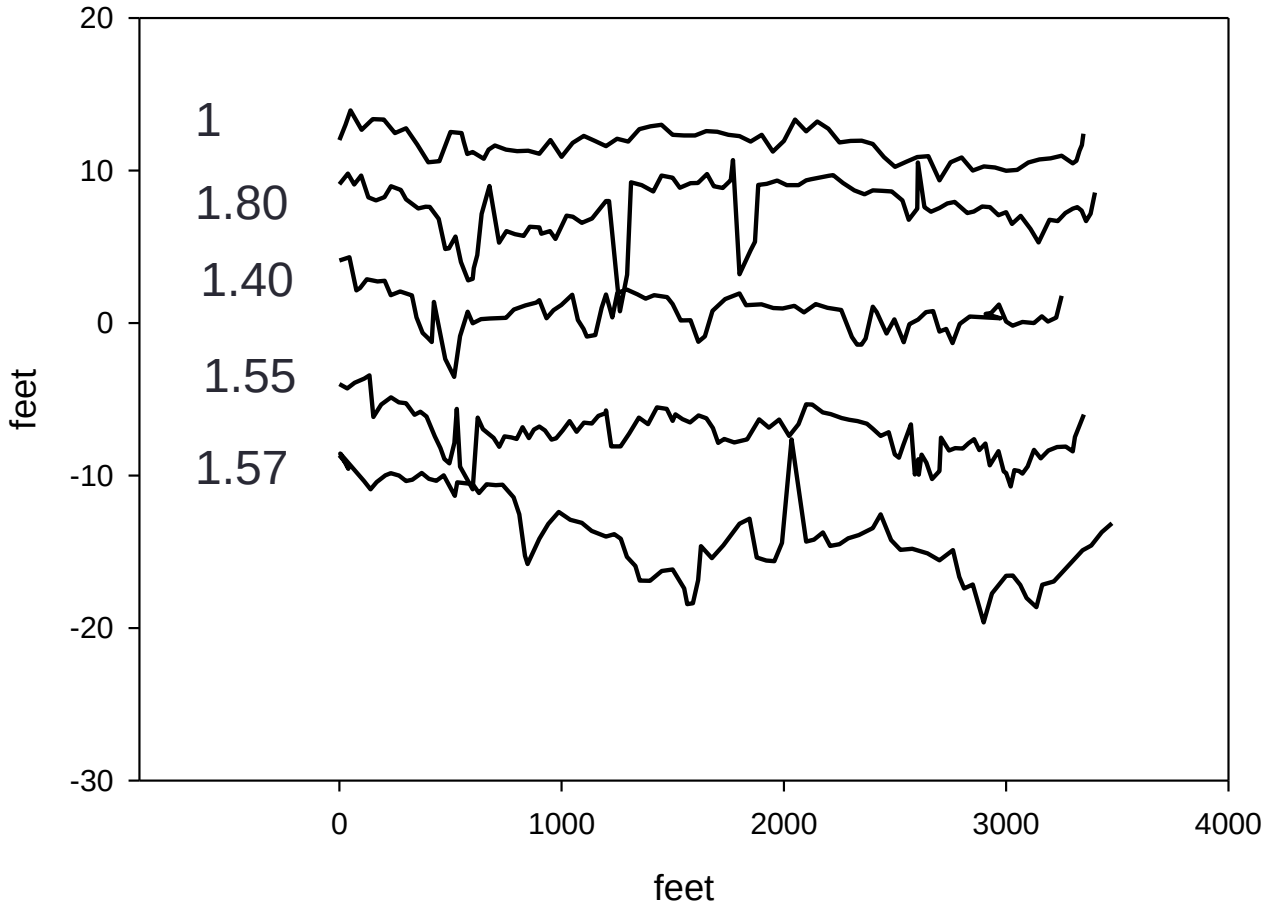



- Greatest substrate change was the lower reach in 2011 with a 22% decrease in sand
- 12% decrease in sand over 4 years in the lower reach
- Drier years seem to deposit more sand?

| | Precip in Charleston |
|---|---|
| 2009 | 30.09 |
| 2010 | 30.92 |
| 2011 | 28.91 |
| 2012 | 15.04 |
| 2013 | 29.92 |

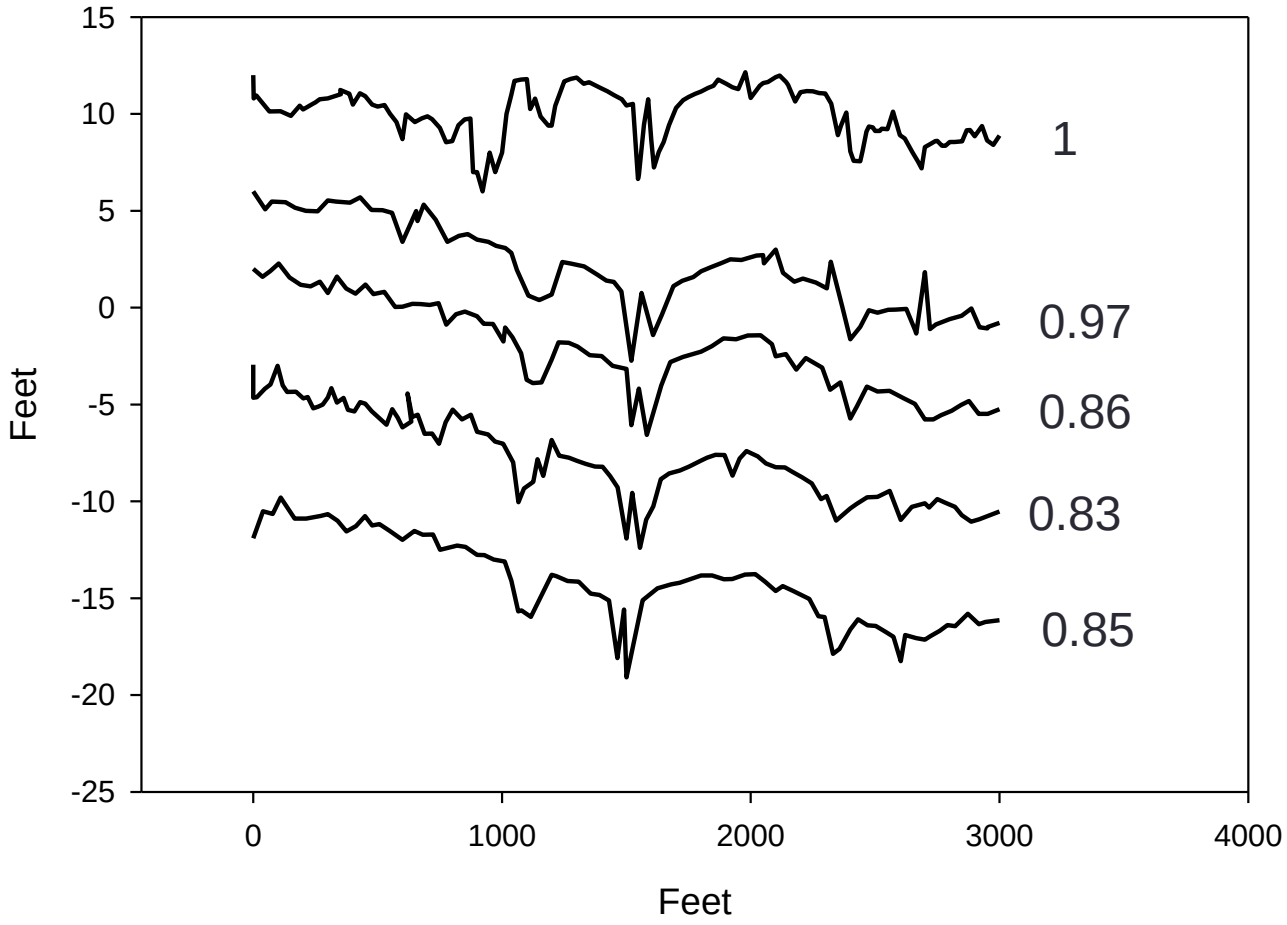
| | Global | 2009-2010 | 2009-2011 | 2009-2012 | 2009-2013 |
|---|---|---|---|---|---|
| **Entire River** | 0.539 | 0.972 | 0.492 | 0.303 | 0.825 |
| **Upper** | **0.019** | 0.512 | 0.751 | **0.029** | 0.114 |
| **Reference** | **0.092** | 0.766 | **0.083** | 0.651 | **0.086** |
| **Lower** | **0.084** | 0.209 | **0.006** | 0.451 | 0.207 |

# Lower Reach Longitudinal Profile



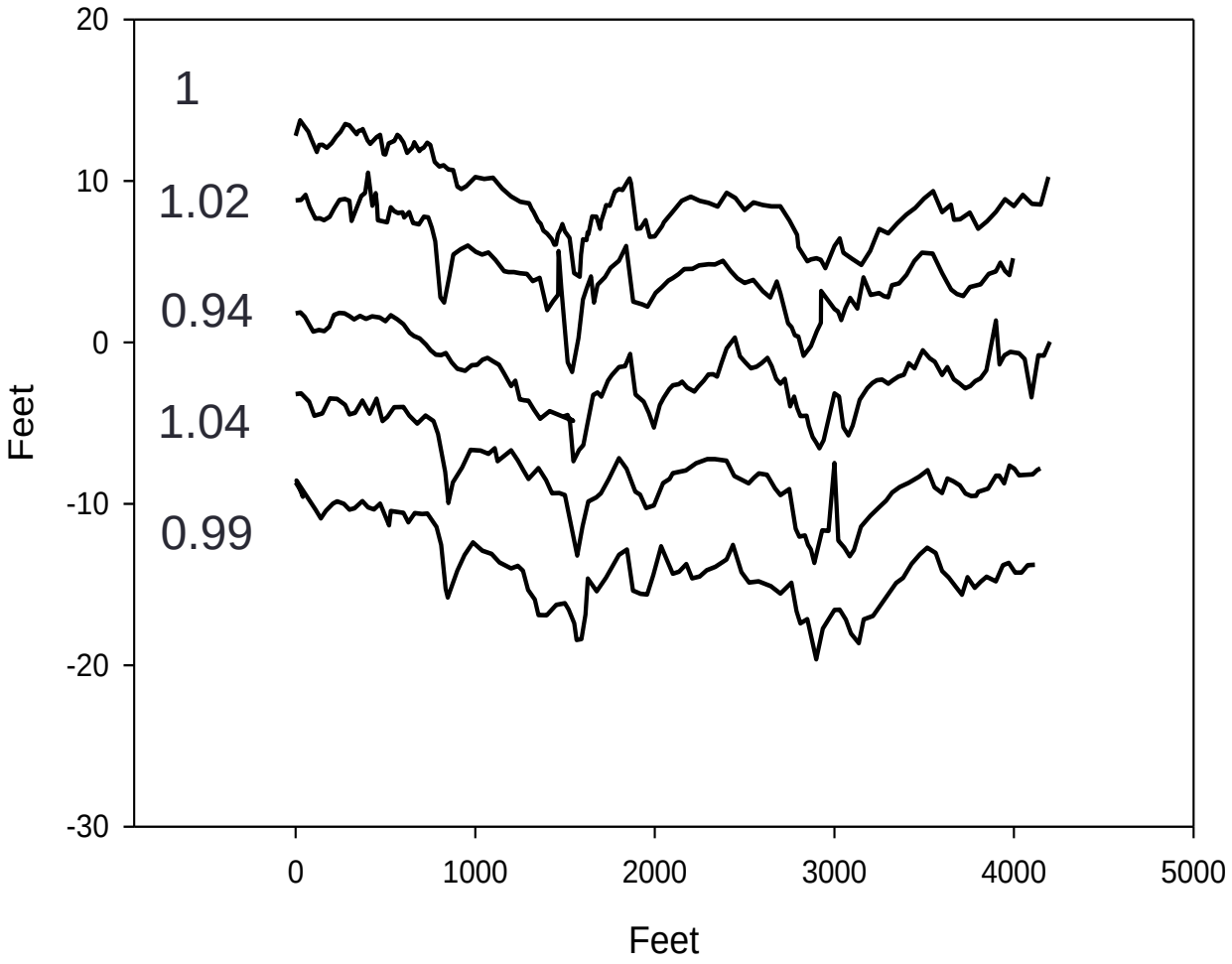

- **Profiles in order starting from the top, 2009-2013**
- **Numbers indicate ratio of perimeter compared to 2009**
- **Immediate 80% increase in perimeter**
- **After 4 years a 57% increase in perimeter prior to construction**

# Upper Reach Longitudinal Profile



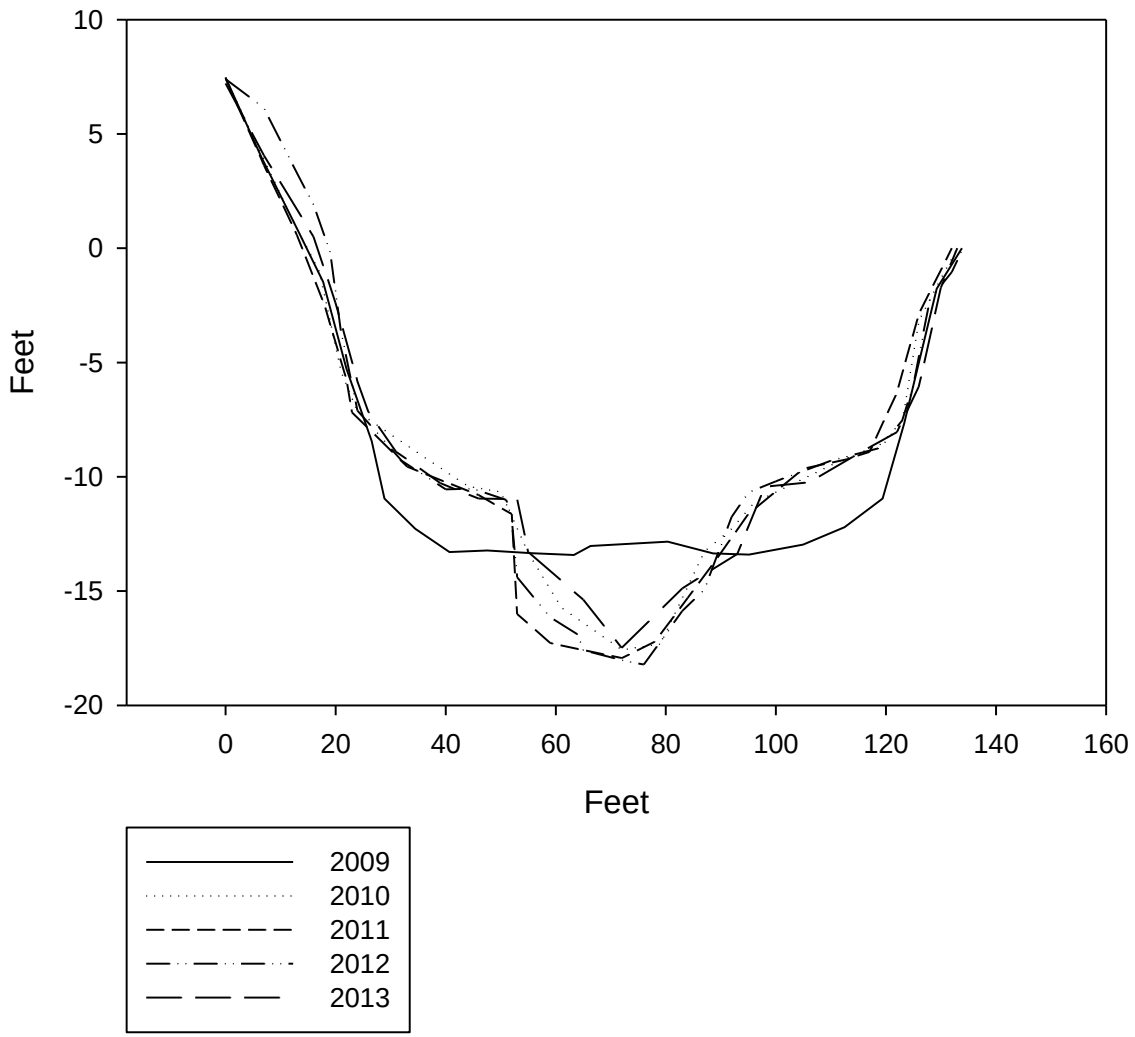

- Profile shows upper reach is decreasing in streambed complexity
- 15% decrease in perimeter over 5 year period

# Reference Reach Longitudinal Profile



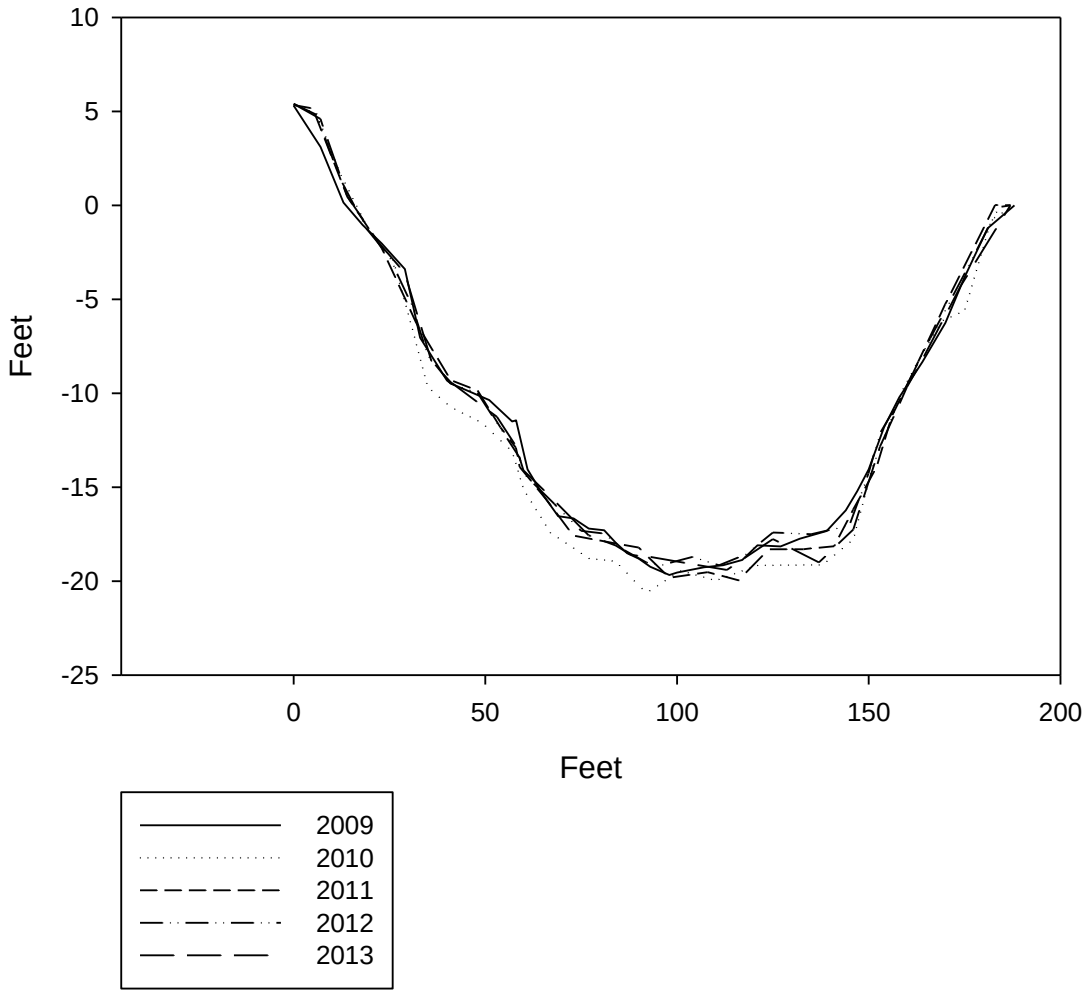

- Profile shows reference reach has maintained its complexity throughout the study period

# Cross-sectional Profile Below Structure

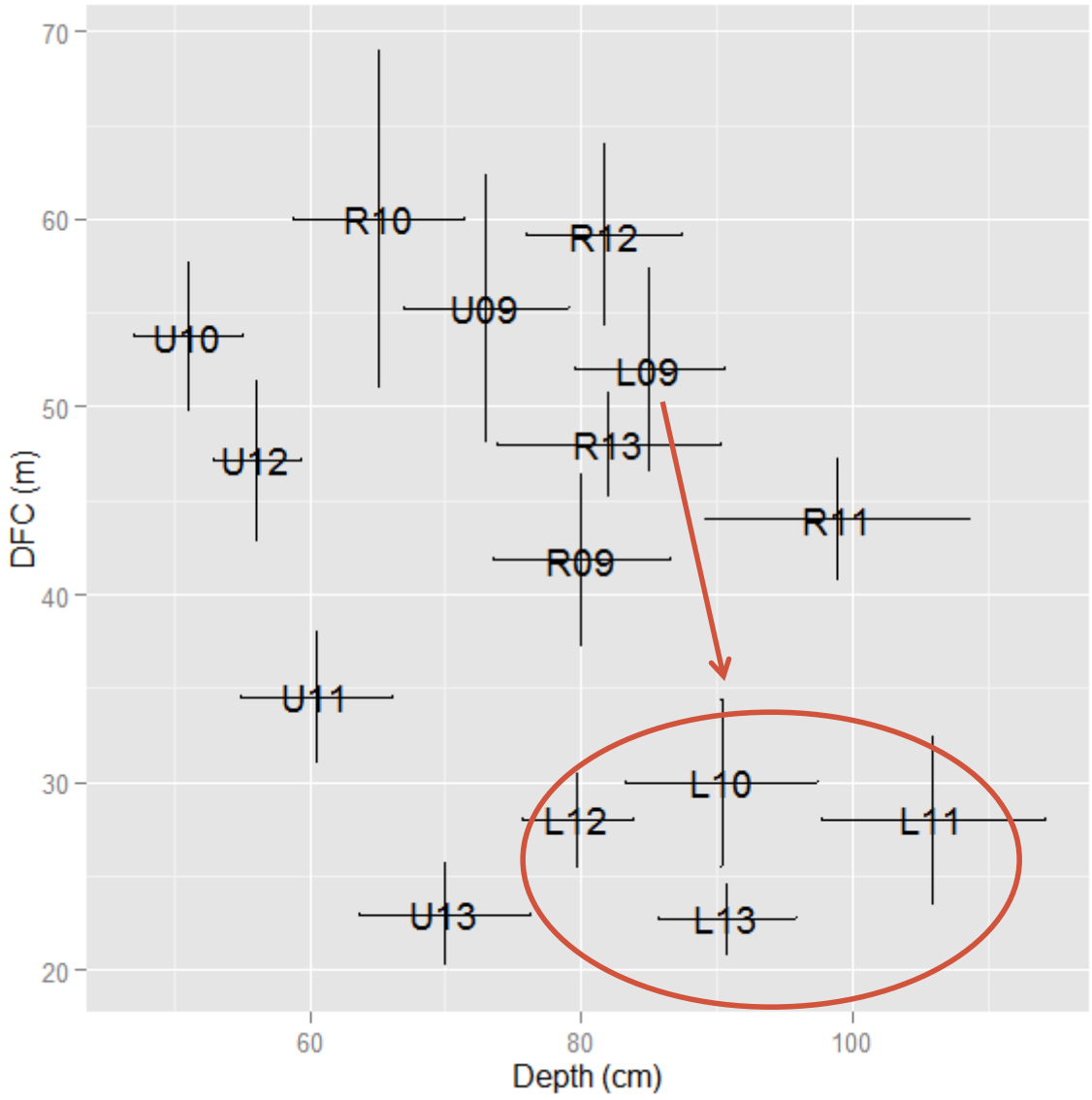



- Cross section of a structure in the lower reach
- Pool has maintained overall, however is deposition over 4 years post-construction
- Results are similar to other structures

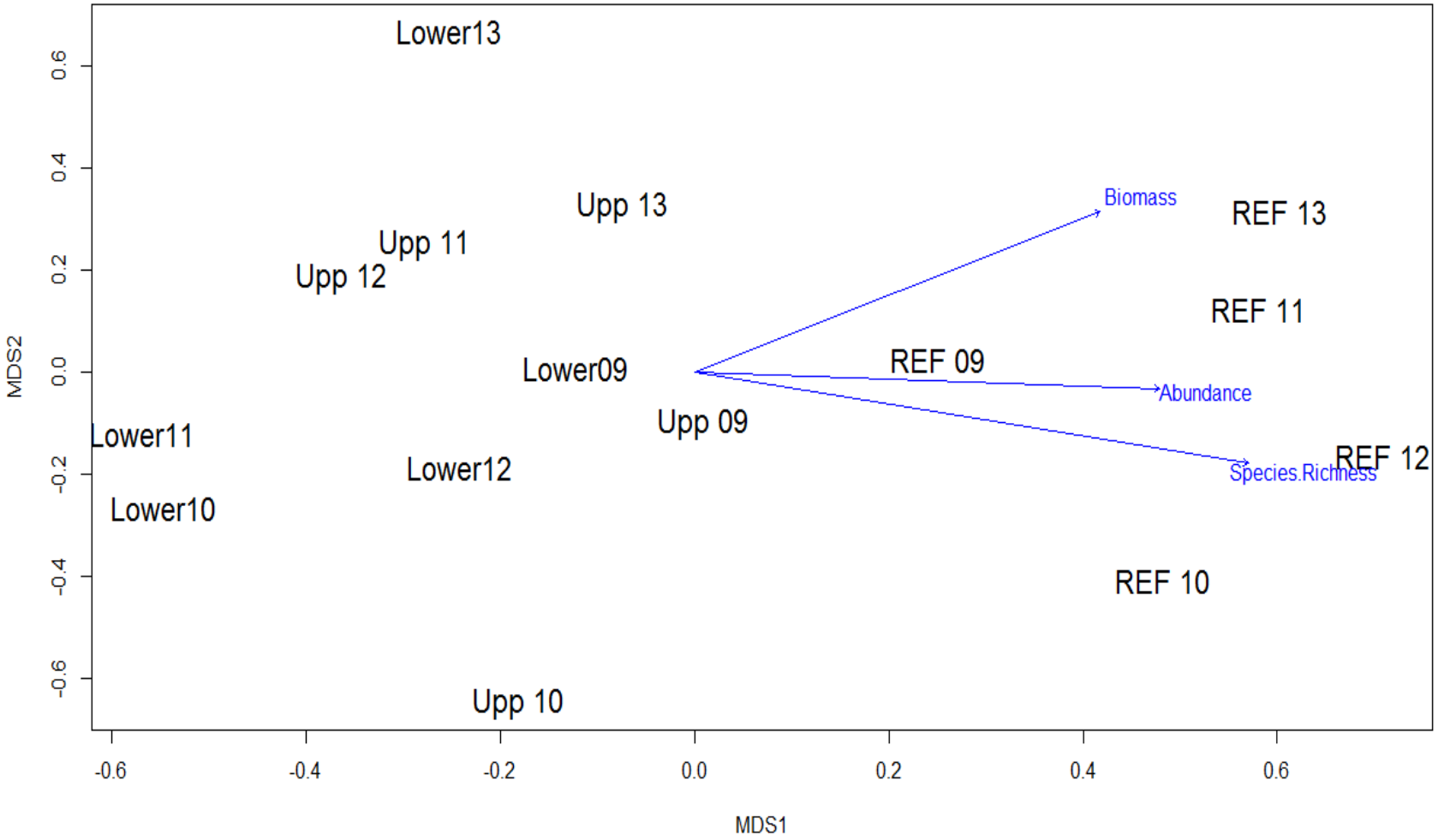
# Cross-sectional Profile Above Structure



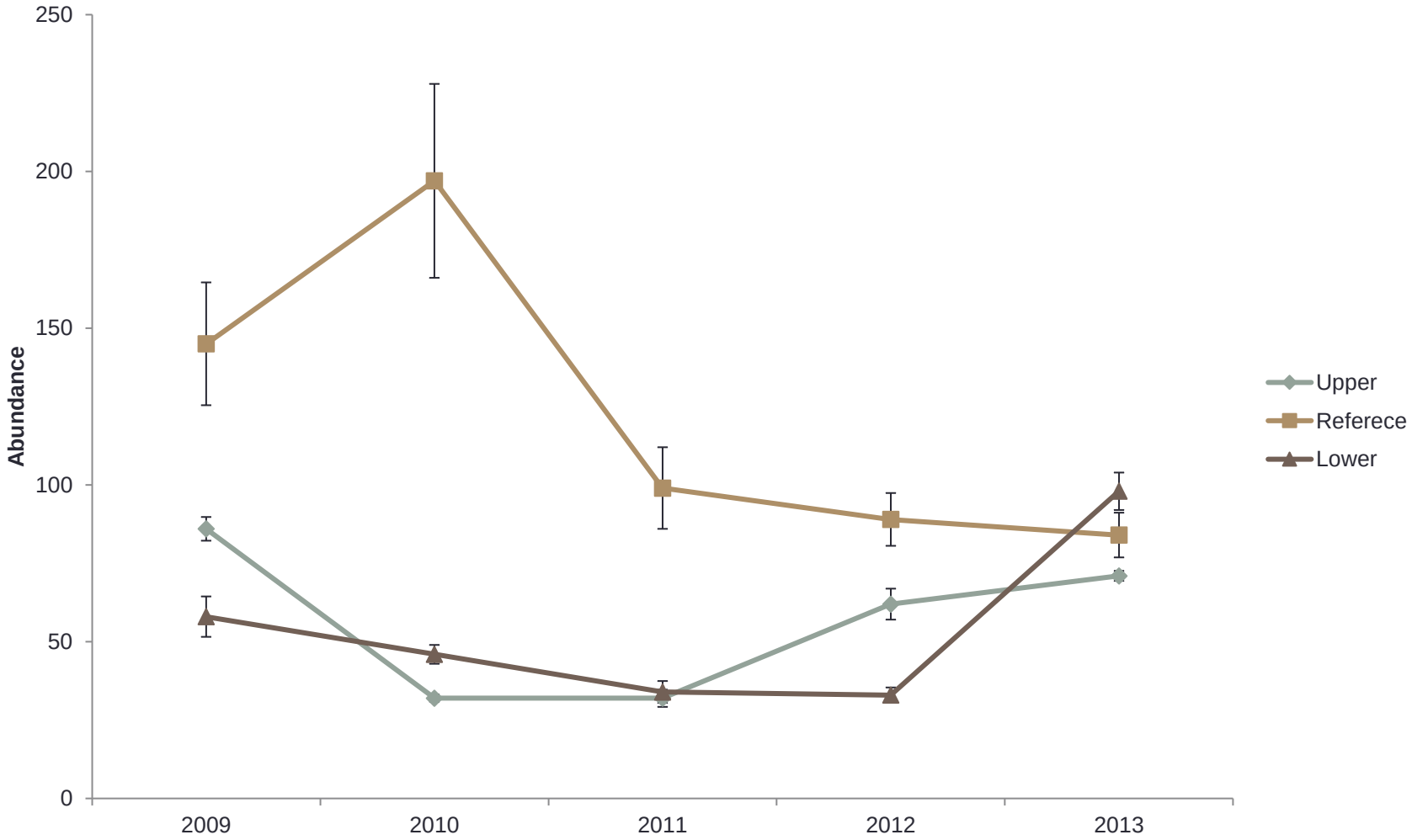

- Cross section above structure in lower reach
- Minimal scouring above structure
- Banks remain stable


70
60
50
40
30
20
DFC (m)
60
80
100
Depth (cm)
R10
R12
U09
U10
L09
U12
R13
R11
R09
U11
L10
L12
L11
U13
L13

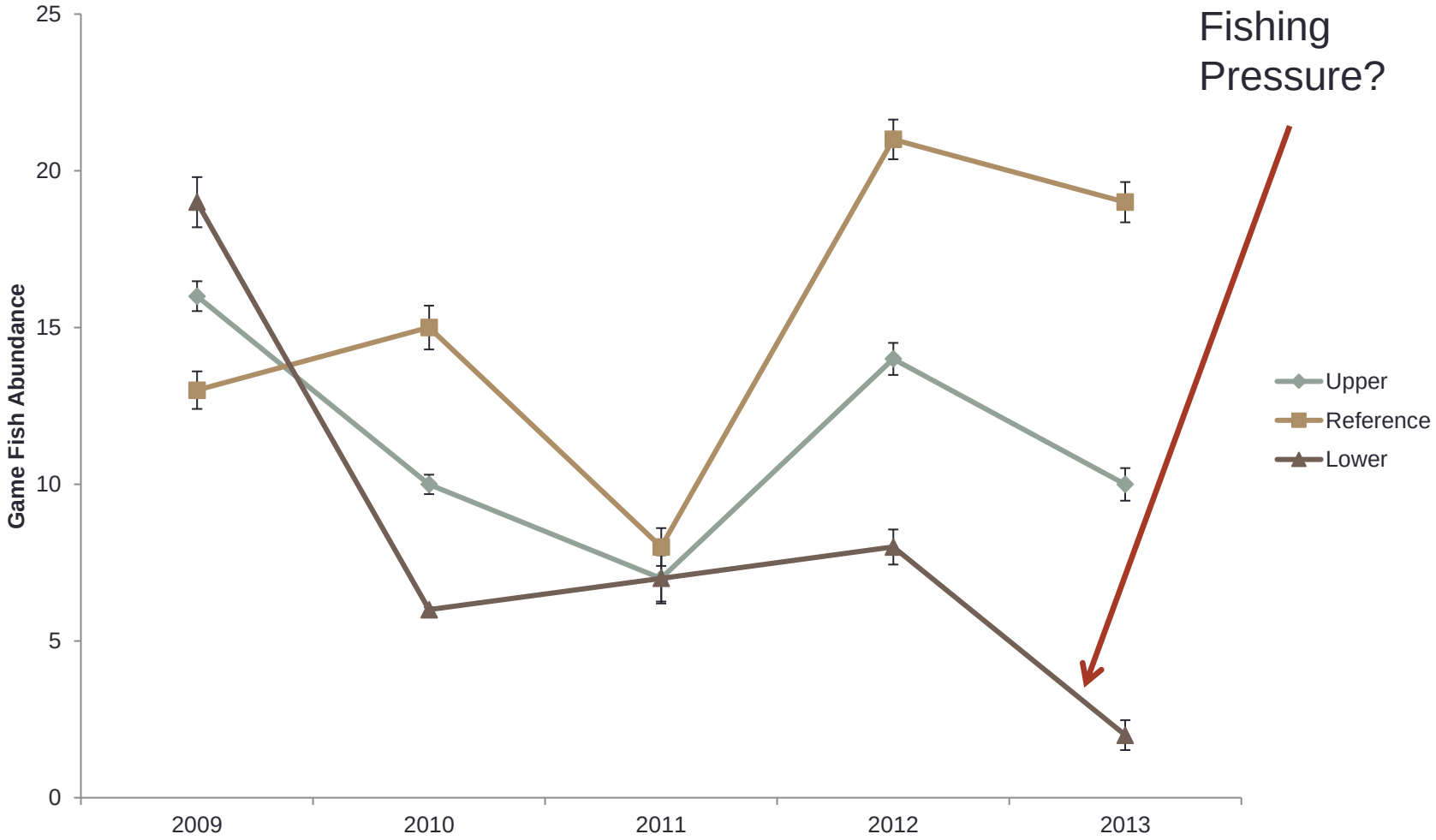
# NMDS of Fish Assemblage



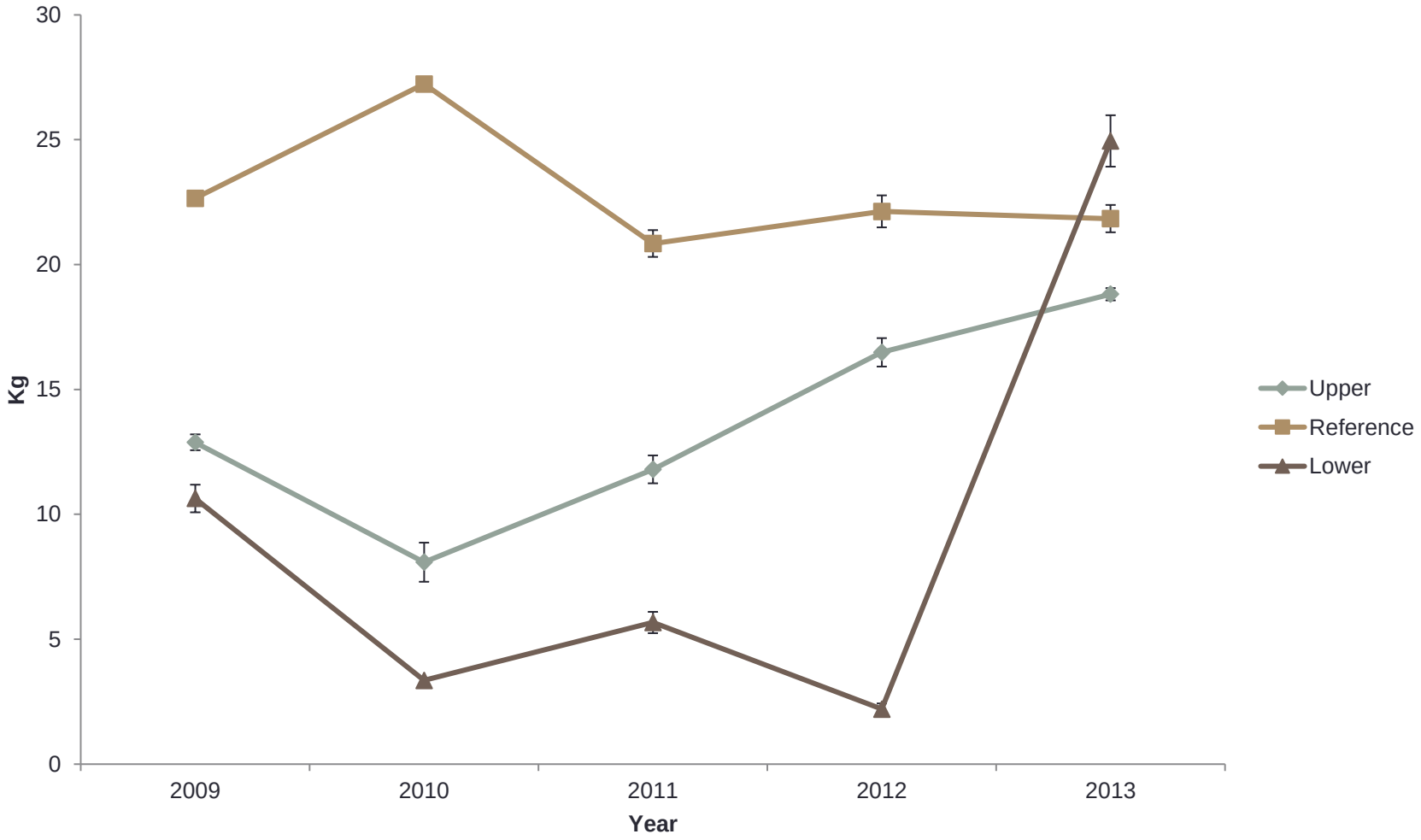
# Total Fish Abundance



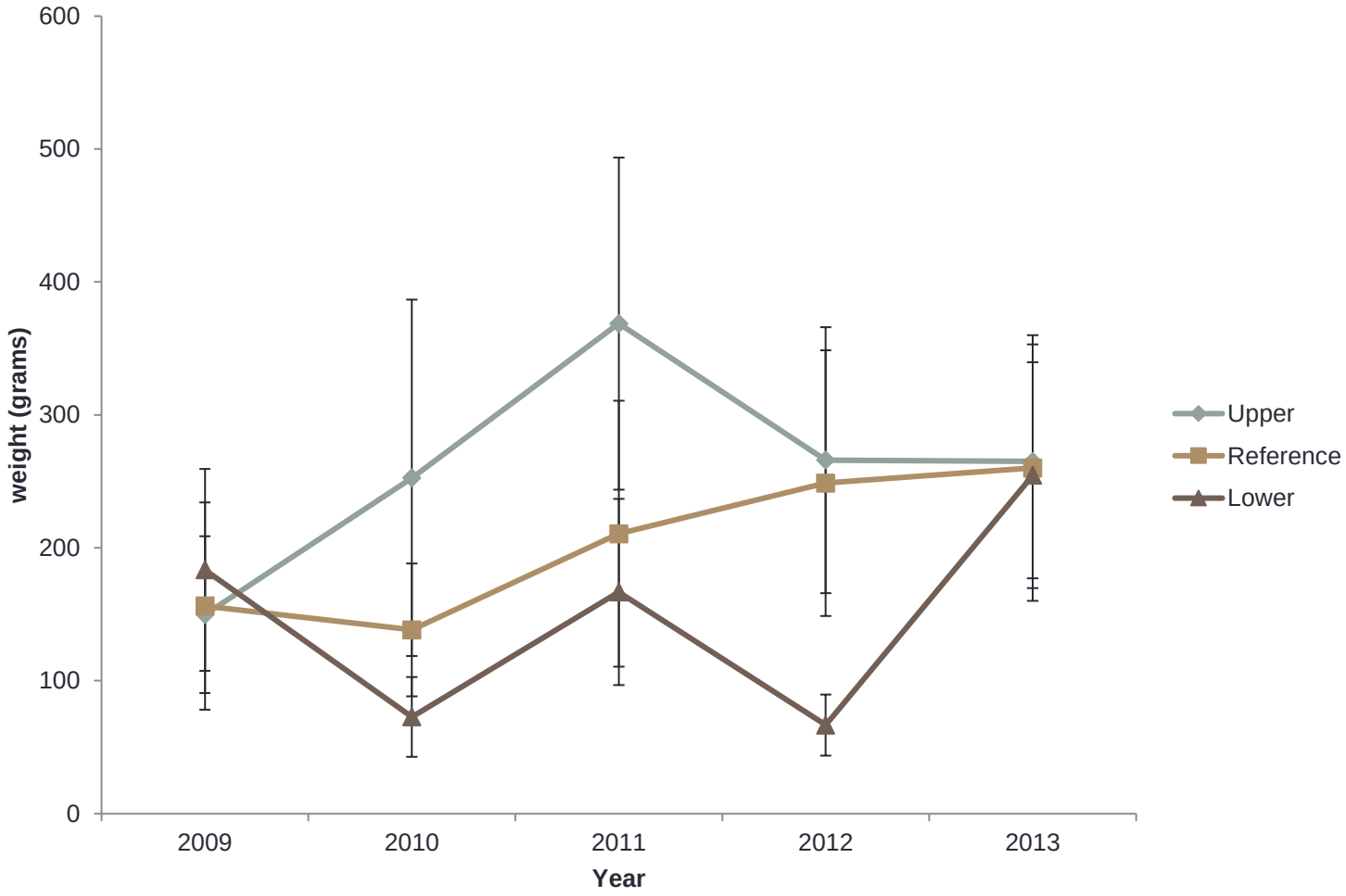
# Game Fish Abundance



# Total Fish Biomass



# Average Fish Biomass



# LCR Conclusions

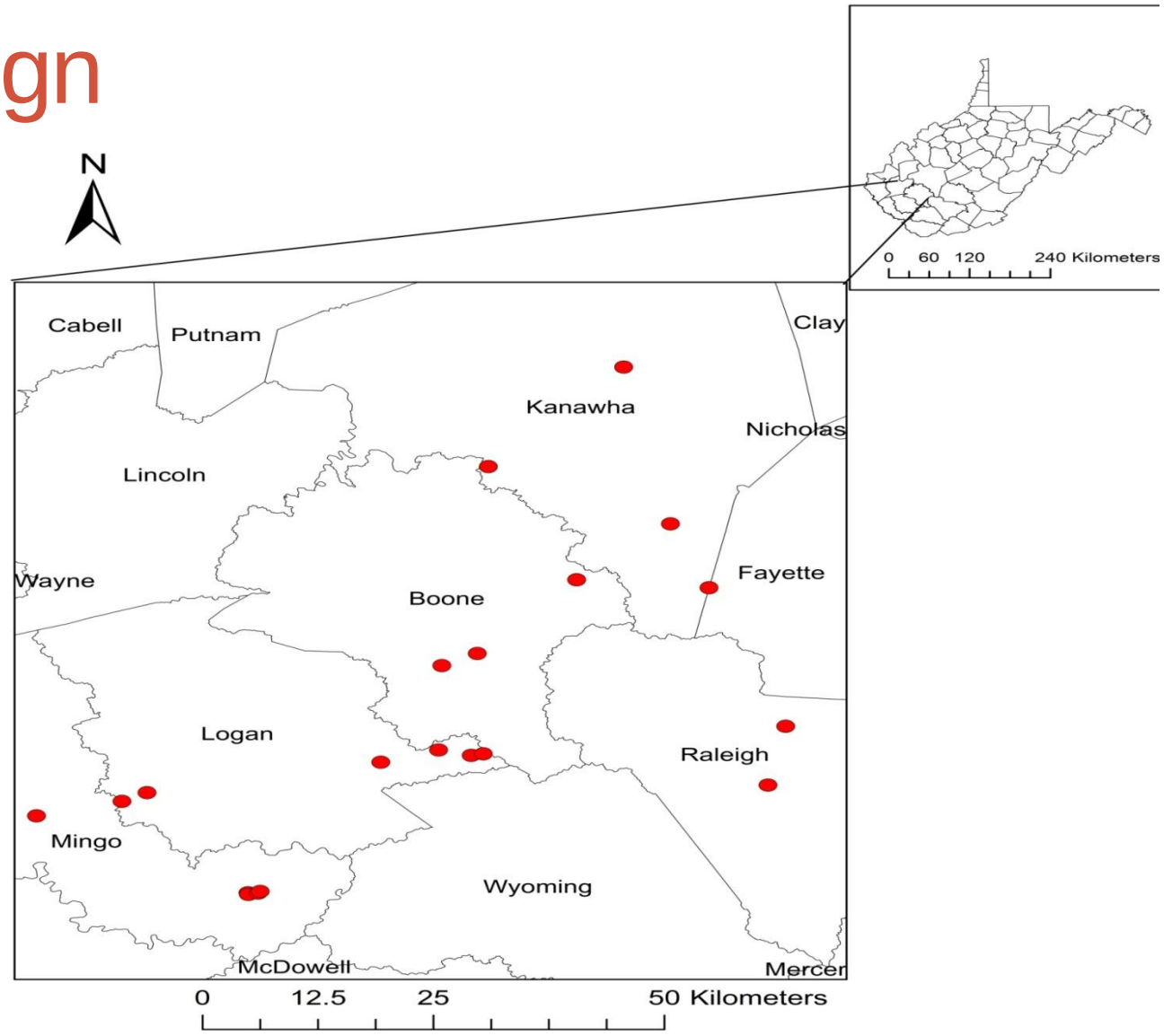
- Reduction in sand substrate
  - 12% decrease in the lower reach
  - Flow dependent?
- Change in morphology
  - Lower reach had an increase of 57% in streambed complexity
  - Upper reach may be failing?
- Fish are responding to structures
  - a 15 kg (33 pounds) increase in biomass in 4 years
  - 50% increase in abundance over 4 years
  - However, 90% decrease in game fish
- Do these results persist?
- See similar results in new construction? Especially areas with less fishing pressure

# Study Design

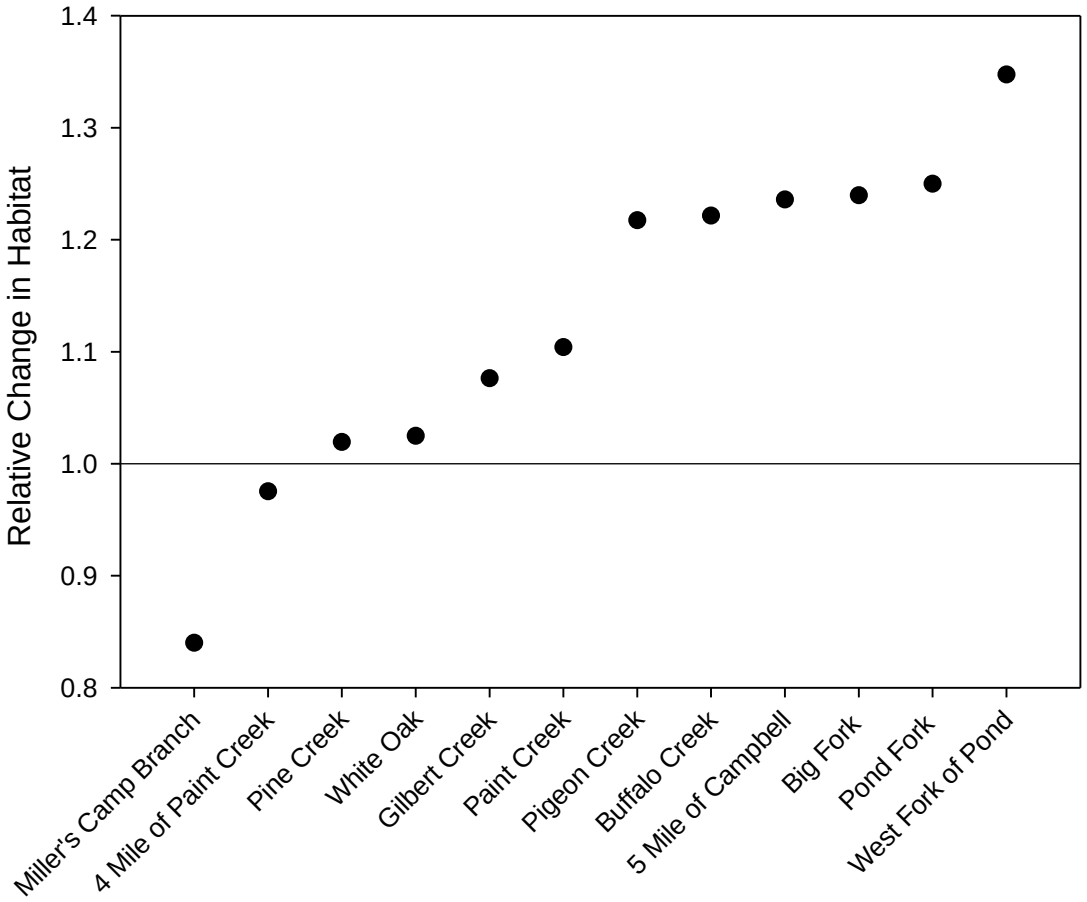
12 Mitigation Projects

18 Control Streams

- 11 regional
- 7 upstream

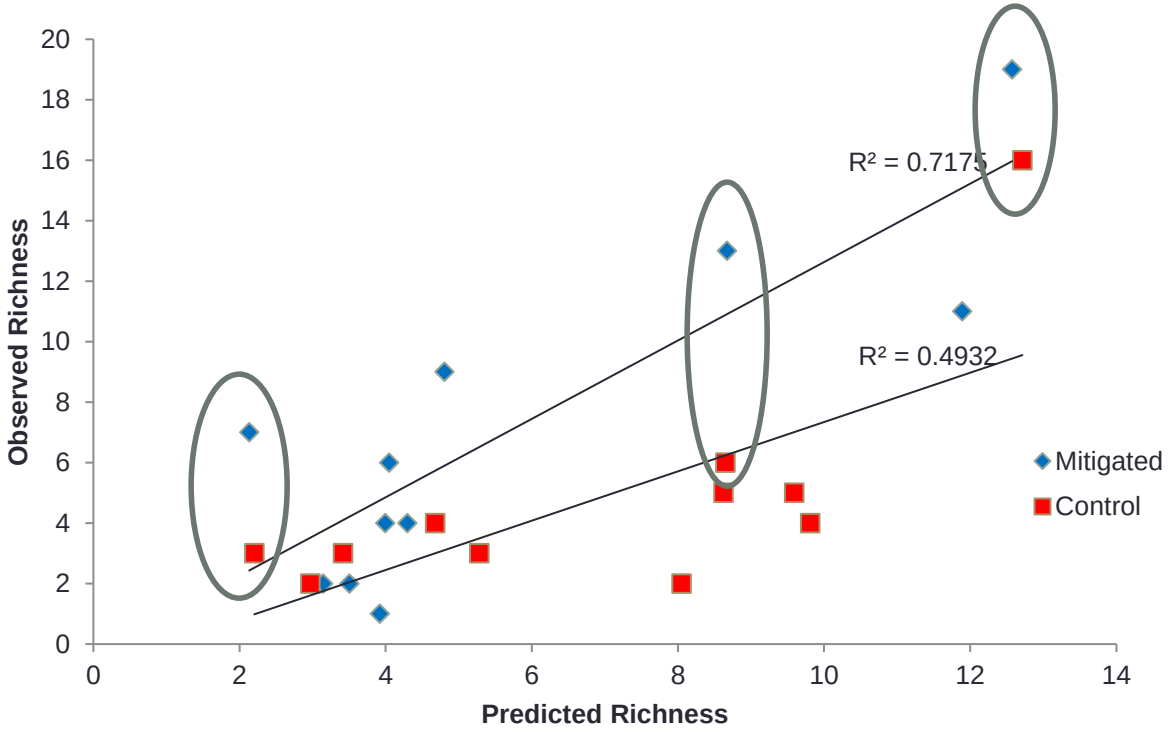


# Relative change in habitat (RVHA) compared to upstream counterpart



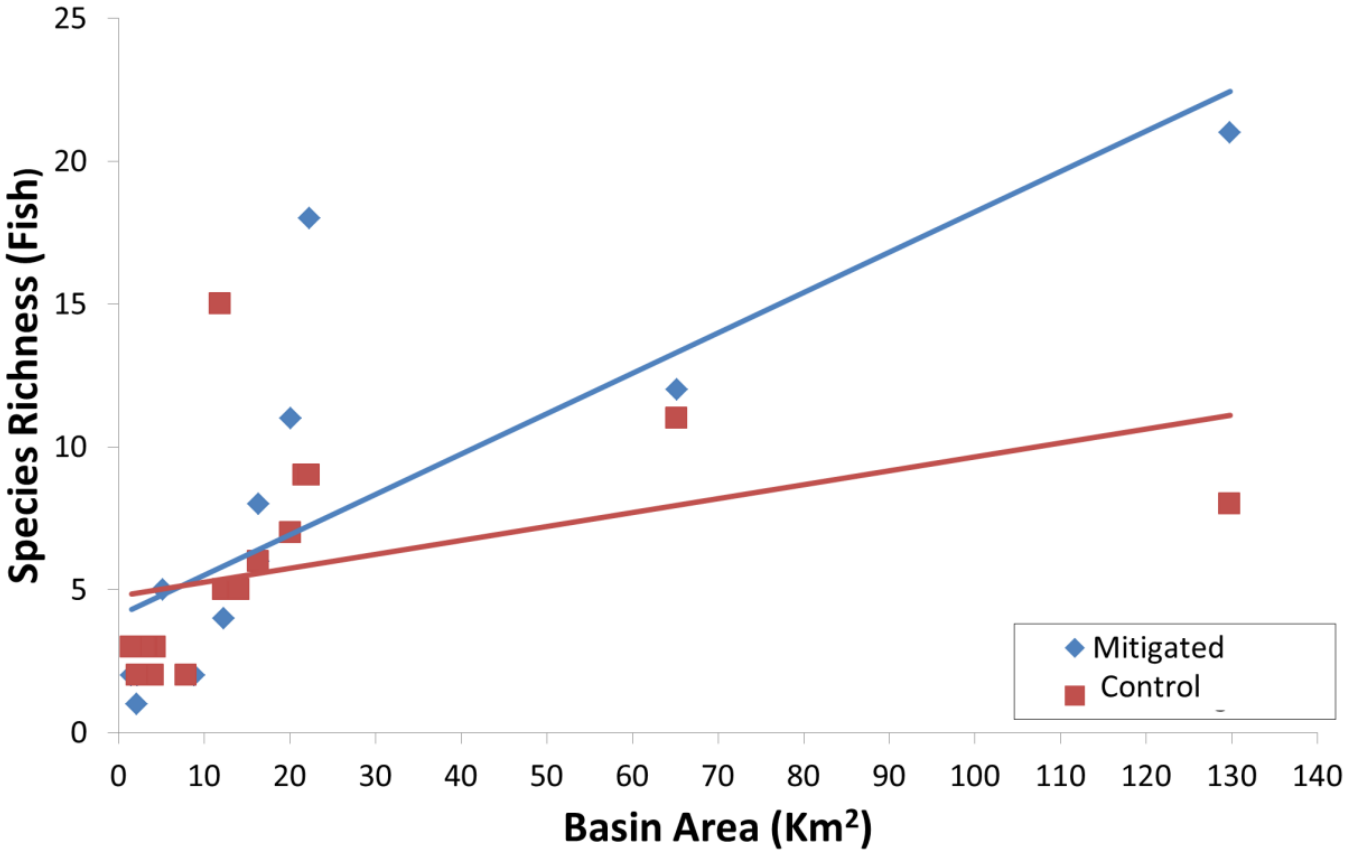

- 84% of streams show increase in habitat complexity
- Average increase in habitat is 17.5%

# Observed vs. Predicted Fish Species Richness



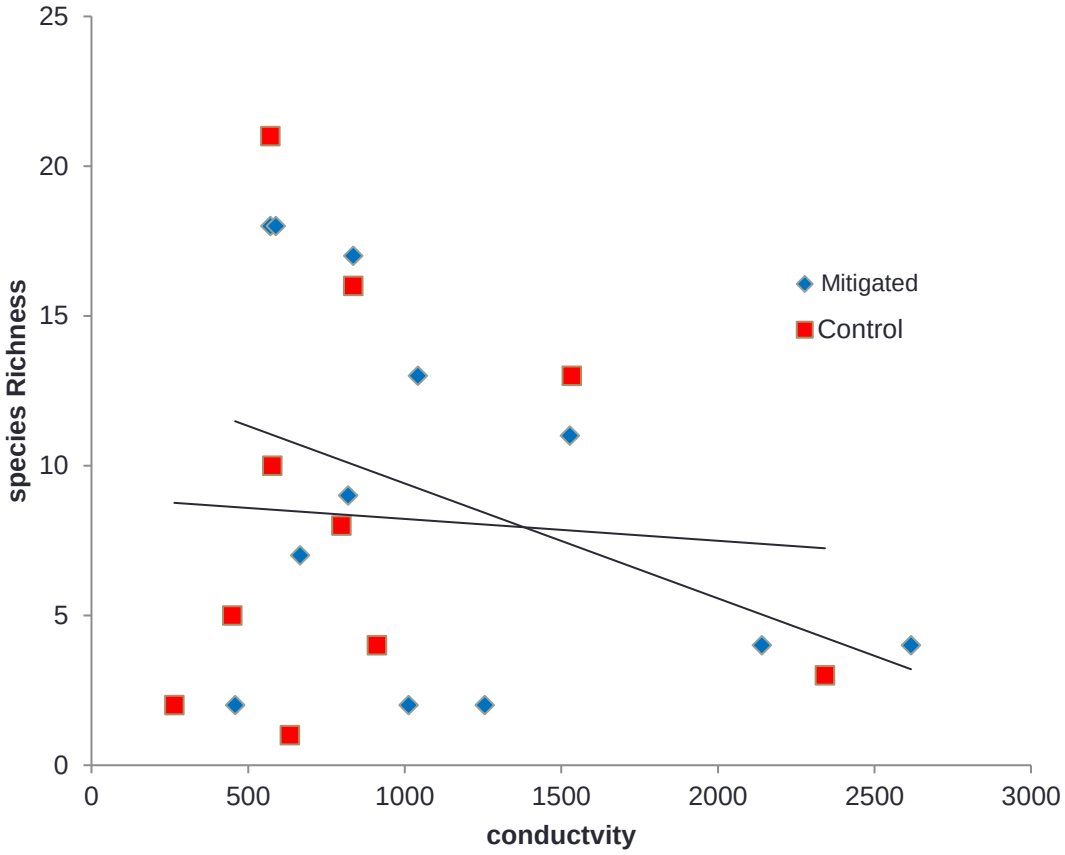

- Circles Indicate Paired Sites
- Difference in lines is due to mitigation

# Basin Area vs. Species Richness



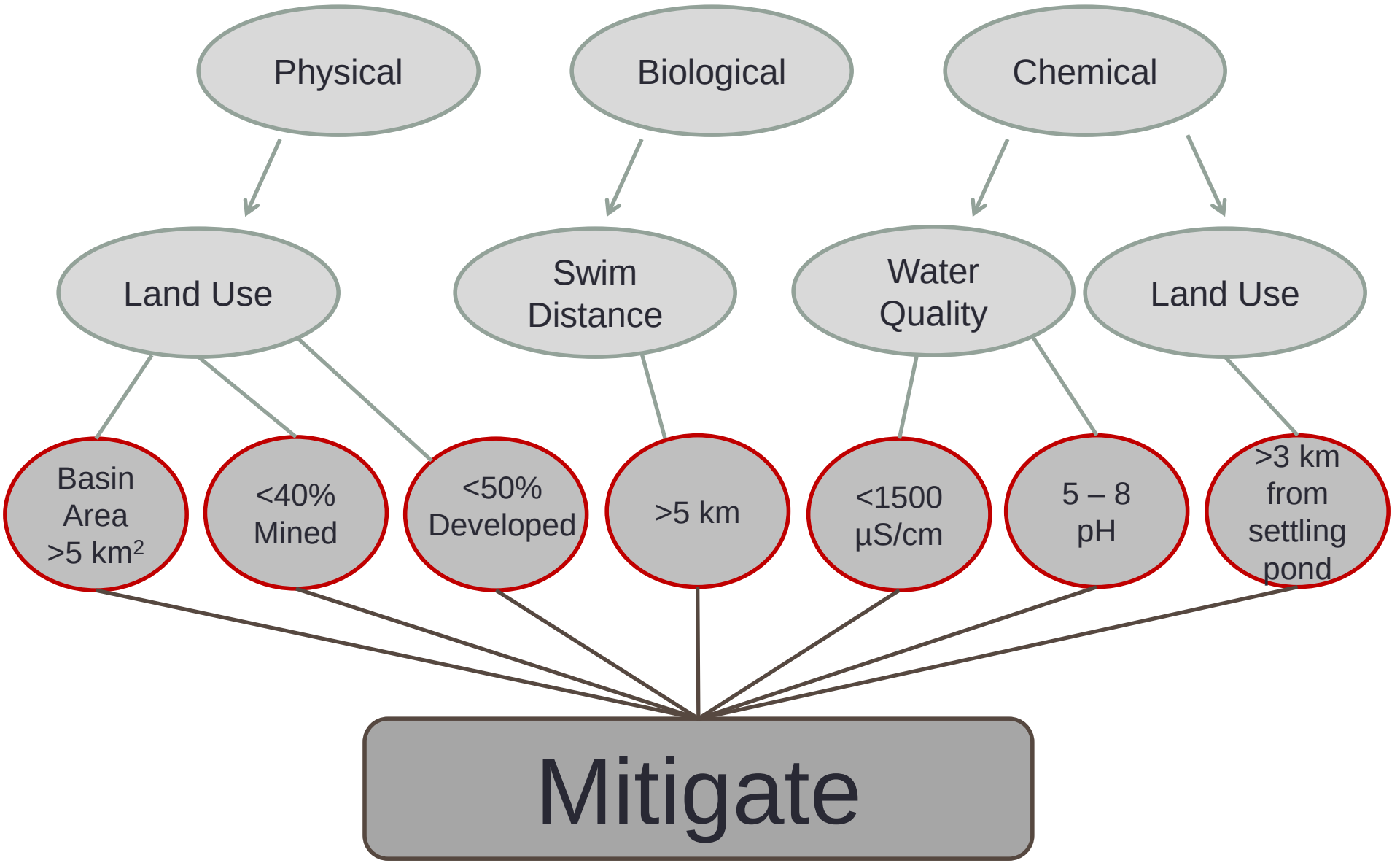

- Sites over 5 km show largest improvement in fish species richness

# Conductivity vs Species Richness

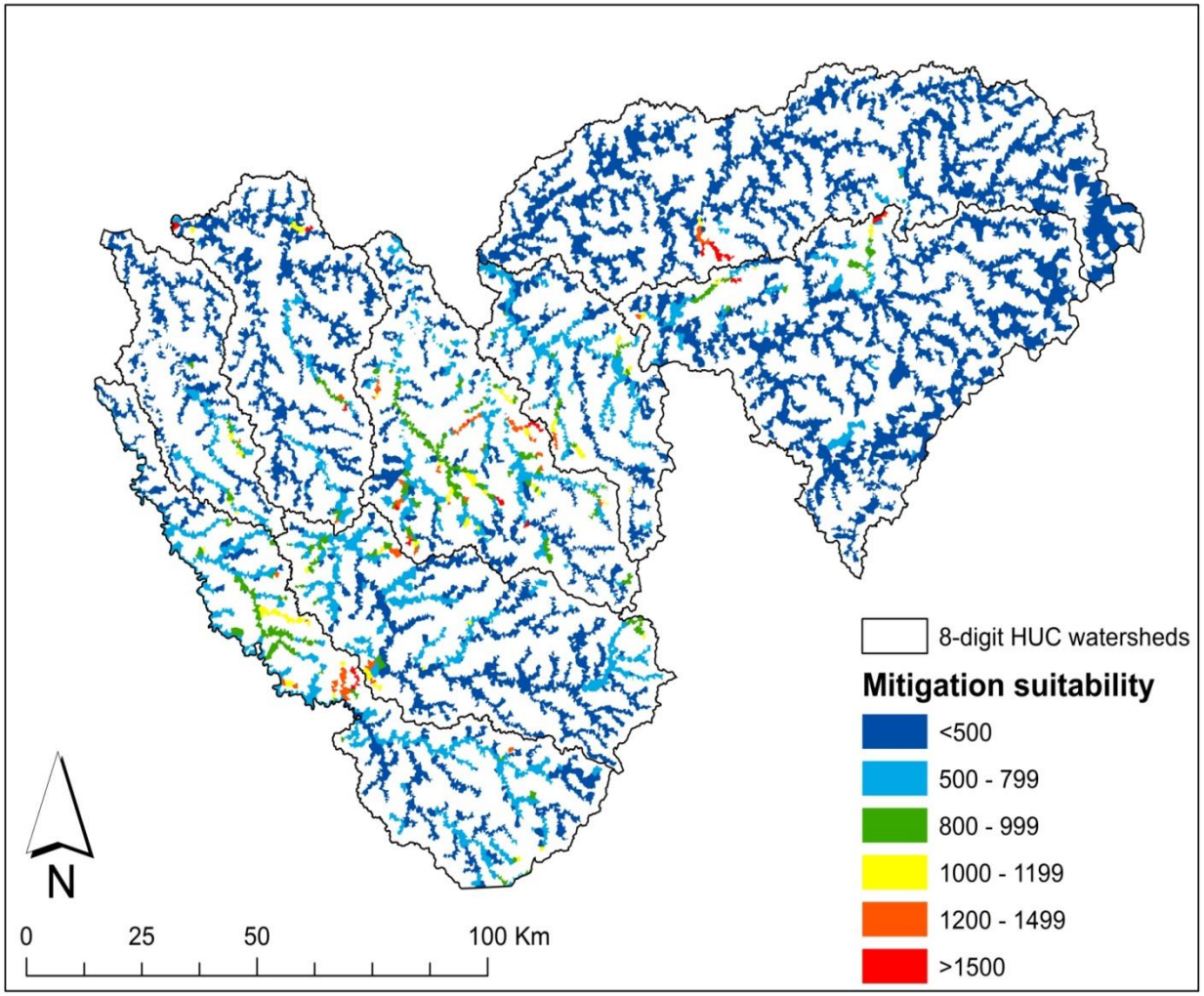



- Sites above conductivity of 1500 show no improvement to restoration

# Flow chart criteria for mitigation



# Sites that meet criteria and are suitable for mitigation




- **Based on our flow chart**
- **All sites shown are >5km²**
- **The bluer sites would have higher mitigation response**

# Conclusions

- There is a measurable benefit to stream mitigation
  - Average site has 17.5% increase habitat complexity
- A site selection tool will allow restoration projects to have the best available foundation to be built upon
- Fish respond better based on site selection
  - Conductivity under 1500
  - Larger sites have larger response

# Remaining Tasks

- Identify remaining Macroinvertebrates
- Refining Site selection tool
- Dissertation

# Presentations and Publications

- Presented a poster at 2 conferences
- Oral presentation at 11 conferences (SDAFS, NEFWA, WV water conference, MASRC)
  - 4 were national conferences
    - National American Fisheries Society (2010,2012, and 2014)
    - Society of Ecological Restoration International (2011)
    - Society of Freshwater Science (2012)

- Been an invited speaker 4 times
  - Sierra Club
  - Society of Ecological Restoration Mid-Great Lakes
  - Coal River Group
  - Madison Middle School

- Physical Benefits of Restoration on a Large Mainstem River (to Restoration Ecology by March 31, 2014)
- Biological Benefits of Restoration on a Large Mainstem River (by July 31, 2014)
- Effects of Restoration in Southern West Virginia ( by December 31, 2014)

# Future Directions

- Continue to populate the mitigation GIS database (project led by Catherine Artis) and expand to include non-mining related projects.
- Continue lower Little Coal River monitoring and expand to include additional restoration in upper reaches with particular focus on fish assemblage response.
- Continue monitoring of select mitigation projects, region-wide, with particular focus on fish assemblage response.
- Include pre-post restoration monitoring of new mitigation projects as they come on-line.