



Effects of Dams on Fish and Macroinvertebrate Assemblages in the Vermilion River

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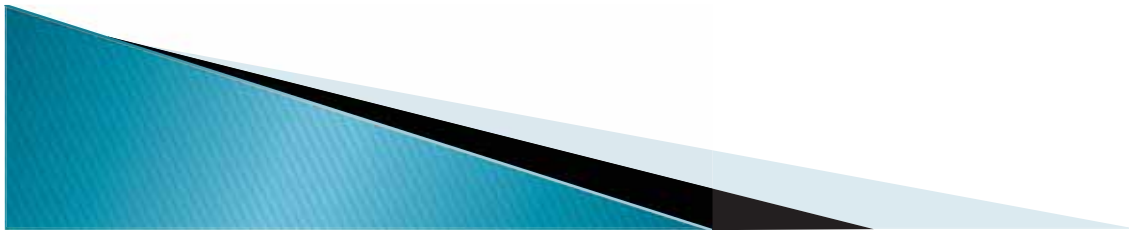
Dams

▶ Problems

- Lotic to Lentic Habitats
- Sediment Transportation
- Changes in Water Quality
- Physical Barriers

▶ Removal

- Reconnect Isolated Populations
- Increase Native, Endangered, and Threatened Species
- Reduce Invasive, Lentic species
- Improve Habitat & Water Quality
- Natural Flow Regimes



Bio-Indicators

- ▶ Fish
 - Long Lived Species
 - Index of Biotic Integrity
 - Dams as Physical Barriers
- ▶ Macroinvertebrates
 - Short Lived Species
 - Macroinvertebrate Biotic Index
 - Dams Changing Environment



<http://www.waterbugkey.vcsu.edu/php/familydetail.php?idnum=8&f=Potomanthidae&ls=larvae>

Location



- ▶ **Vermilion River**




- ▶ Tributary to the Wabash River
- ▶ Danville Dam

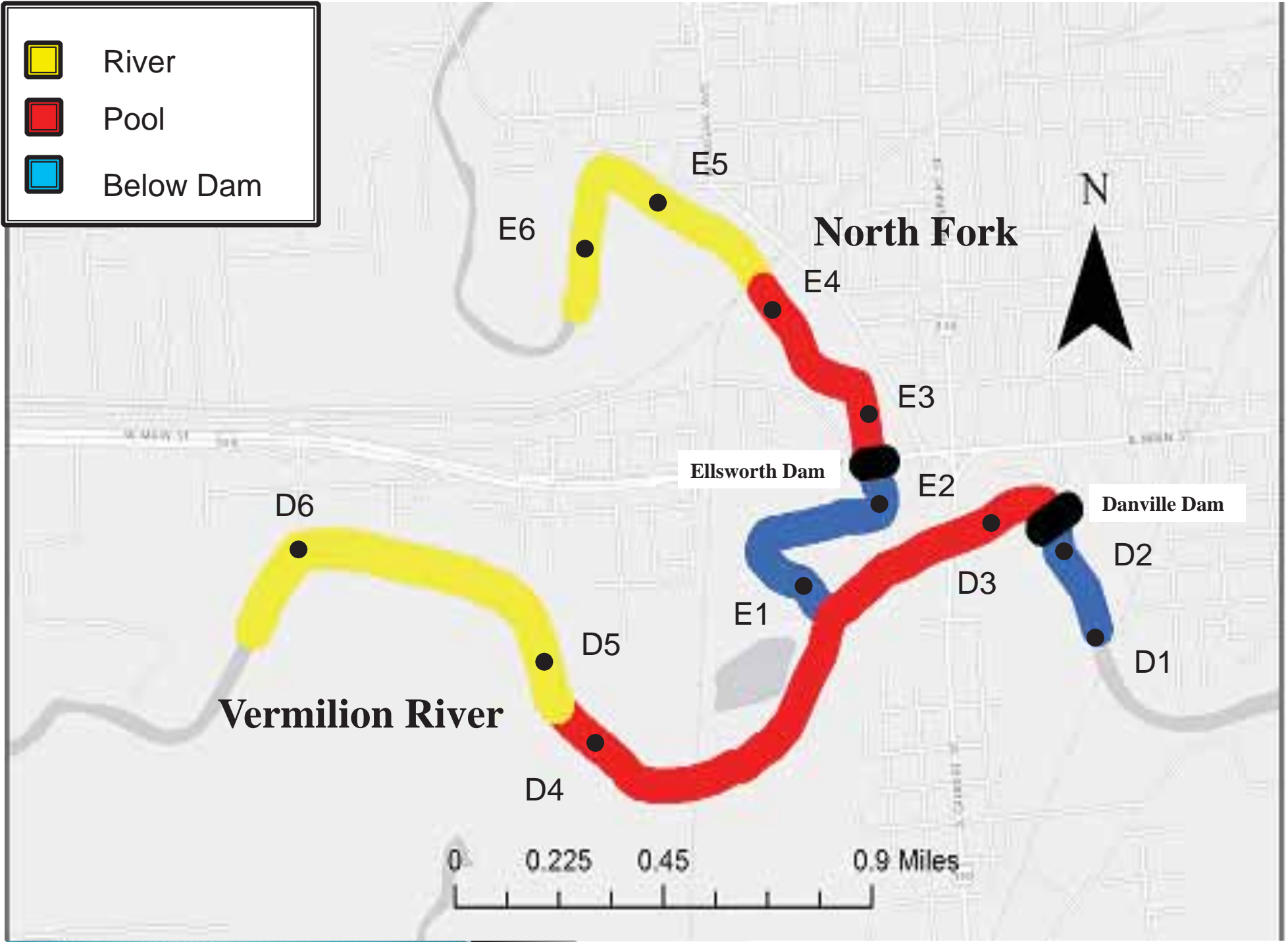


- ▶ **North Fork**

- ▶ Tributary to the Vermilion River
- ▶ Ellsworth Dam



	River
	Pool
	Below Dam



Fish Sampling Methods

▶ Vermilion River

- DC Electrofishing (Fall/Spring)
- Seine Pulls (Fall)
- Mini Fyke (Spring)

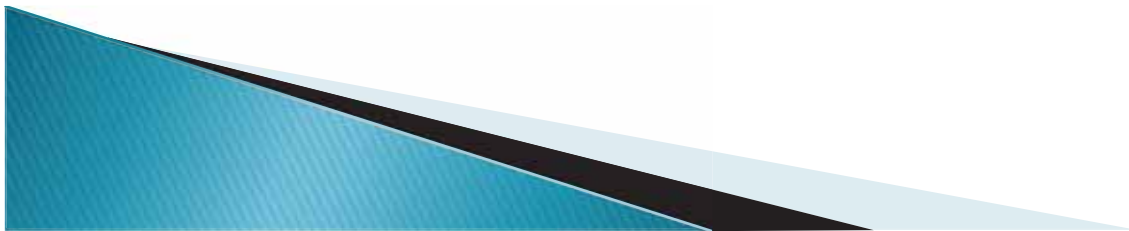
▶ North Fork

- DC Barge Shocking (Fall)
- DC Boat Electrofishing (Spring)
- Minifyke (Spring)



Habitat Assessment

- ▶ Ohio Qualitative Habitat Evaluation Index
 - Quality Score
 - Substrate abundance
- ▶ Average Velocity
- ▶ Water Quality
 - Field – DO, Temperature, PH, Conductivity
 - Laboratory – Solids, Nitrogen, Phosphorous, Ammonia

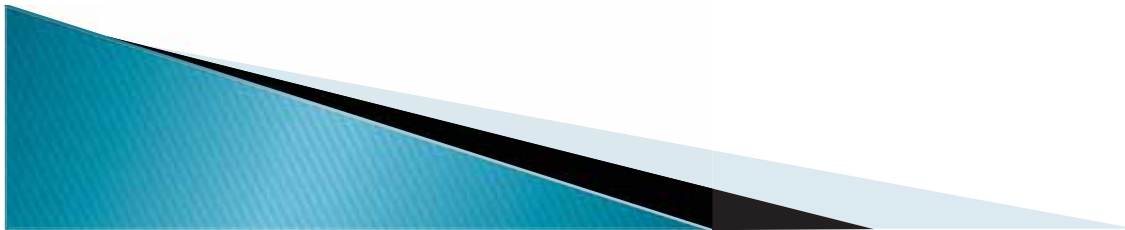


Macroinvertebrate Sampling

- ▶ Based from QHEI Outcome
- ▶ 20 Jab Protocol
- ▶ Specimens ID to Highest Level of Taxonomy
 - Chironomids (sub family)

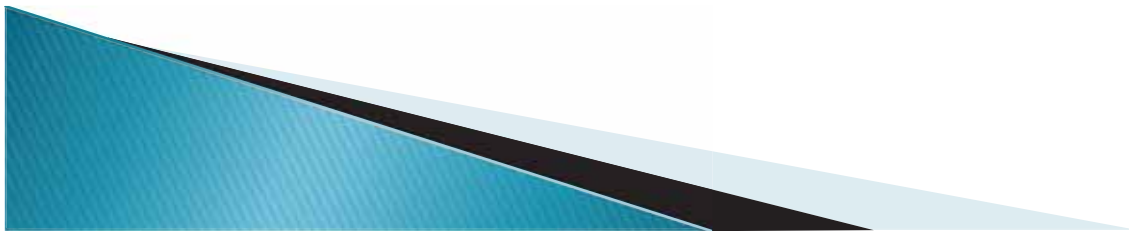


Photos By: Dave Petry (EIU)



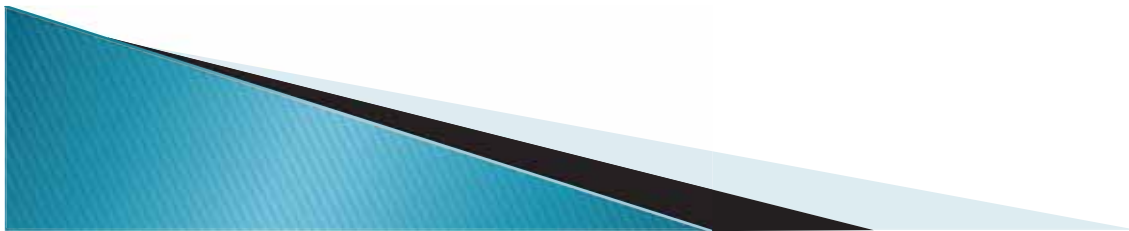
Objectives

- ▶ When to Sample Dam Effects (Seasonal)
- ▶ Habitat Quality, Diversity, and Biotic Index (Base Flow)
- ▶ Spatial Structure of Fish and Macroinvertebrate Assemblages (Base Flow)



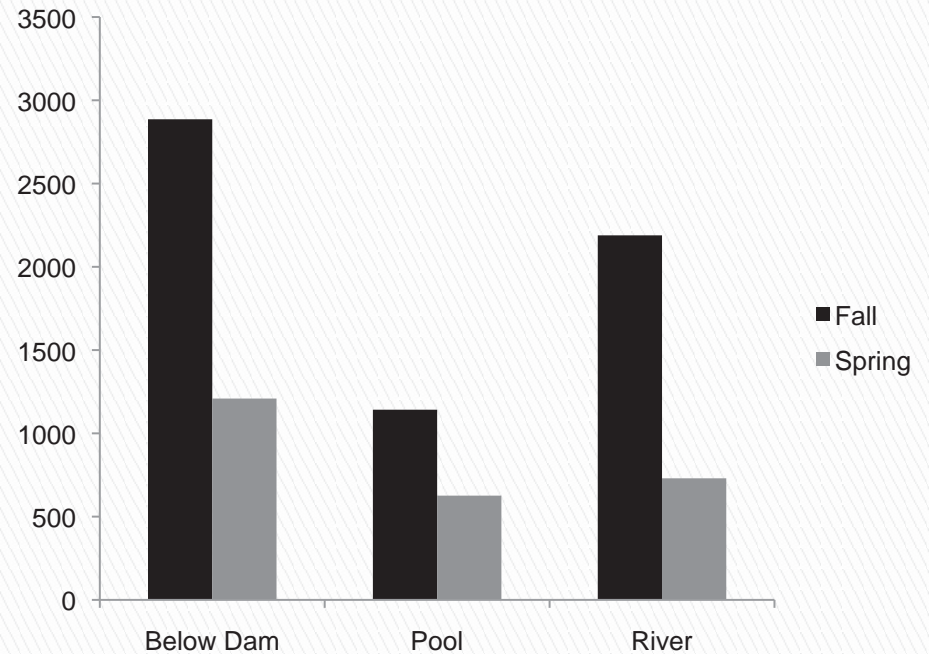
Objectives

- ▶ **When to Sample Dam Effects (Seasonal)**
- ▶ Habitat Quality, Diversity, and Biotic Index (Base Flow)
- ▶ Spatial Structure of Fish and Macroinvertebrate Assemblages (Base Flow)



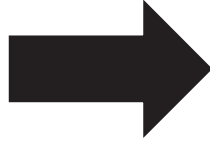
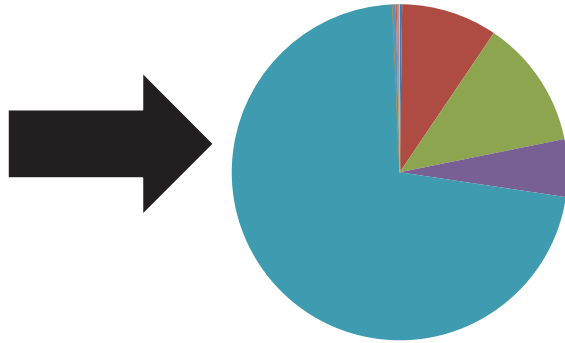
Total Catch

- ▶ **Fall 2012 – 6217**
 - Vermilion – 3771
 - North Fork – 2446
- ▶ **Spring 2013 – 2565**
 - Vermilion -1438
 - North Fork - 1127

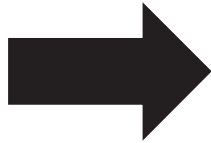
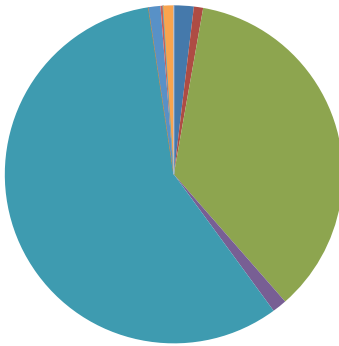


Fall 2012

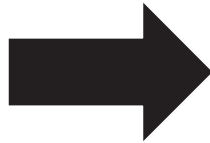
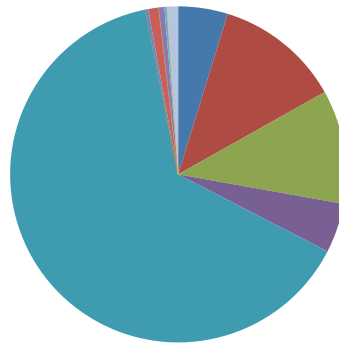
River



Pool



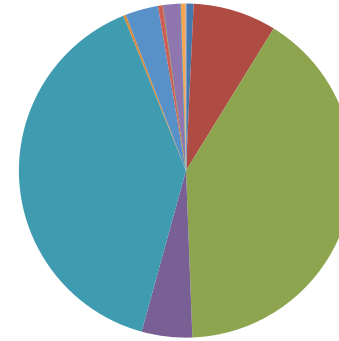
Below Dam



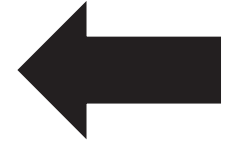
Vermilion Family Composition

- Catostomidae
- Centrarchidae
- Clupeidae
- Cyprinidae

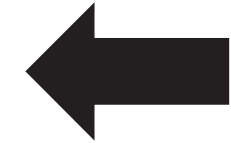
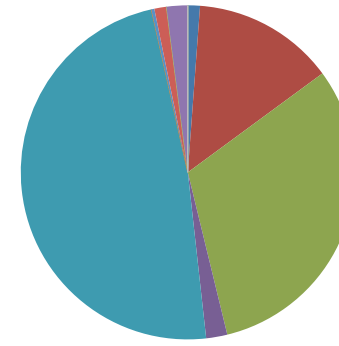
River



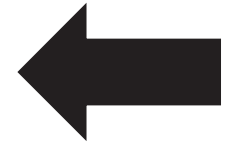
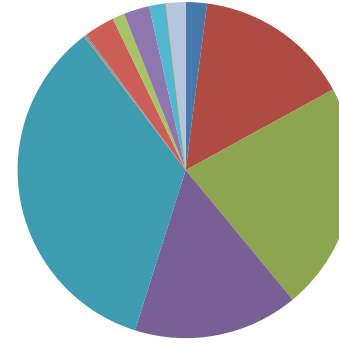
Spring 2013



Pool

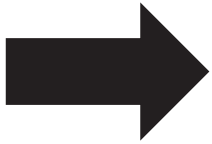
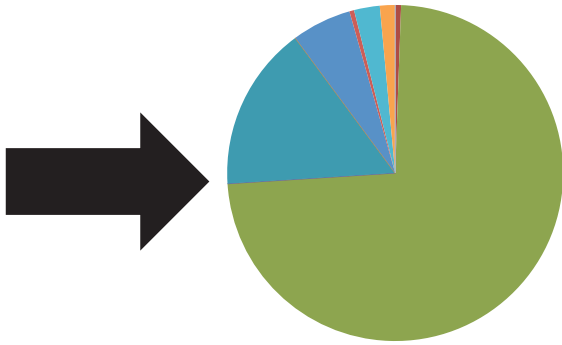


Below Dam



Fall 2012

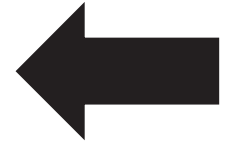
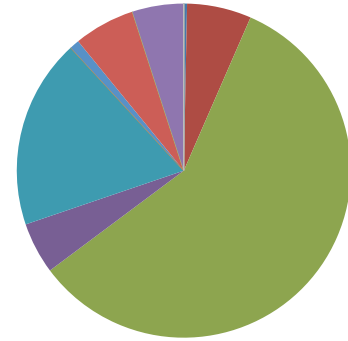
River



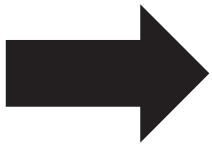
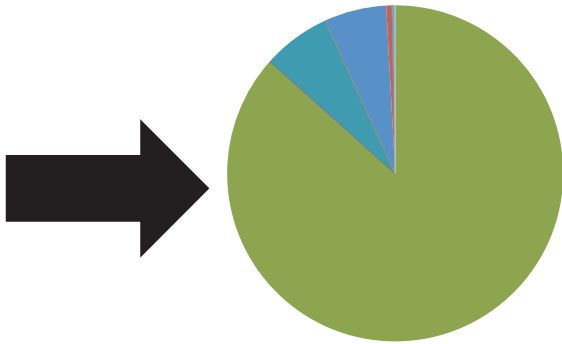
North Fork Family Composition

River

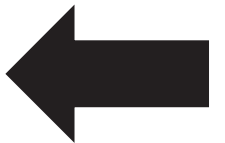
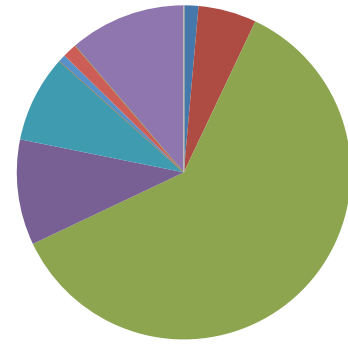
Spring 2013



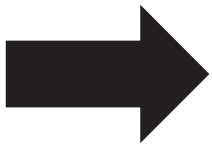
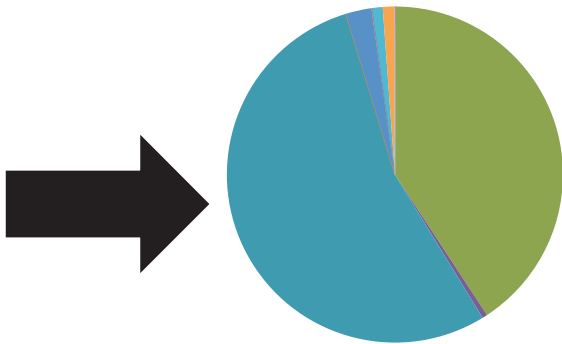
Pool



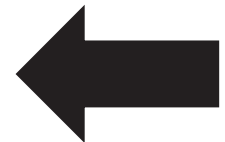
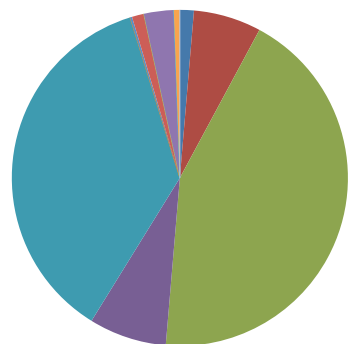
Pool



Below Dam

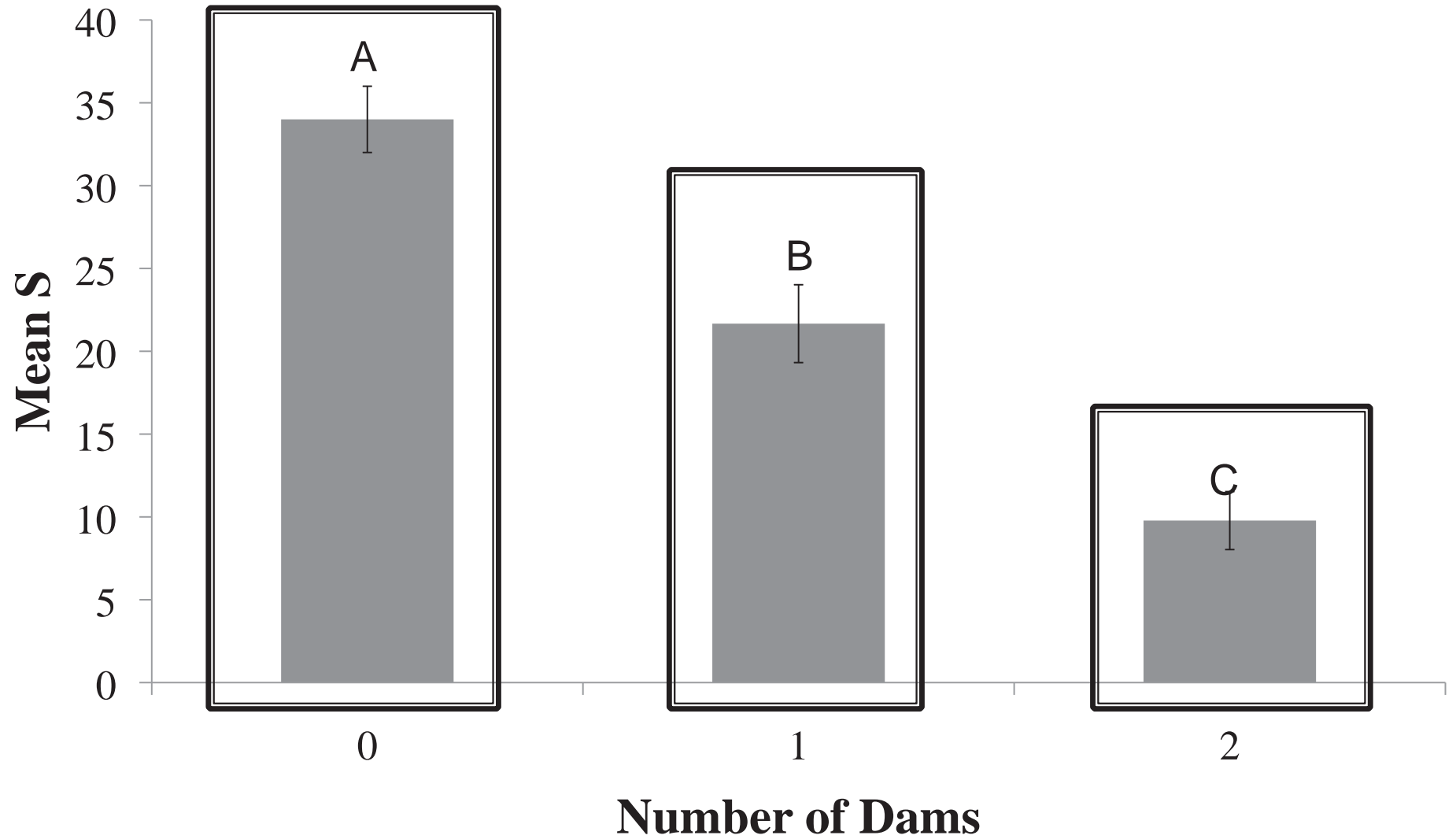


Below Dam

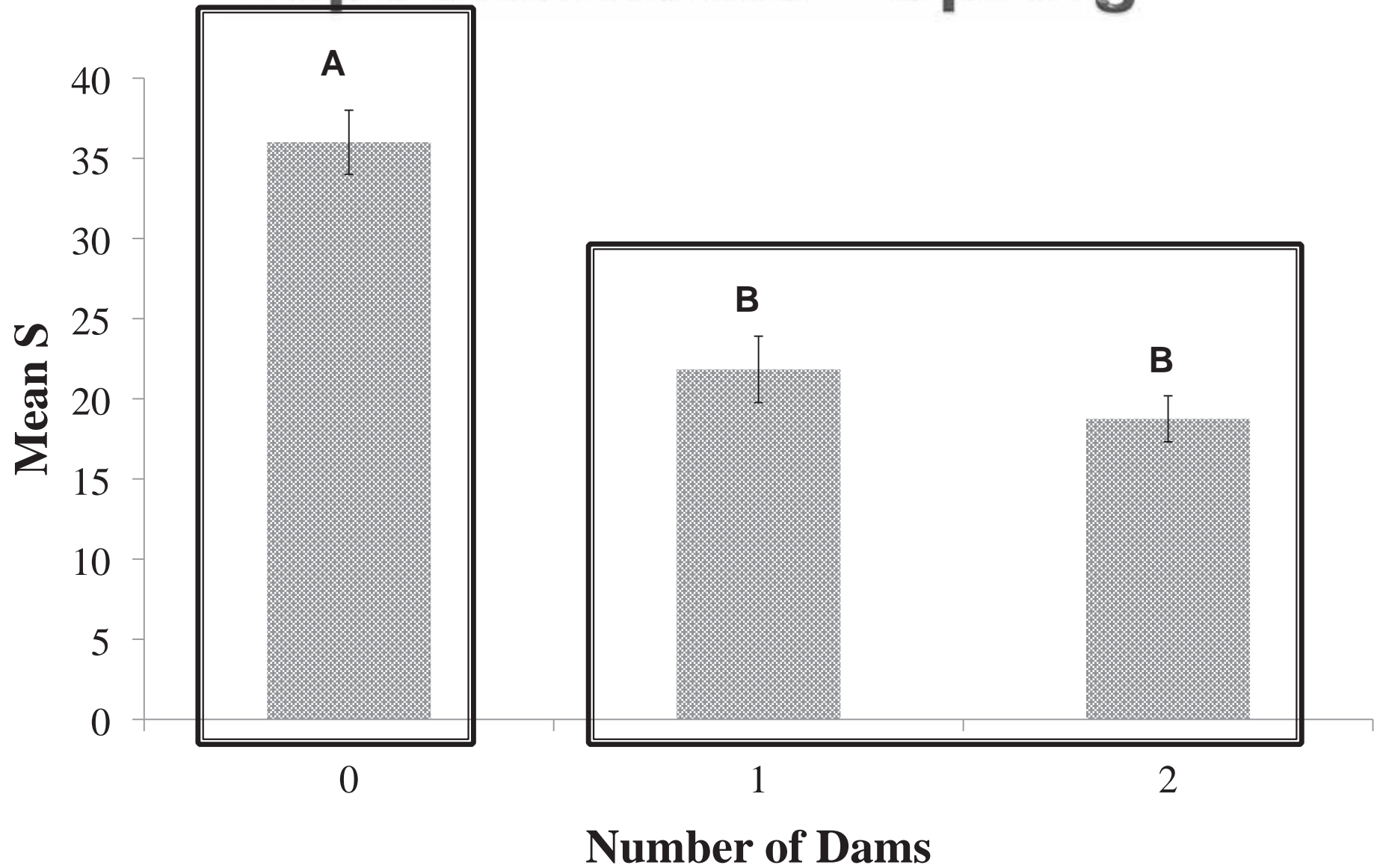


- Catostomidae
- Centrarchidae
- Clupeidae
- Cyprinidae

Impoundments - Fall



Impoundments - Spring



Fall 2012

Information Remaining (%)

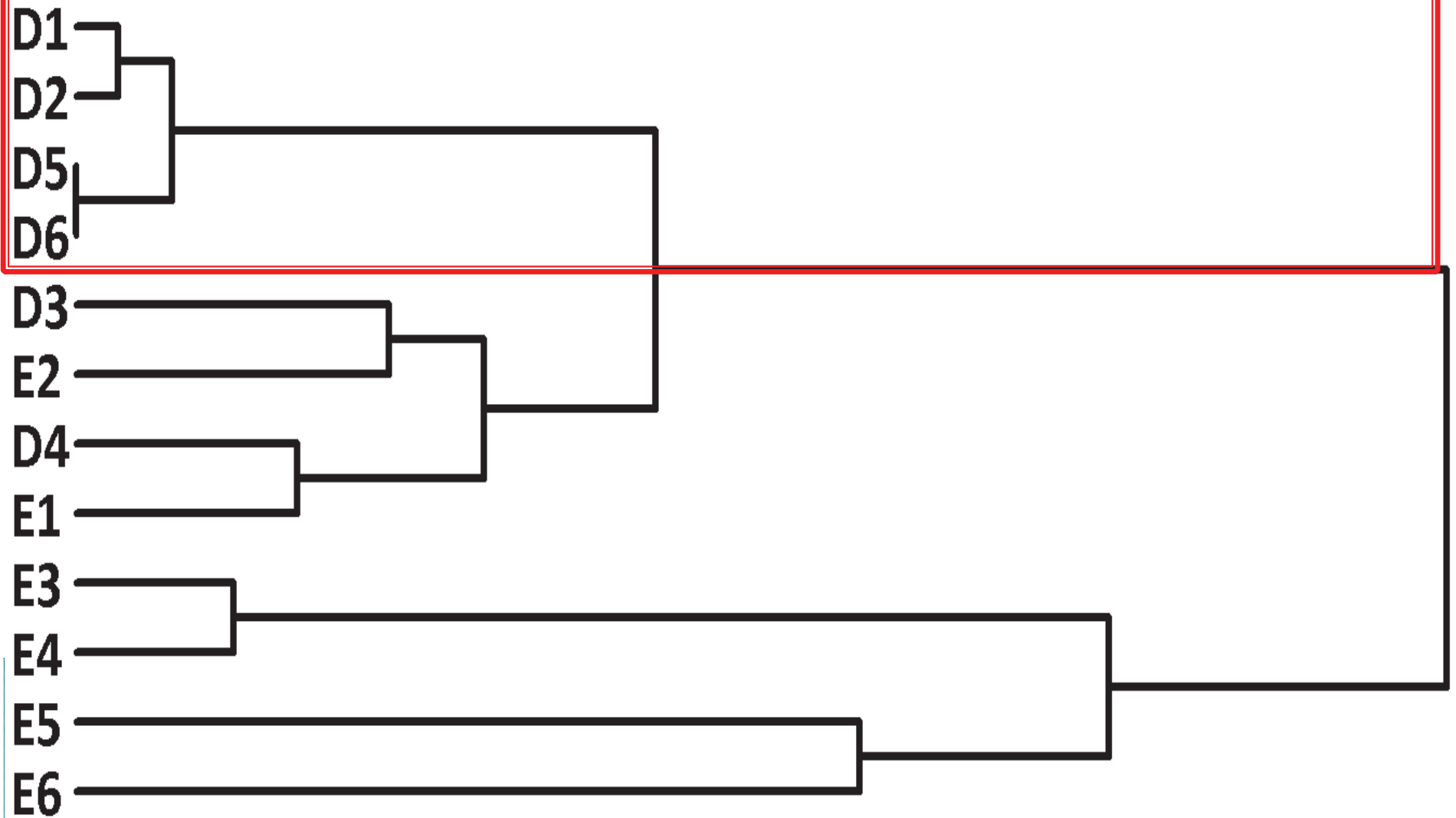
100

75




50

25

0



Legend:

-  River
-  Pool
-  Below Dam

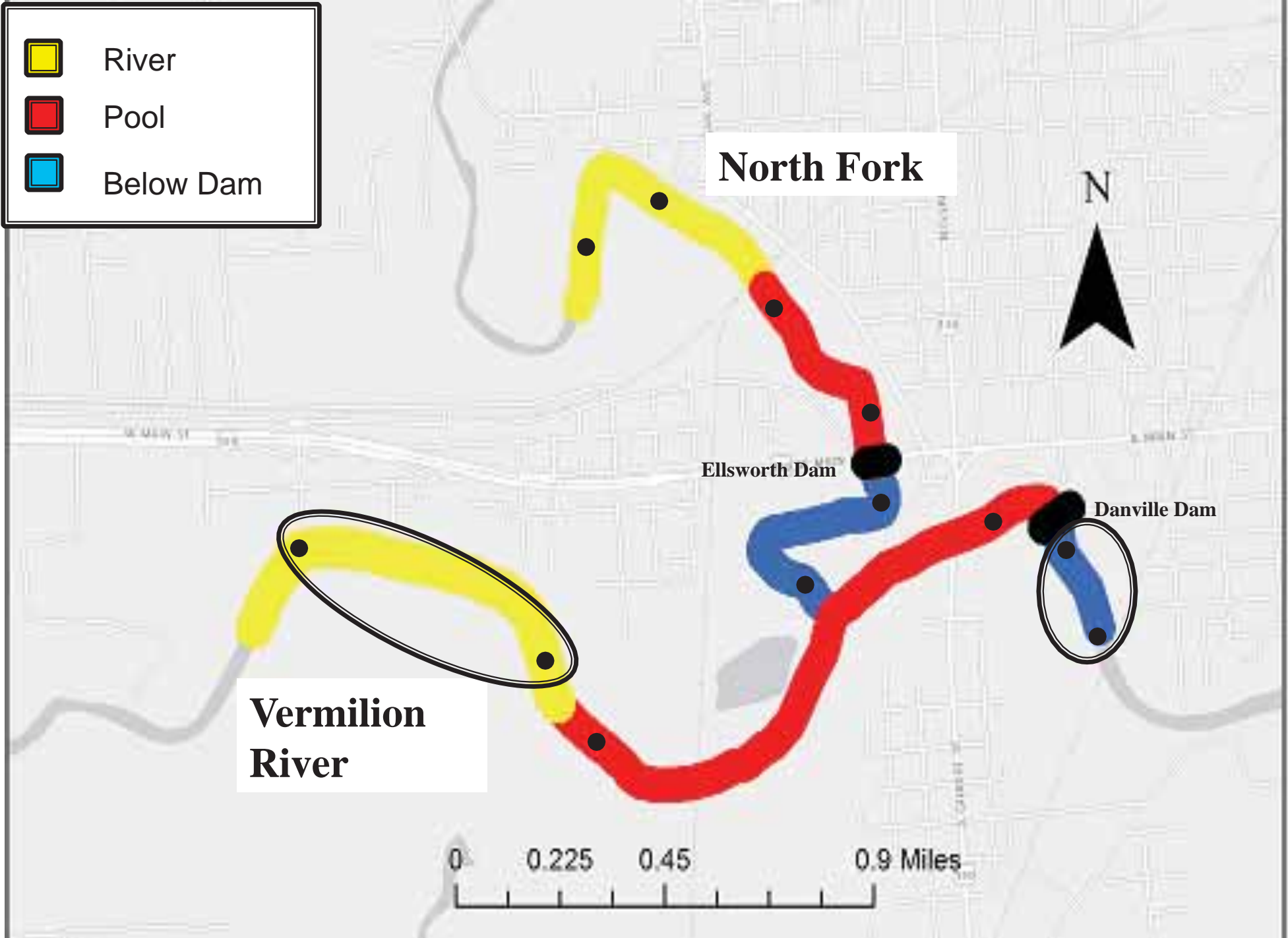
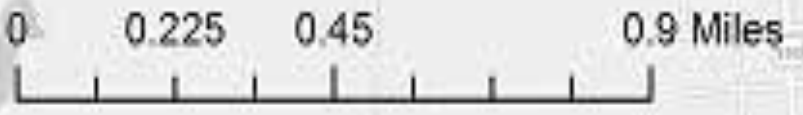
North Fork



Ellsworth Dam

Danville Dam

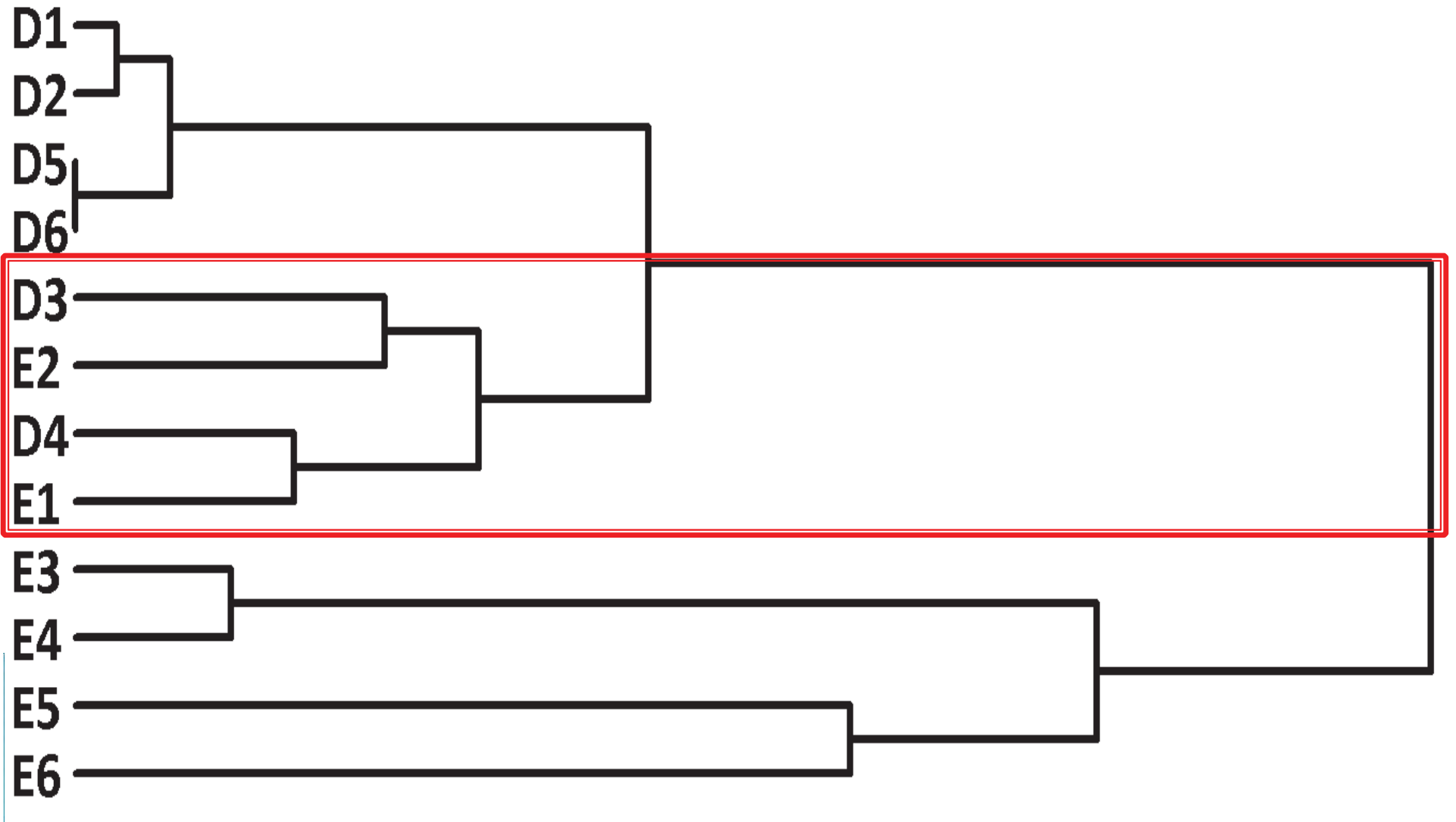
Vermilion River






Fall 2012

Information Remaining (%)

100 75 50 25 0



Legend:

-  River
-  Pool
-  Below Dam

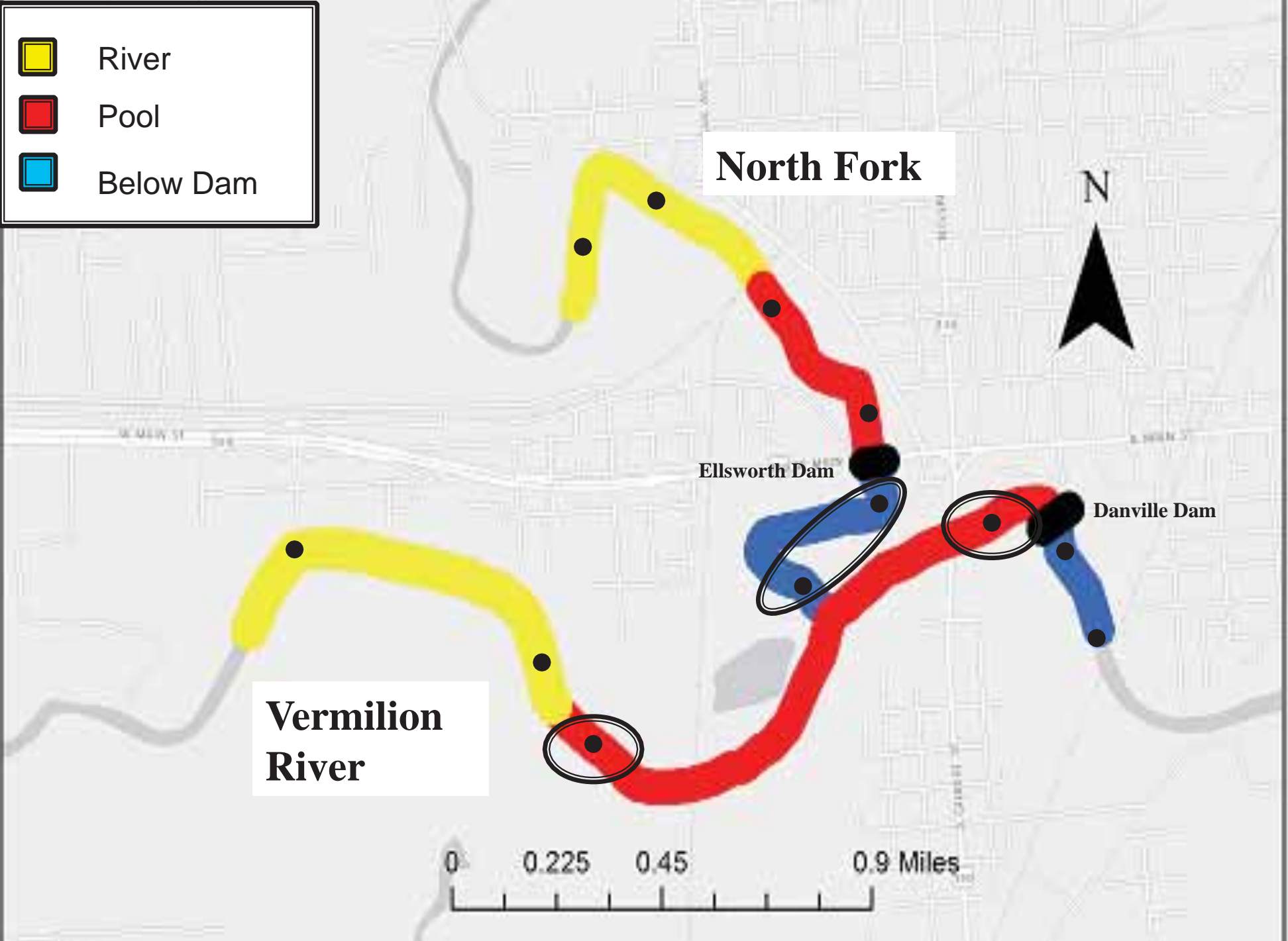
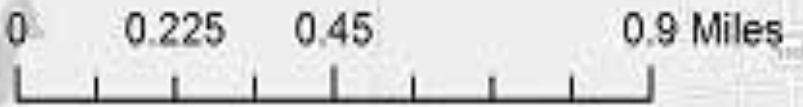
North Fork



Ellsworth Dam

Danville Dam

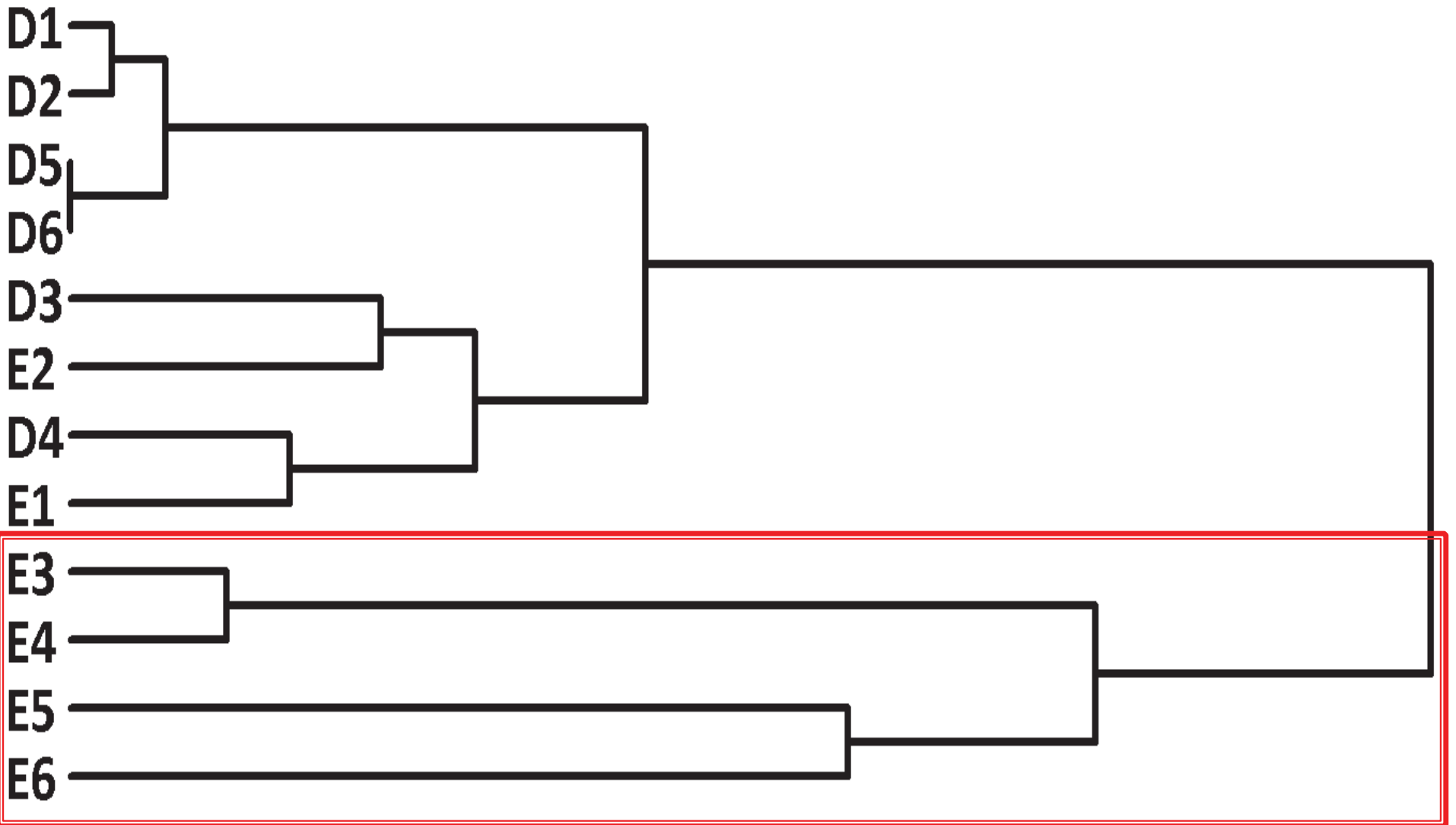
Vermilion River






Fall 2012

Information Remaining (%)

100 75 50 25 0



Legend:

-  River
-  Pool
-  Below Dam

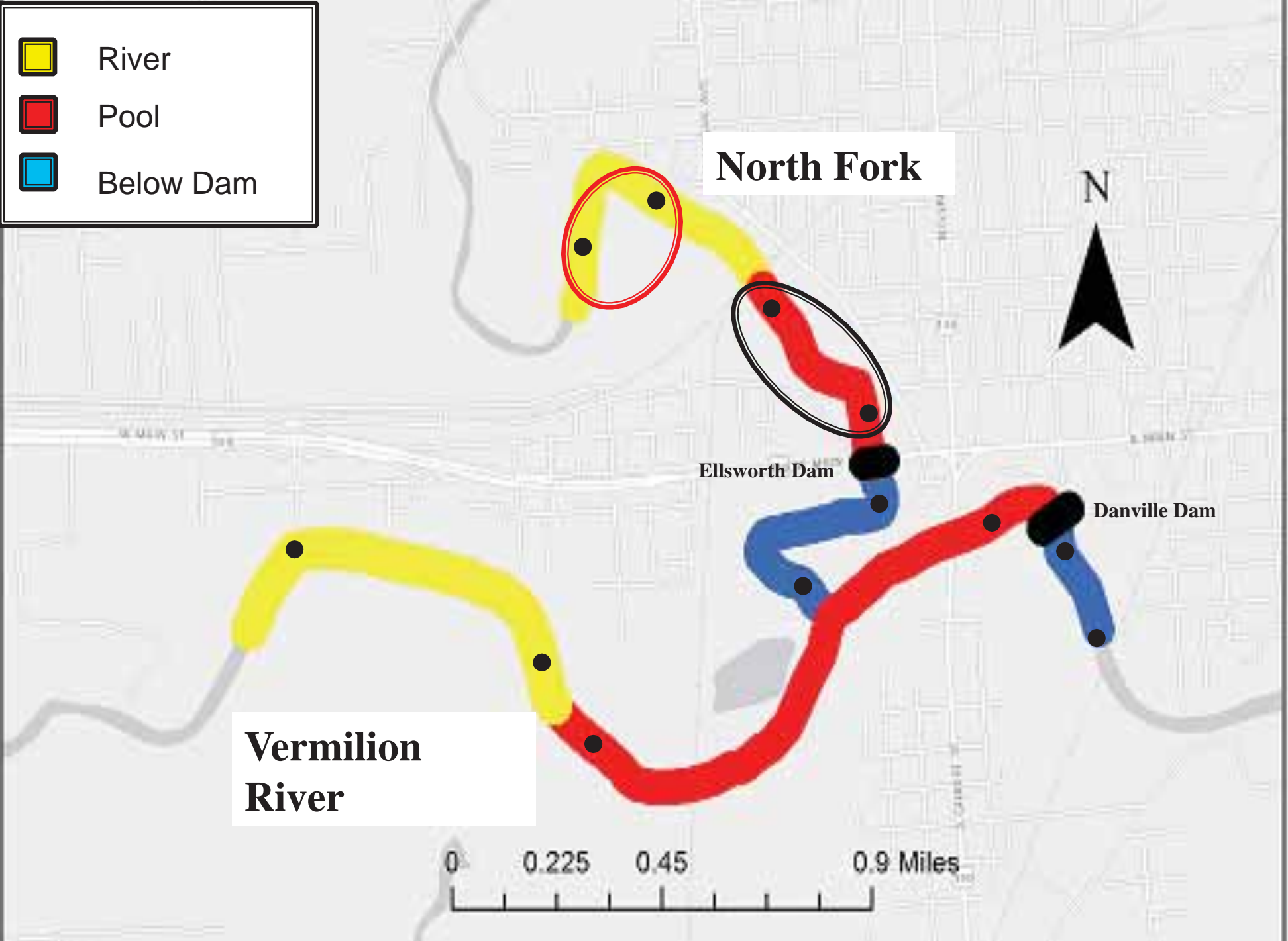
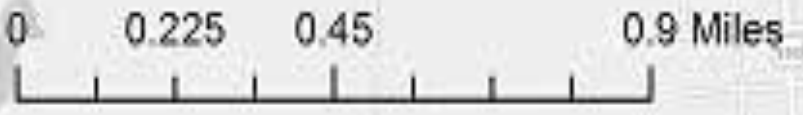
North Fork



Ellsworth Dam

Danville Dam

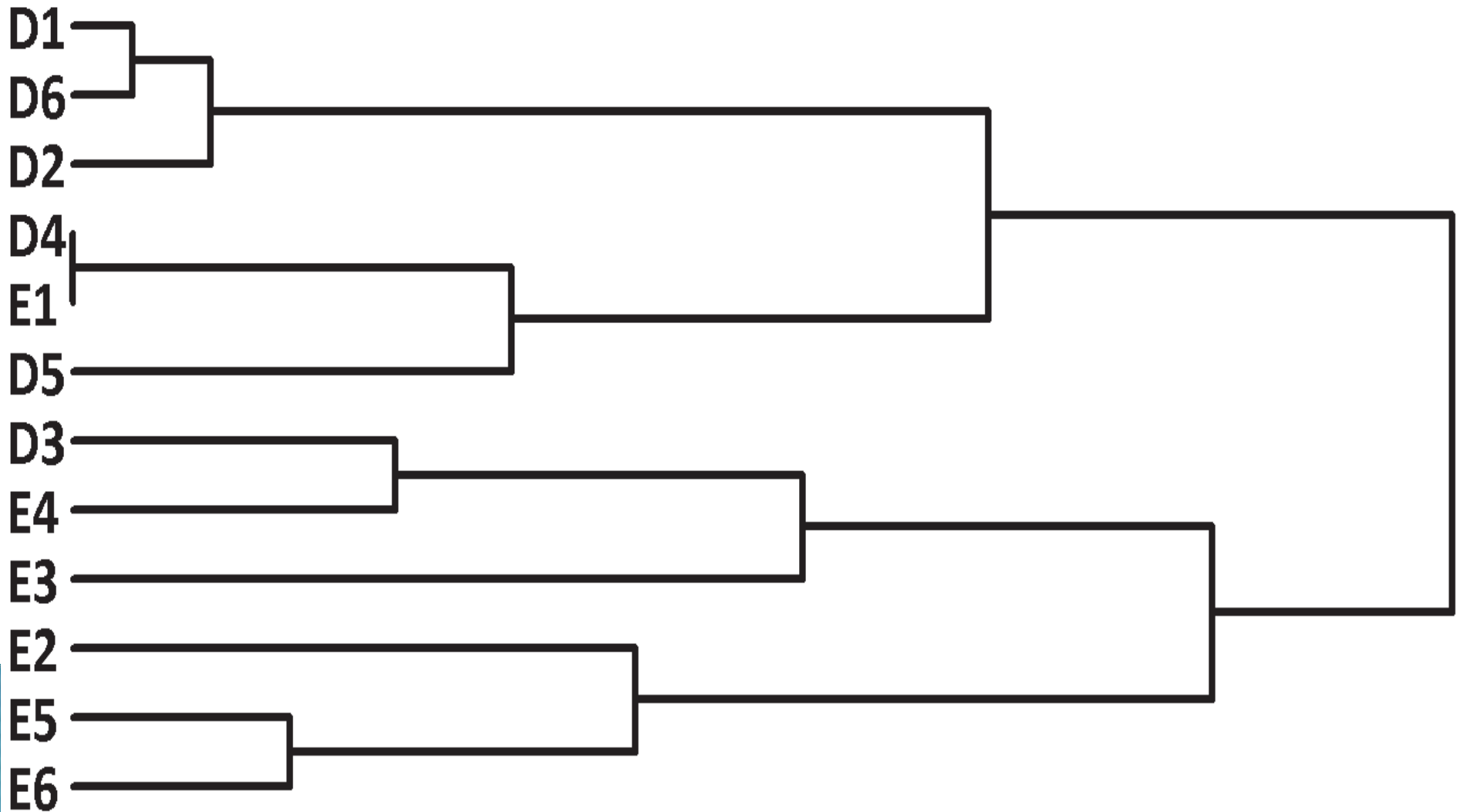
Vermilion River



Spring 2013

Information Remaining (%)

100 75 50 25 0



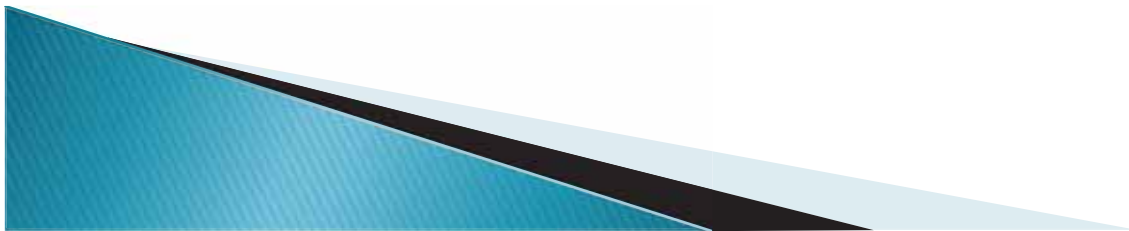
Conclusions

- ▶ Seasonal Shifts in Fish Assemblages
- ▶ Cluster Analysis Suggest Impacts of Dams are Distinct in Fall Season
- ▶ Continuous Sites are Less Similar in Spring
- ▶ Assessment of Impacts of Dams on Fish Assemblages Should Be Conducted at Base Flow

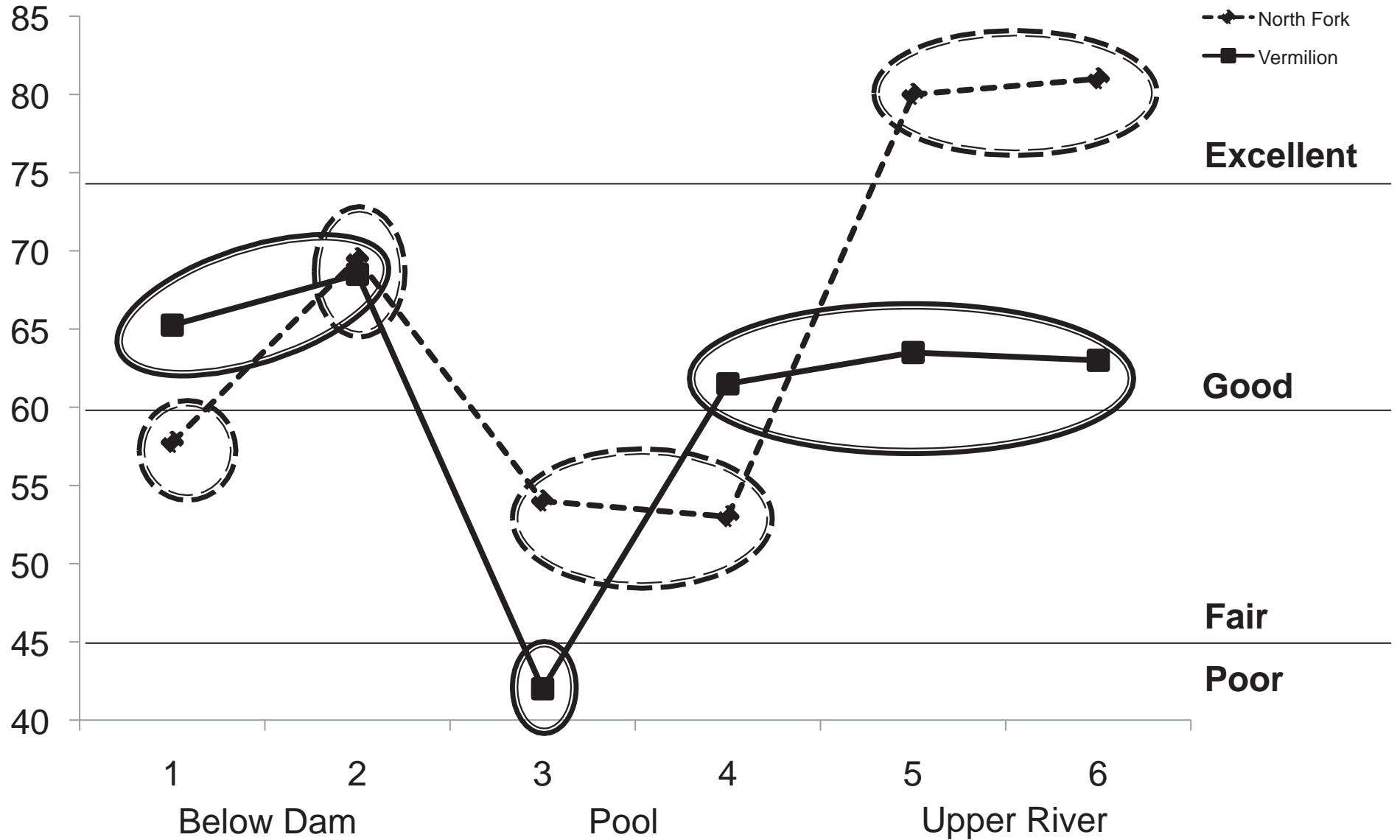


Objectives

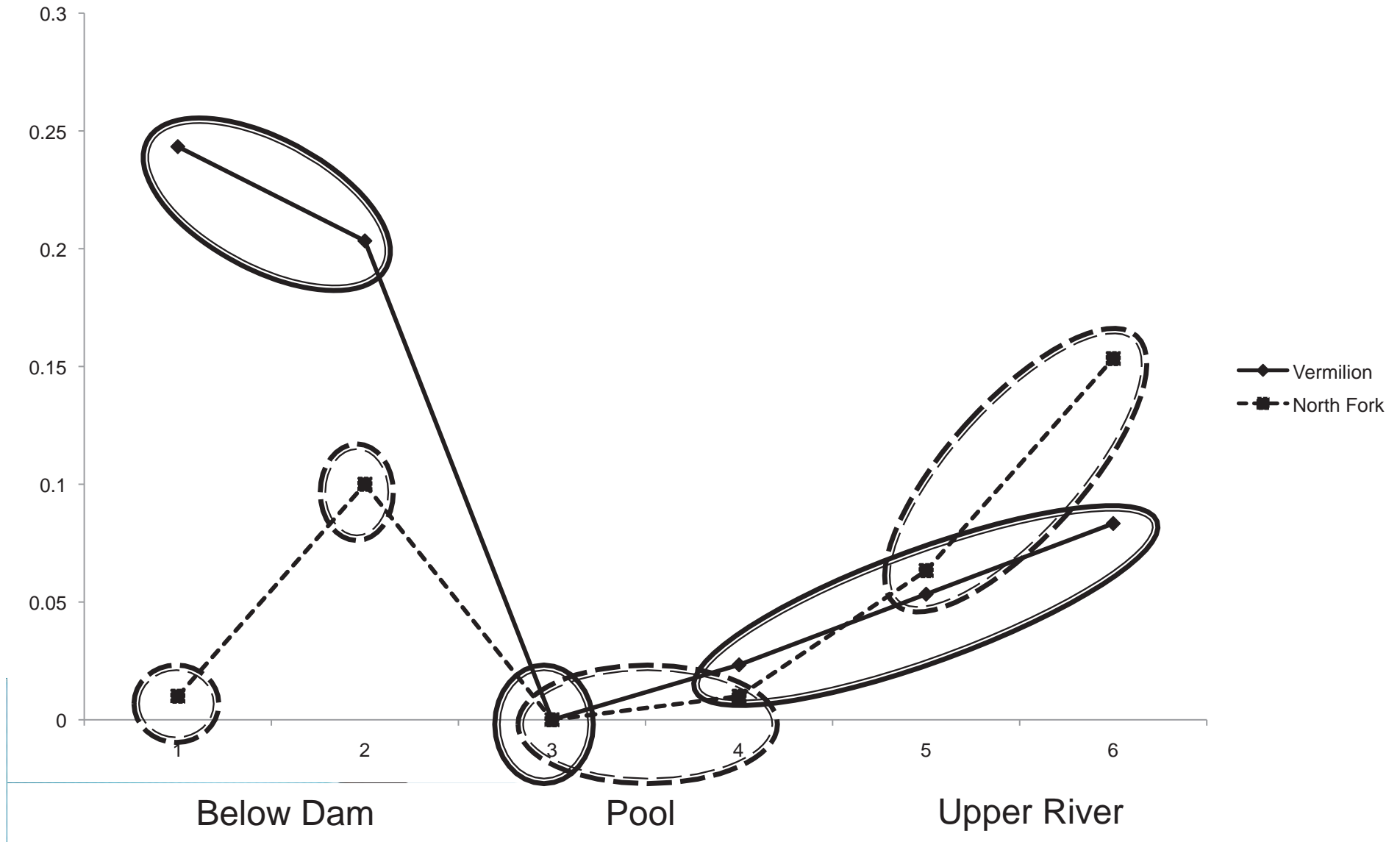
- ▶ When to Sample Dam Effects (Seasonal)
- ▶ Habitat Quality, Diversity, and Biotic Index (Base Flow)
- ▶ Spatial Structure of Fish and Macroinvertebrate Assemblages (Base Flow)



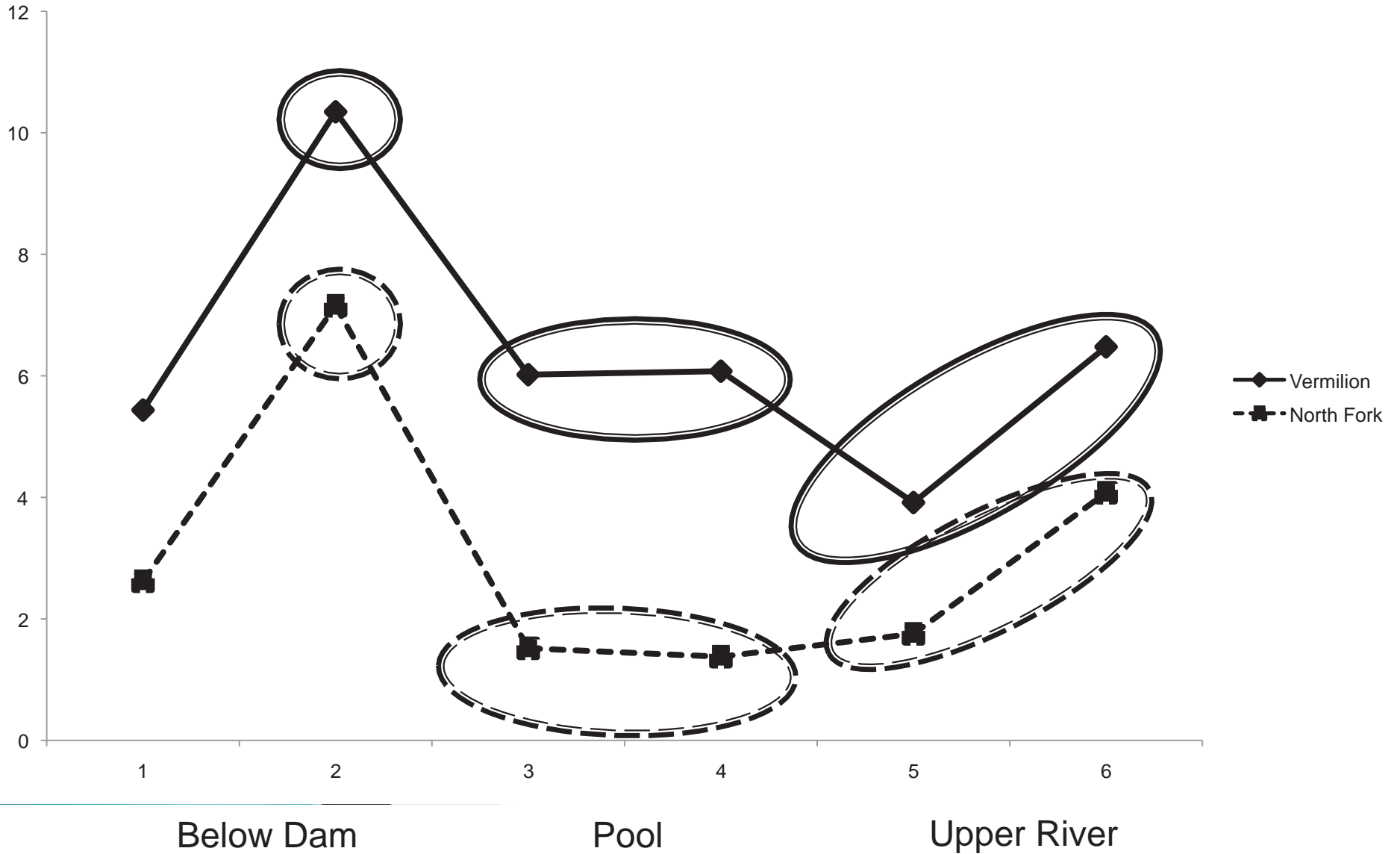
QHEI



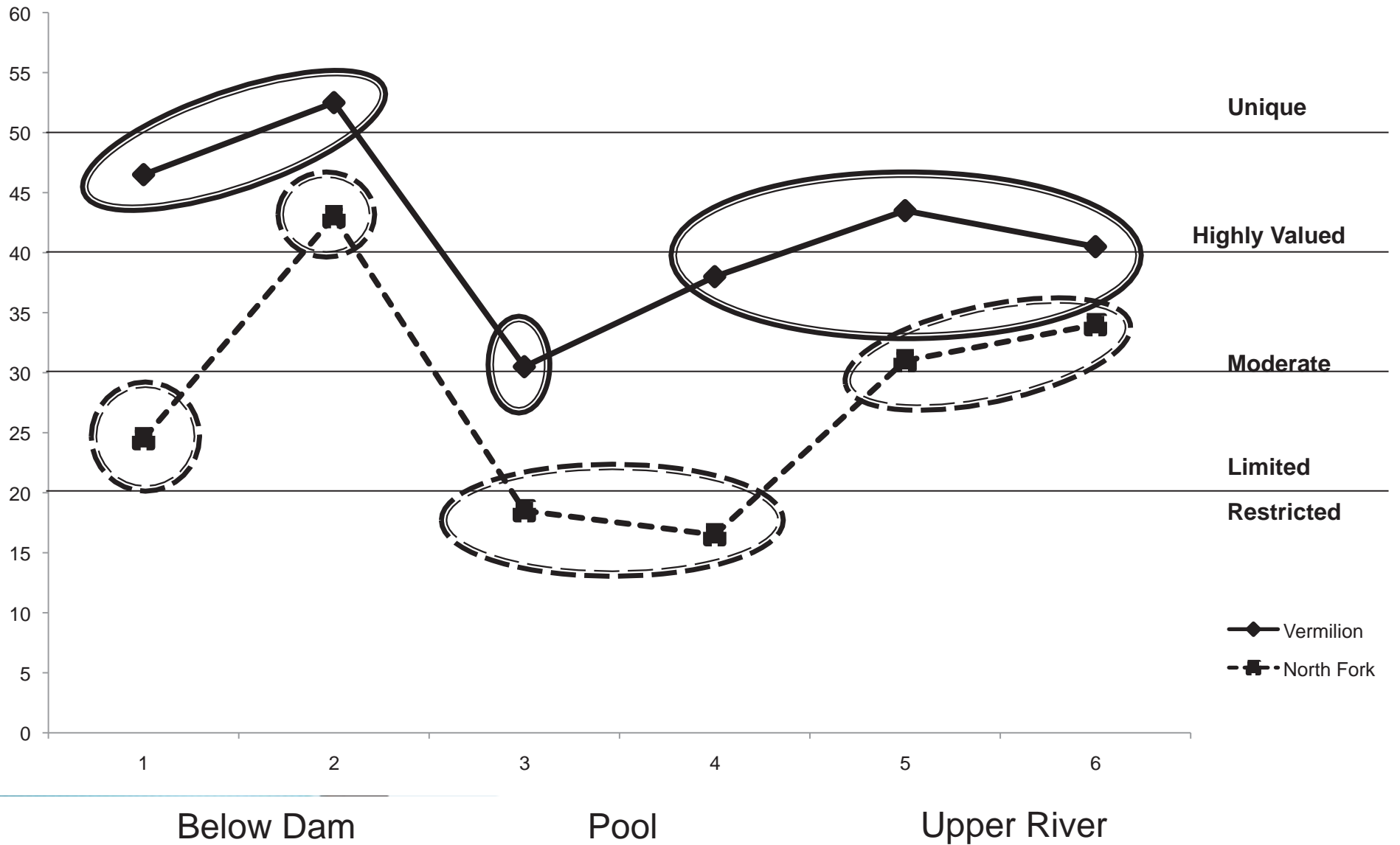
Flow (m/s)



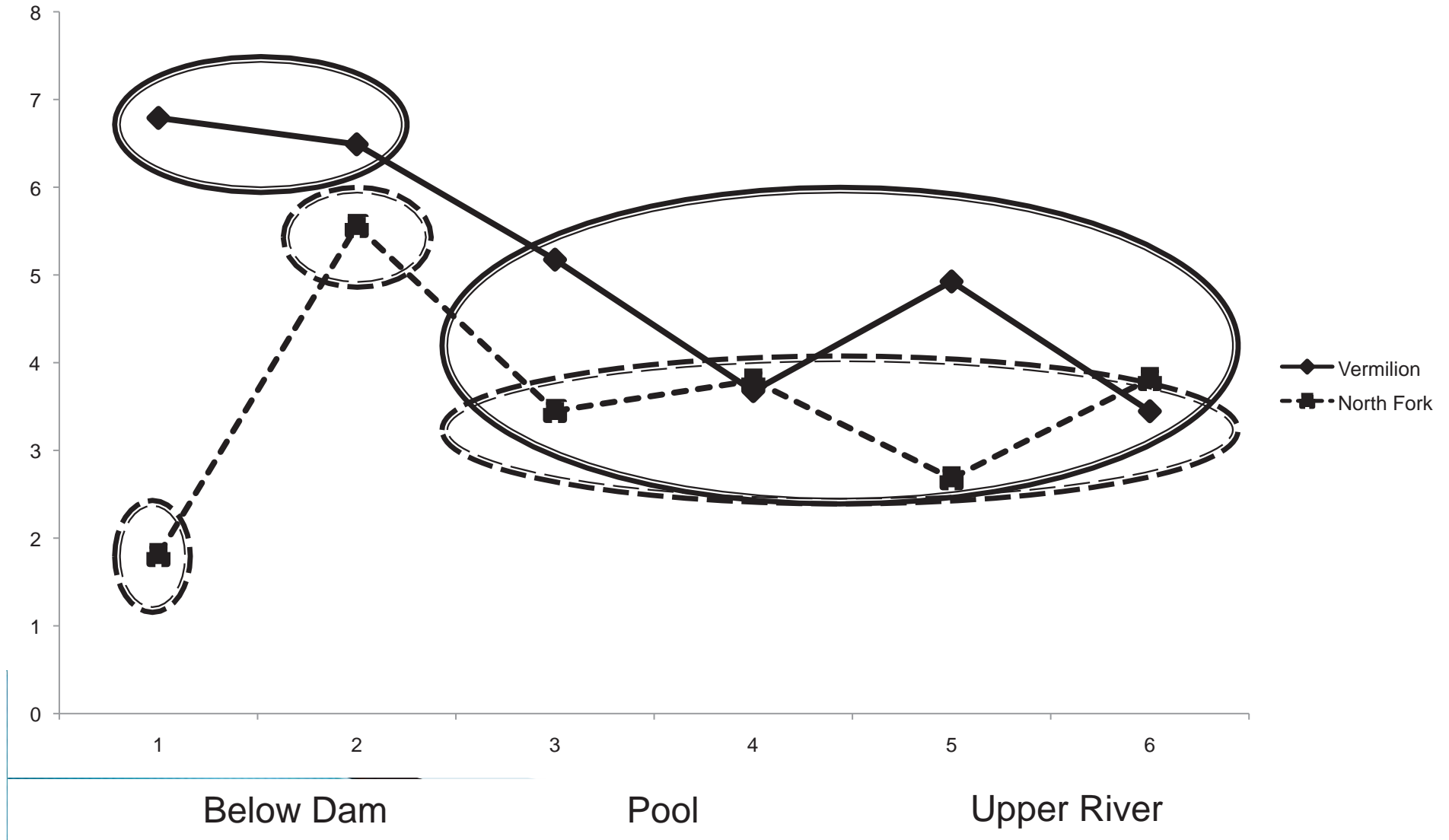
Simpsons (D) - Fish



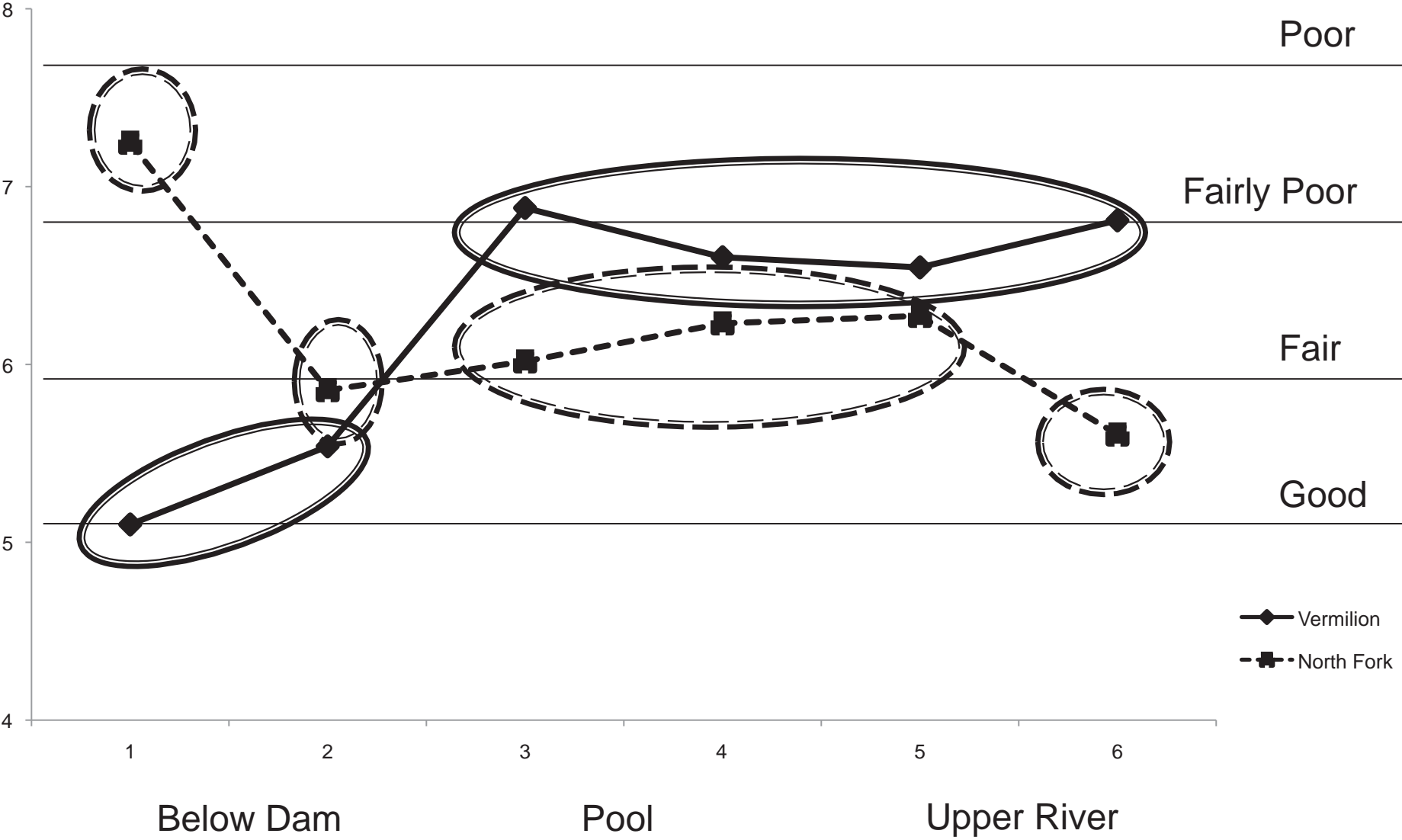
Index of Biotic Integrity



Simpsons (D) - Macroinvertebrate



Macroinvertebrate Biotic Index



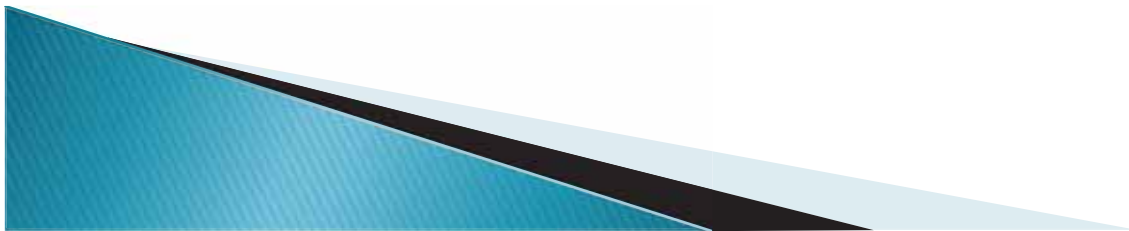
Conclusions

- ▶ **Habitat & Flow**
 - High Flow and QHEI Immediately Below Dams
 - Decrease in Flow and QHEI in Pool Sites
 - Highest QHEI Furthest Distance From Danville Dam (North Fork River Sites)
- ▶ **Fish**
 - Highest Diversity and Biotic Index Below Immediately Below the Dams
 - Lowest Diversity and Biotic Index Immediately Above the Dams
- ▶ **Macroinvertebrates**
 - High Diversity and Index Immediately Below the Dams
 - Average Diversity and Index Among Above Dam Sites



Objectives

- ▶ When to sample Dam Effects (Seasonal)
- ▶ Habitat Quality, Diversity, and Biotic Index (Base Flow)
- ▶ Spatial Structure of Fish and Macroinvertebrate Assemblages (Base Flow)
 - Are Dams influencing Assemblages as Physical Barriers or by Altering the Environment



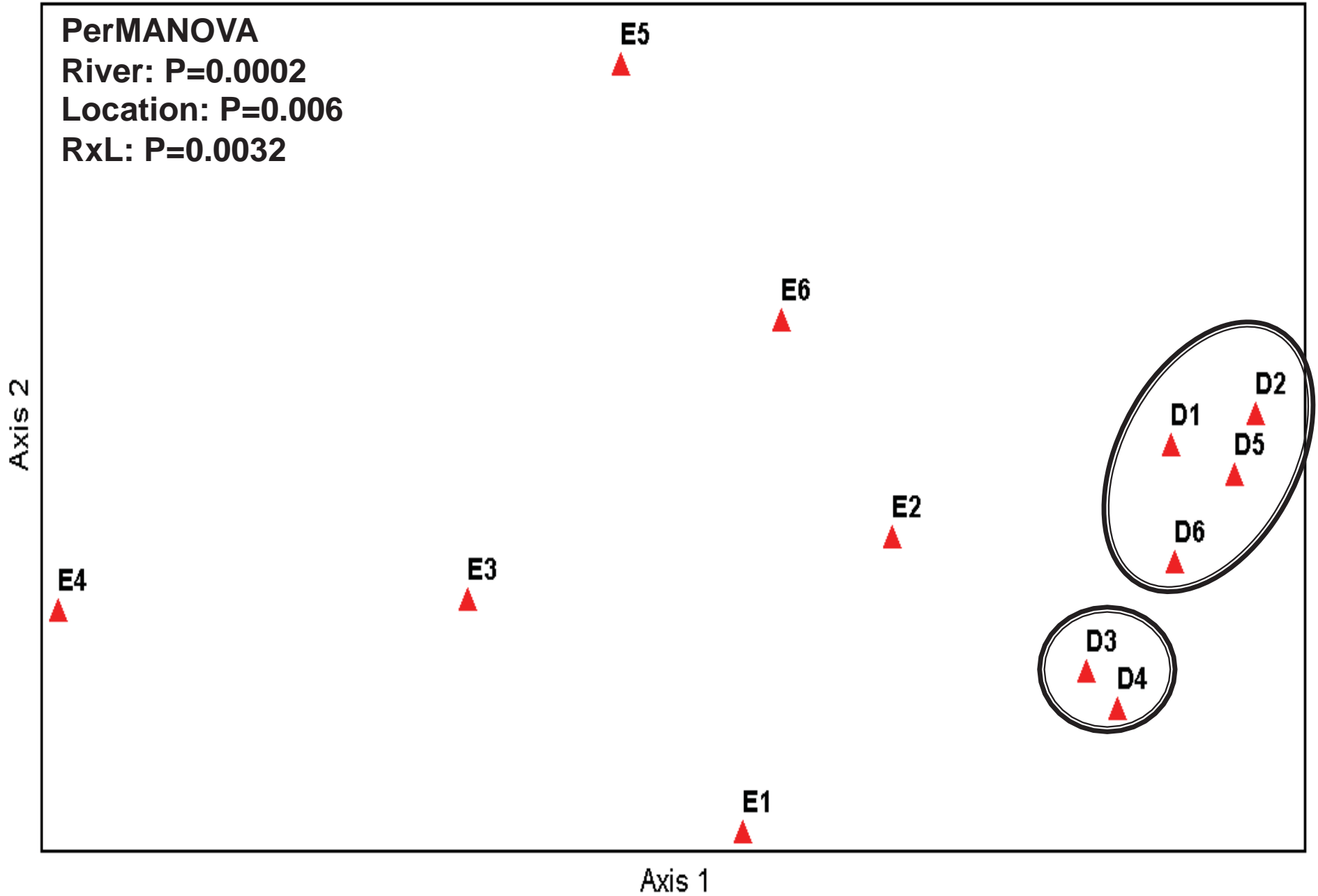
Fall

PerMANOVA

River: $P=0.0002$

Location: $P=0.006$

RxL: $P=0.0032$



Spatial Structure - Fish

- ▶ Mantel Test Relate Physical Distance and Environmental Distance (Sorensen's) to Compositional Distance (Sorensen's)
 - No physical distance effect on fish assemblages
 - (t=0.248, P=0.104)
 - Significant effect of environment on fish assemblages
 - (t=0.375, P=0.002)



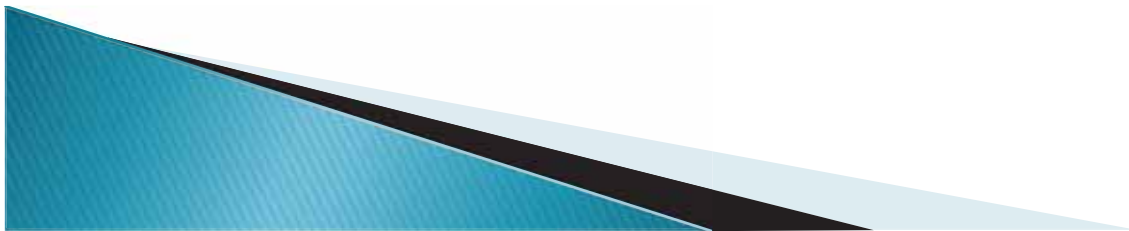
Spatial Structure - Fish

- ▶ Partial Mantel Tests to Control for Distance and Environment
 - Still no distance effect when controlling for environment
 - ($t=-0.001$, $P=0.500$).
 - Still an effect of environment when controlling for distance
 - ($t=0.291$, $P=0.039$)



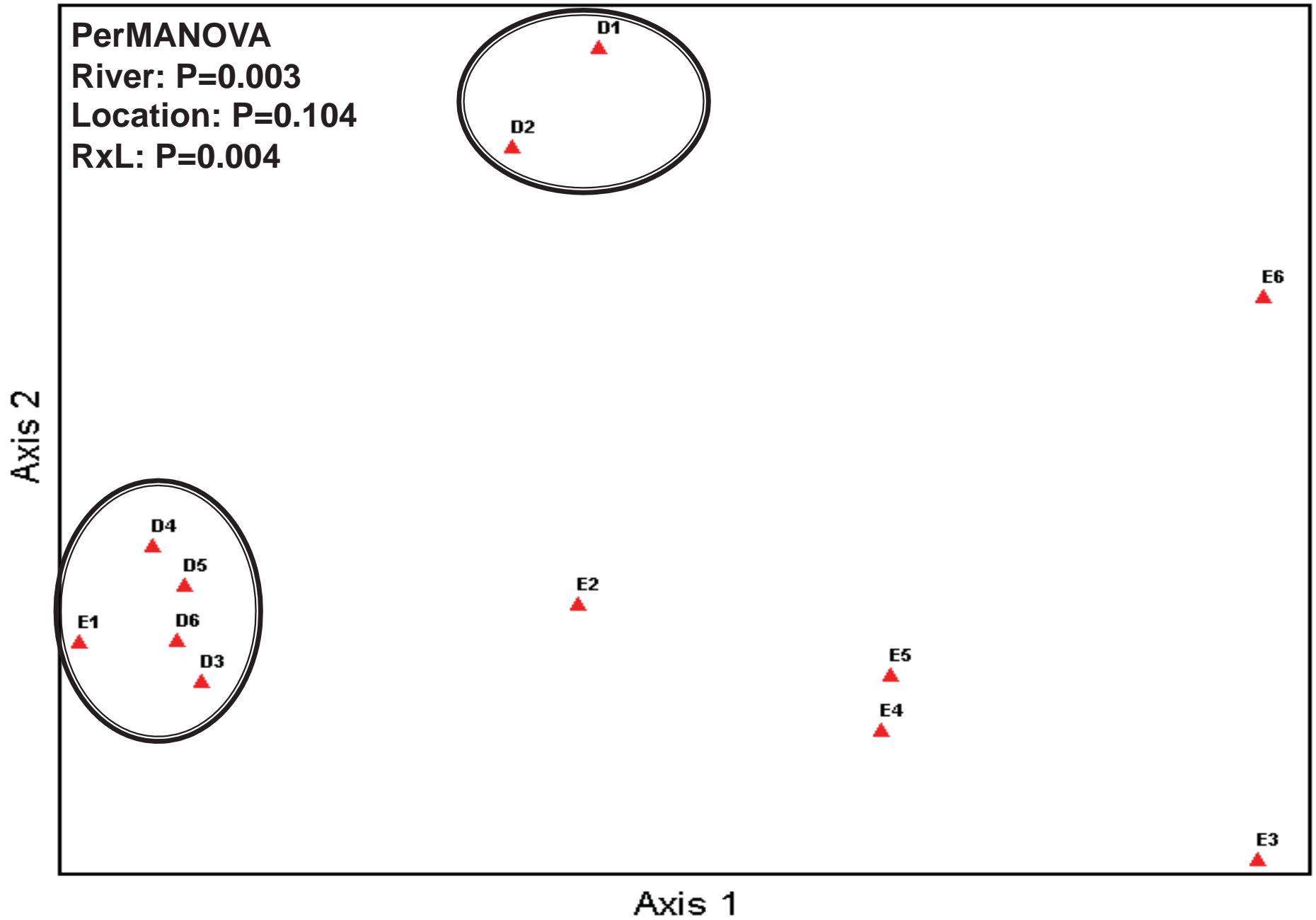
Fish

- ▶ Clear Separation of Rivers
- ▶ Vermilion – Below Dam Sites and River Sites are Closely Related
- ▶ Vermilion – Pool Sites are Clustered
- ▶ North Fork – No Clustering of Sites
 - High Compositional Variability
- ▶ PerMANOVA
 - River, Location, River x Location
- ▶ Affected by Dams from Environmental Changes



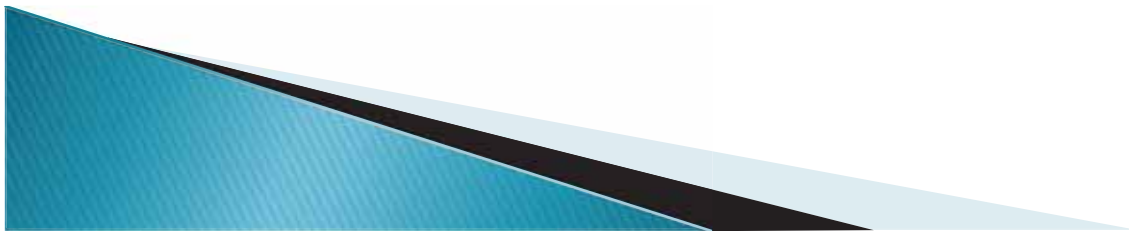
Fall Macro RA FAMily

PerMANOVA
River: P=0.003
Location: P=0.104
RxL: P=0.004



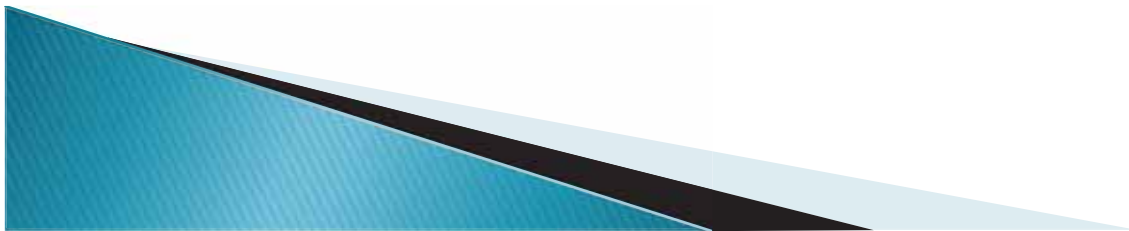
Spatial Structure - Macroinvertebrates

- ▶ Mantel Test Relate Physical Distance and Environmental Distance (Sorensen's) to Compositional Distance (Sorensen's)
 - Physical distance effect on macroinvertebrate assemblages
 - (t=0.403, P=0.004)
 - No affect of environment on macroinvertebrate assemblages
 - (t=0.209, P=0.089)



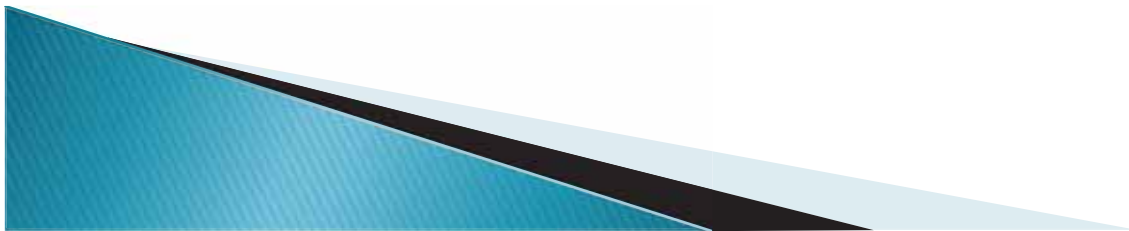
Spatial Structure – Macroinvertebrates

- ▶ Partial Mantel Tests to Control for Distance and Environment
 - Still a distance effect when controlling for environment
 - ($t=0.367$, $P=0.011$).
 - No affect of environment when controlling for distance
 - ($t=-0.088$, $P=0.728$)



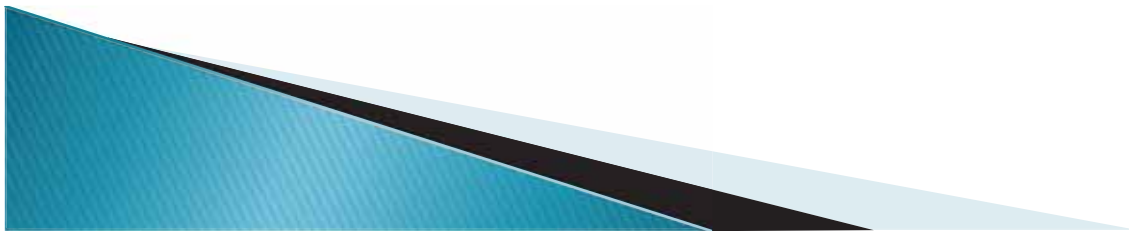
Macroinvertebrates

- ▶ Sites are Separated in Relation Impoundments Downstream
- ▶ High Variability in the North Fork
- ▶ PerMANOVA
 - River, River x Location
- ▶ Affected by Dams as Physical Barriers



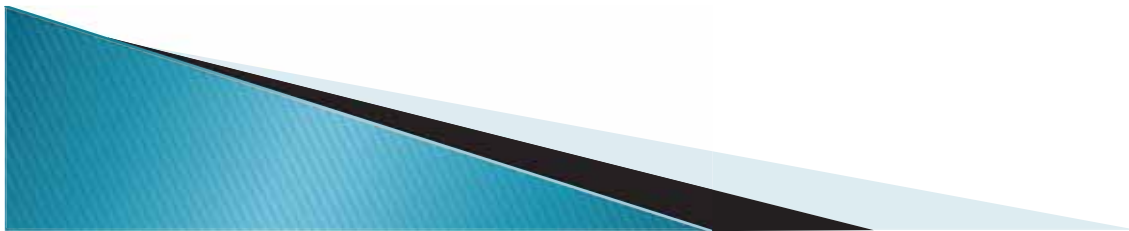
Conclusions

- ▶ Seasonal Variability in Fish Assemblages
- ▶ Structure Disappears between Fall and Spring Seasons
- ▶ Effects of Dams: Sampled at Base Flow



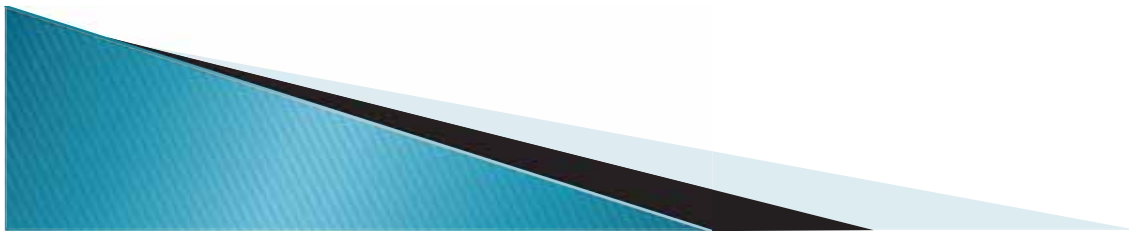
Conclusions

- ▶ Habitat Quality
 - Decrease in Habitat Quality Above the Dams
 - Decrease in Flow Above the Dams
- ▶ Fish & Macroinvertebrates
 - Highest Diversity and Biotic Index Immediately Below the Dams
 - Lowest Diversity and Biotic Index Immediately Above the Dams



Conclusions

- ▶ Clear Compositional Difference Between Rivers
 - Sites Between Rivers
- ▶ Fish
 - Affected by Environmental Changes Caused by the Dams
 - Changes in Substrate Abundances and Flow
- ▶ Macroinvertebrates
 - Affected by Dams as Physical Barriers
 - Act as Barriers for Dispersal of Eggs and Larvae



Acknowledgements



Eastern Illinois University Fisheries Lab
Illinois Department of Natural Resources

Questions?

