

# A USGS Partnership to Investigate Possible Causes for Freshwater Mussel Health Decline in the Clinch River Basin in Virginia and Tennessee

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Funded by the USGS Ecosystems Change Fund, and a Cooperative Investigation with Tennessee Wildlife Resources Agency and The Nature Conservancy

<http://va.water.usgs.gov/projects/clinch.htm>

# Purpose and Approach to USGS Research in the Clinch Basin

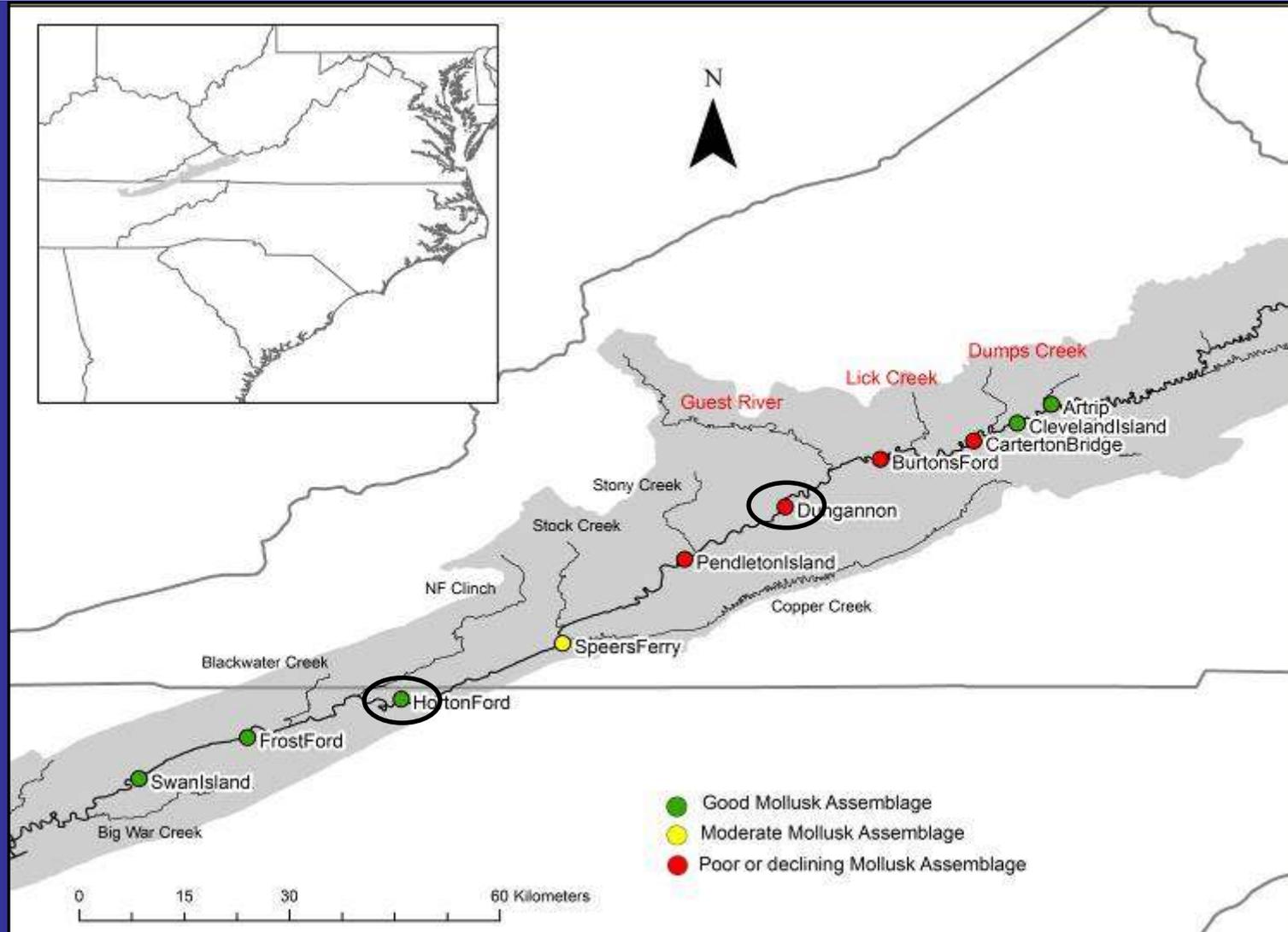
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**Purpose:** Quantitatively characterize a 40-mile section of the Clinch River to compare site characteristics between degraded mussel populations upstream and healthier populations downstream.

**Approach:** 2 primary sites, 8 secondary sites

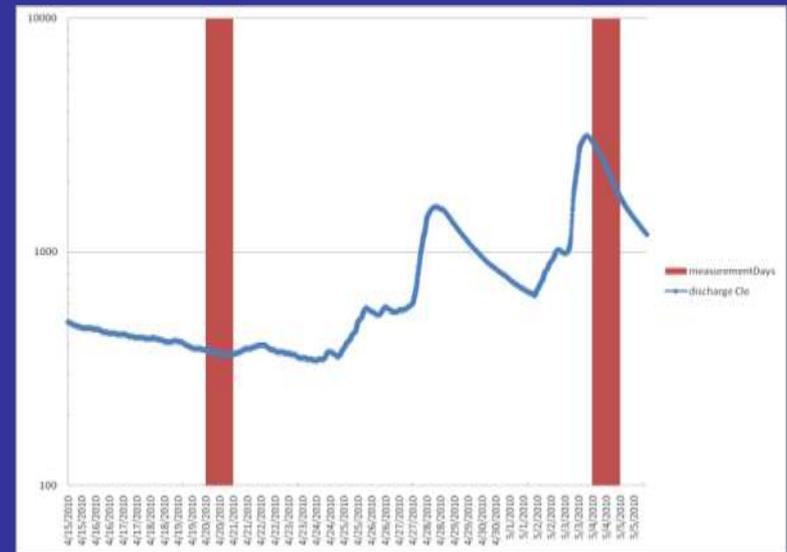
- Water-Quality: Continuous & Discrete (2 sites)
- Mussel Health: Native density & richness (10 sites), Juvenile growth & survival (4 sites)
- Geomorphology: Time of travel dissolved constituents
- Physical Habitat (10 sites)
- Sediment Quality (10 sites)

# Mussel Health Along Study Reach



# Causes for Differences Between Sites?

- Study design to address either a Chronic Stressor or Acute Stressor Hypothesis
  - Contaminants in the Water Column
  - Contaminants in Bed Sediments
  - Physical Habitat Conditions
  - Landscape Patterns



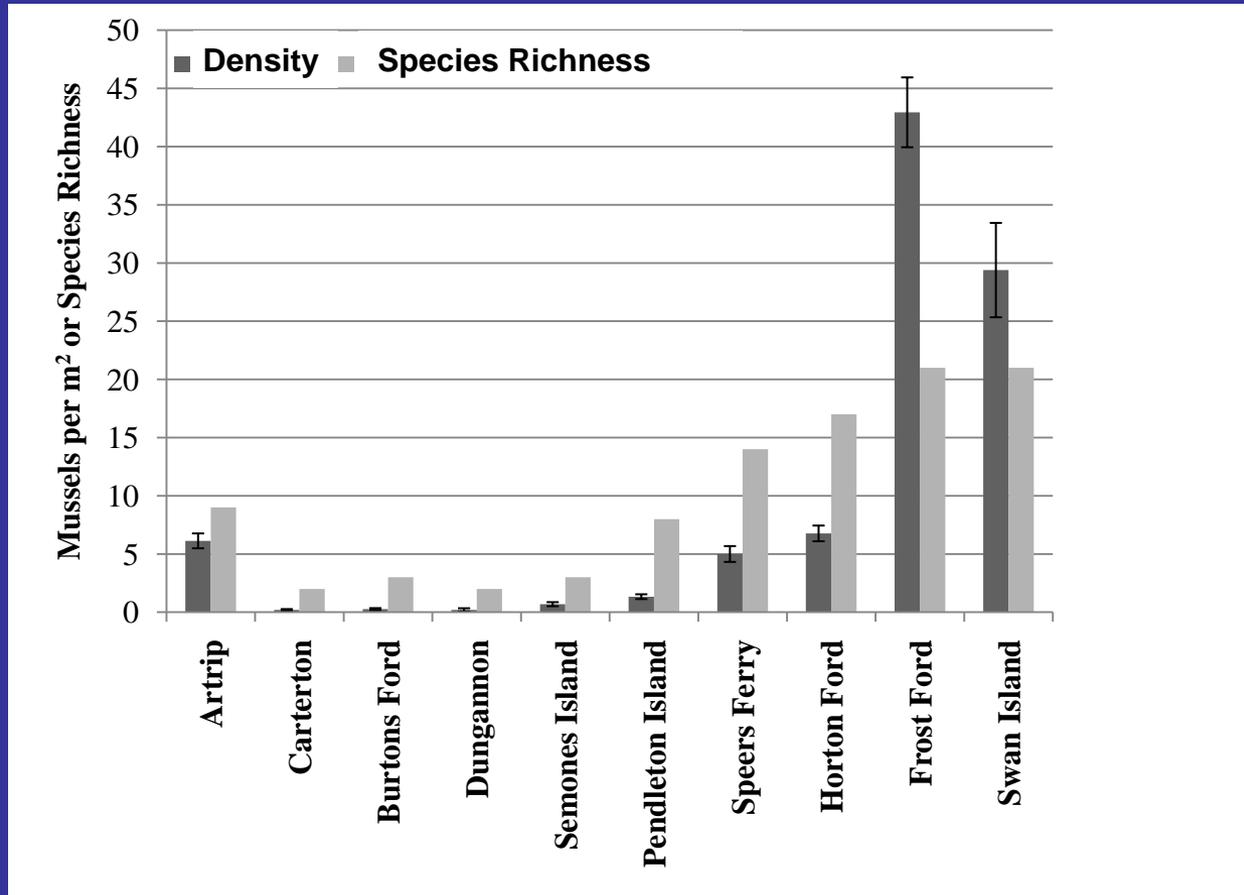
# Mussel Health Assessment

## Goals:

- Detect the dominant species present and relative abundance
- Quantify density of mussels and snails at the central riffle
- Quantitatively measure physical habitat characteristics for comparison among sites.

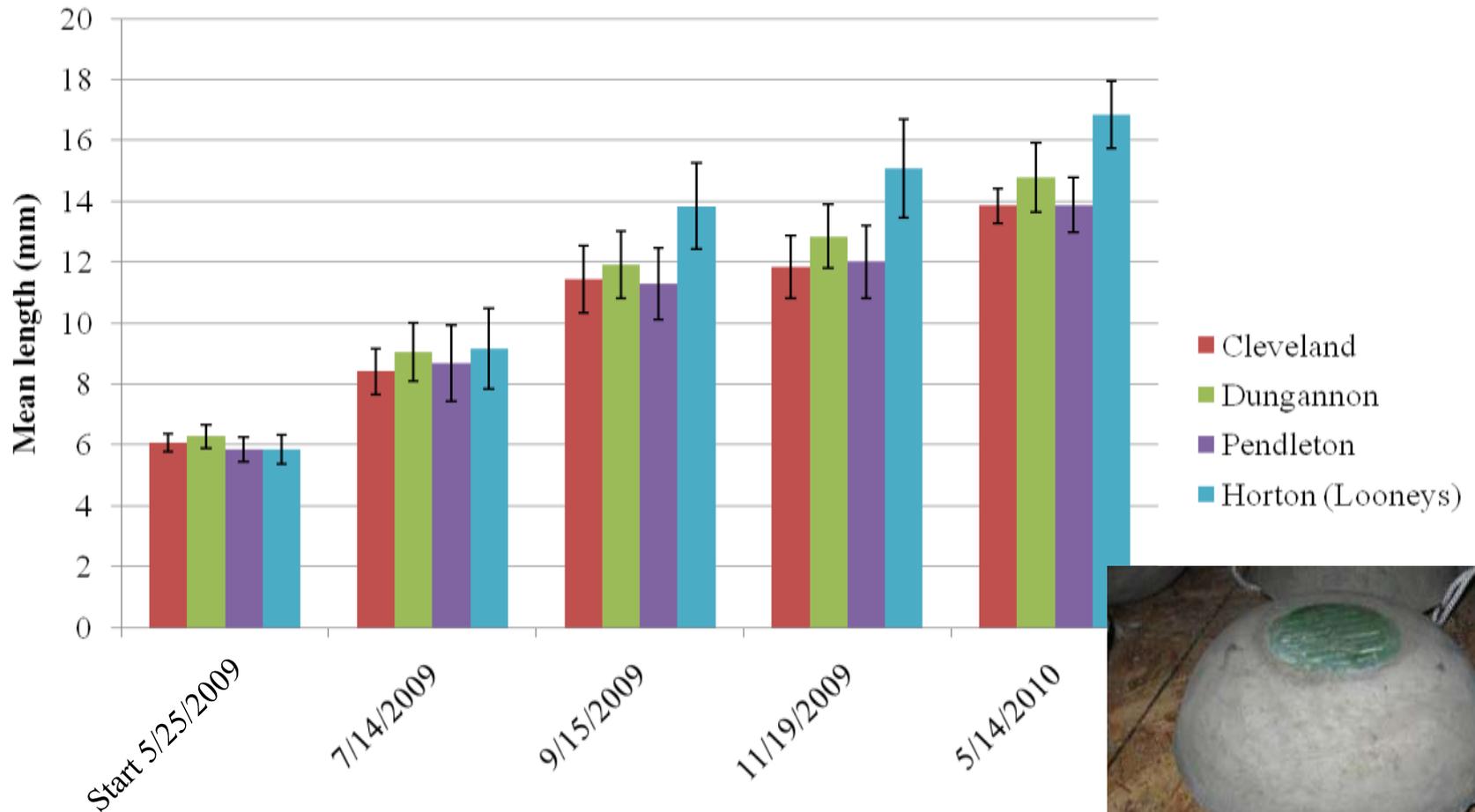


# Mussel Richness & Density 2009 - 2010



Ostby, 2010 Preliminary Data

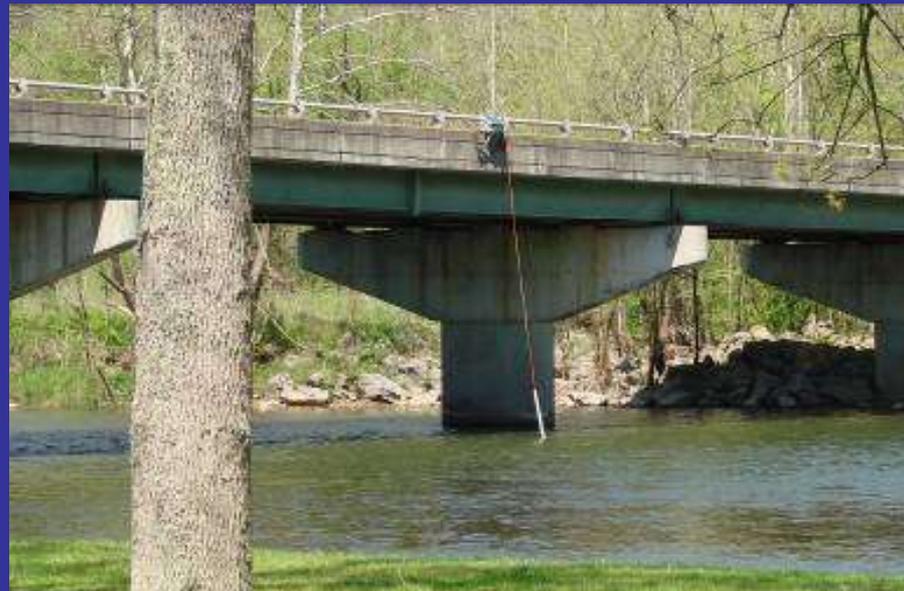
# Mussel Growth Monitoring



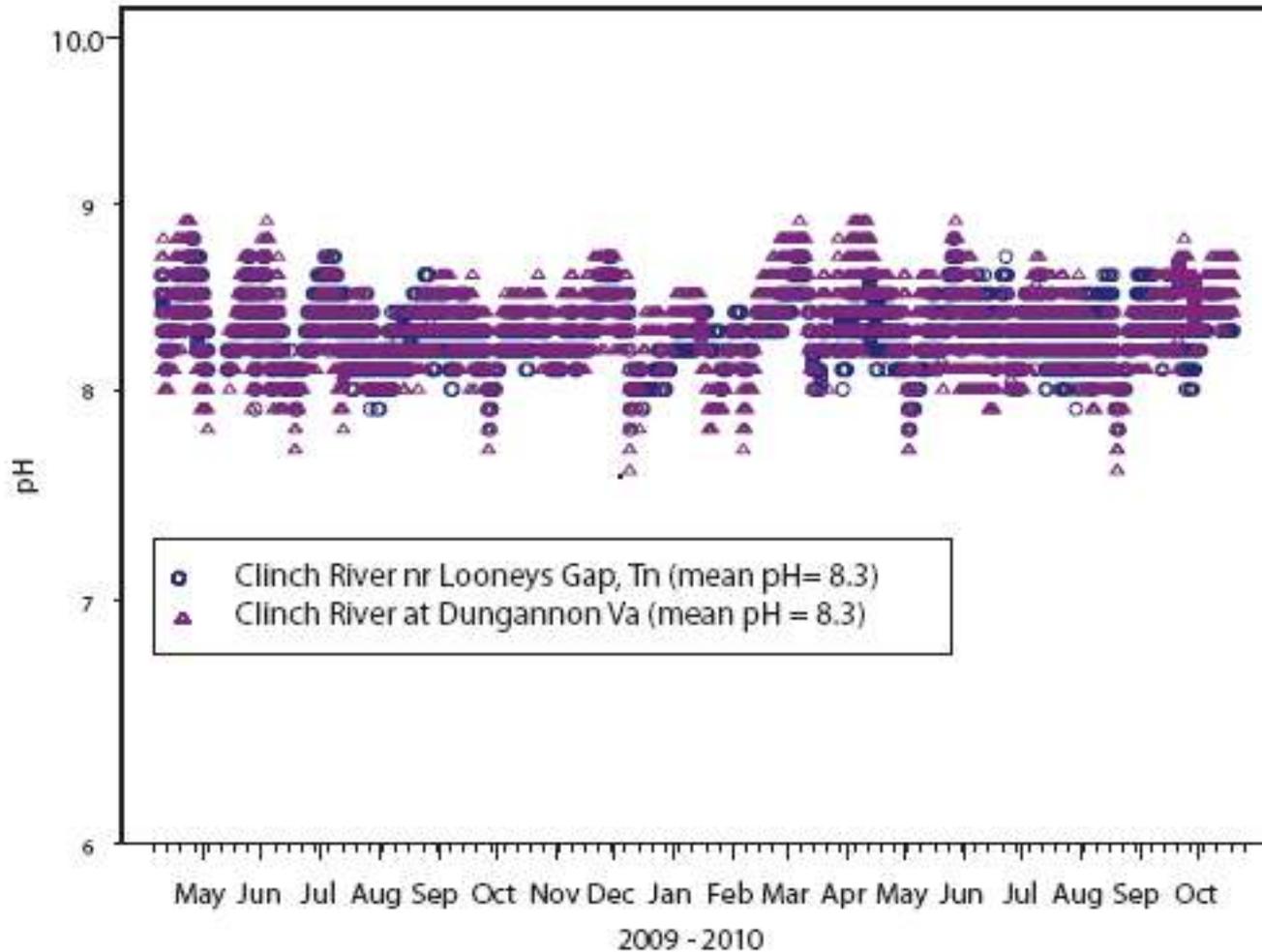
Ostby, 2010 Preliminary Data

# Continuous Water Quality at Dungannon & Horton Ford:

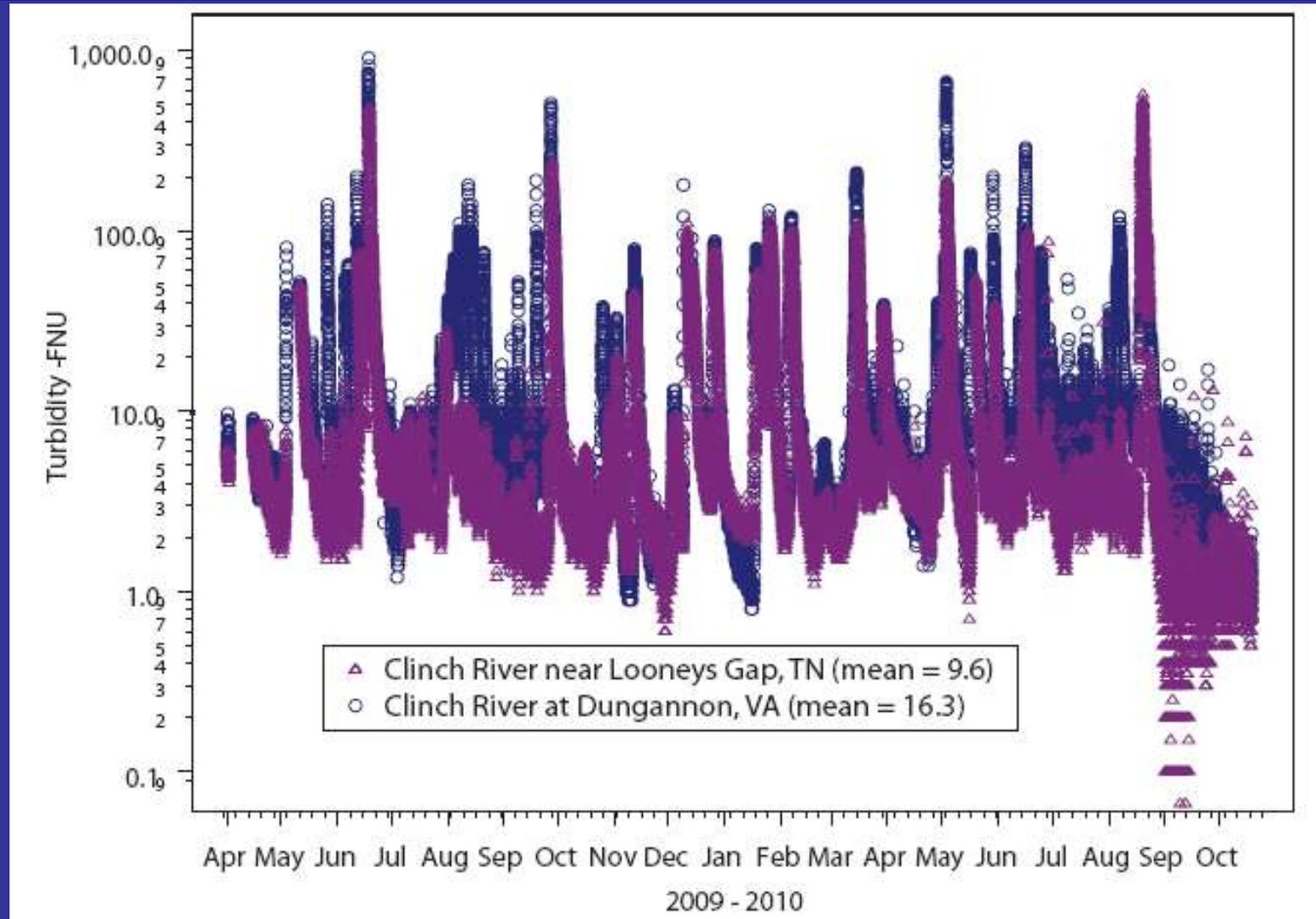
- Real-time Continuous Water Quality:
  - Temperature, pH, Specific Conductance, Turbidity  
USGS [03524740](#) CLINCH RIVER AT ROUTE 65 AT DUNGANNON, VA  
  
USGS [03527220](#) CLINCH RIVER NEAR LOONEYS GAP, TN (HORTON FORD)
- Isco Samples for Suspended Sediment at Horton Ford



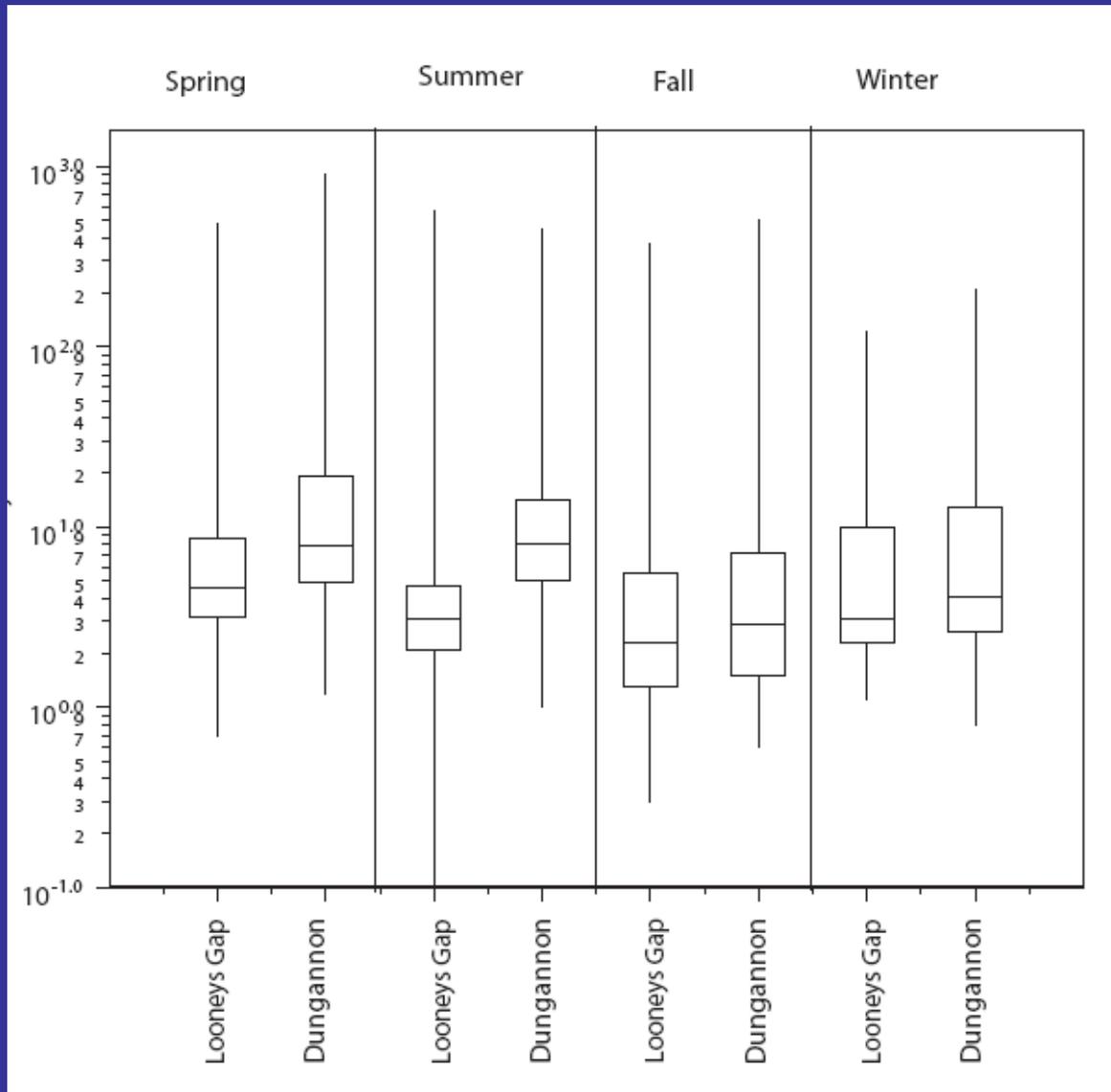
# Continuous pH 2009-2010



# Continuous Turbidity 2009-2010



# Turbidity by Season 2009-2010



Seasons Start:

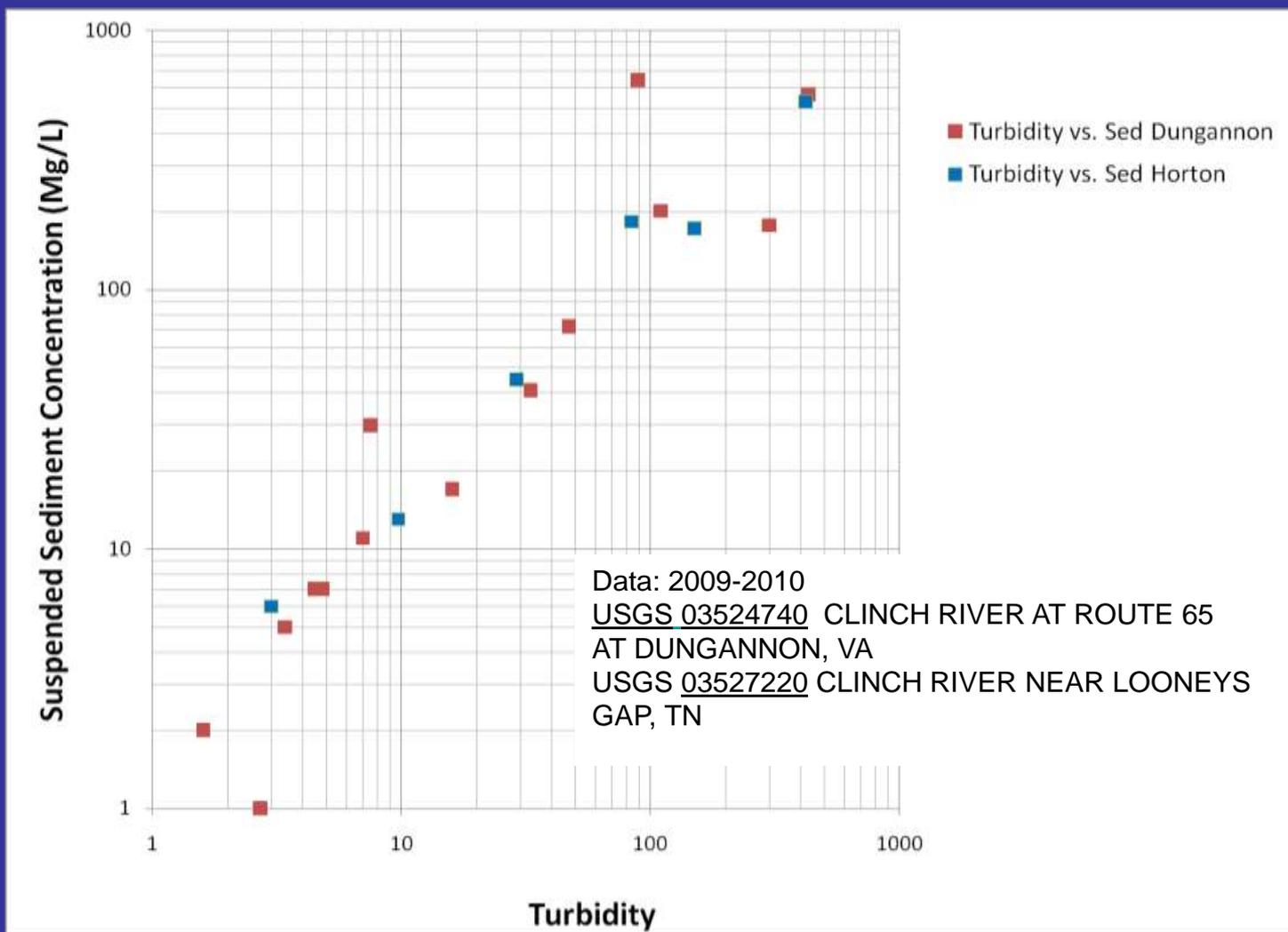
March 21,

June 21,

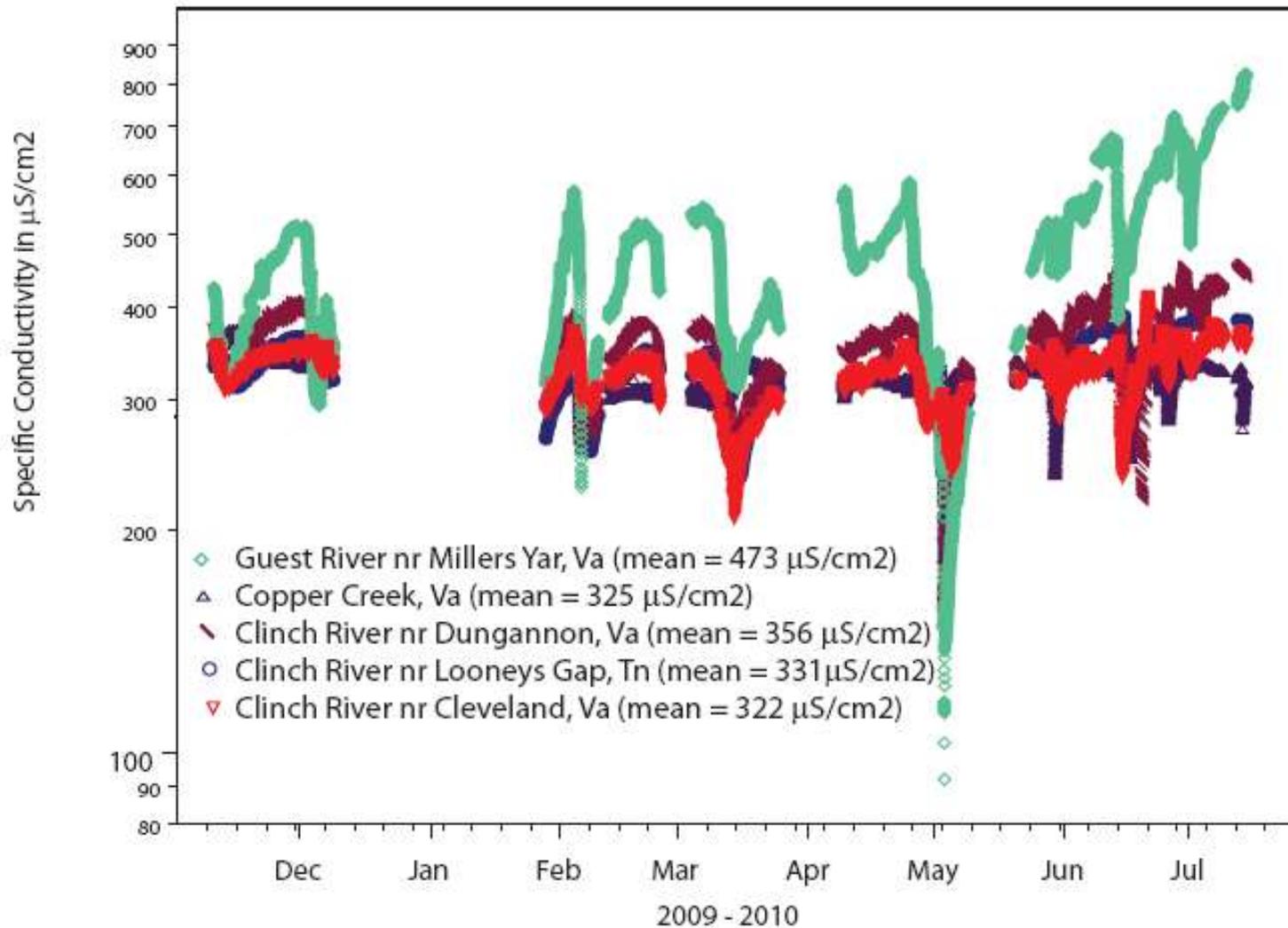
Sept 23

Dec 21

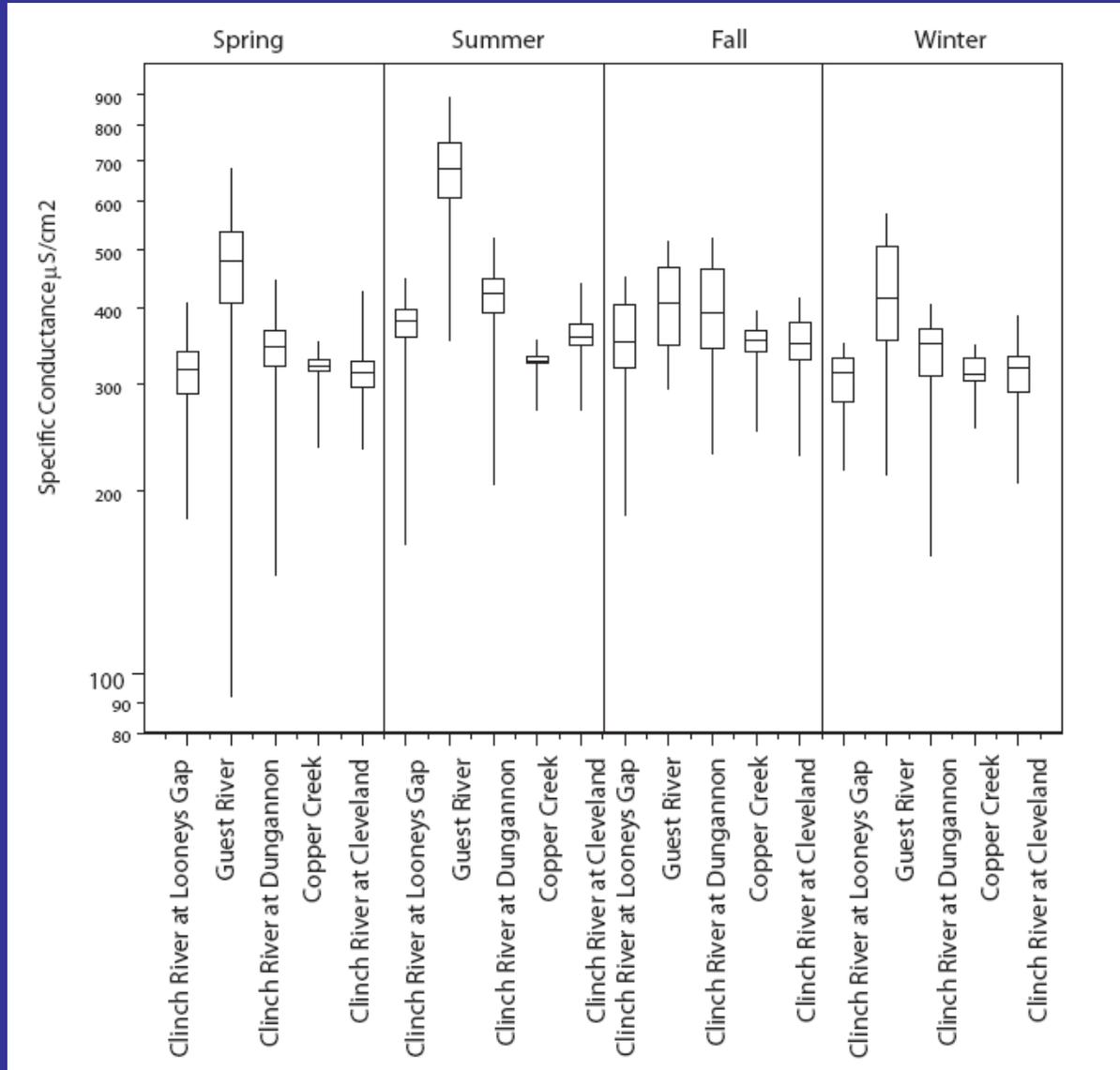
# Suspended Sediment Concentration vs. Turbidity for Discrete Samples



# Continuous Specific Conductance November 2009- July 2010

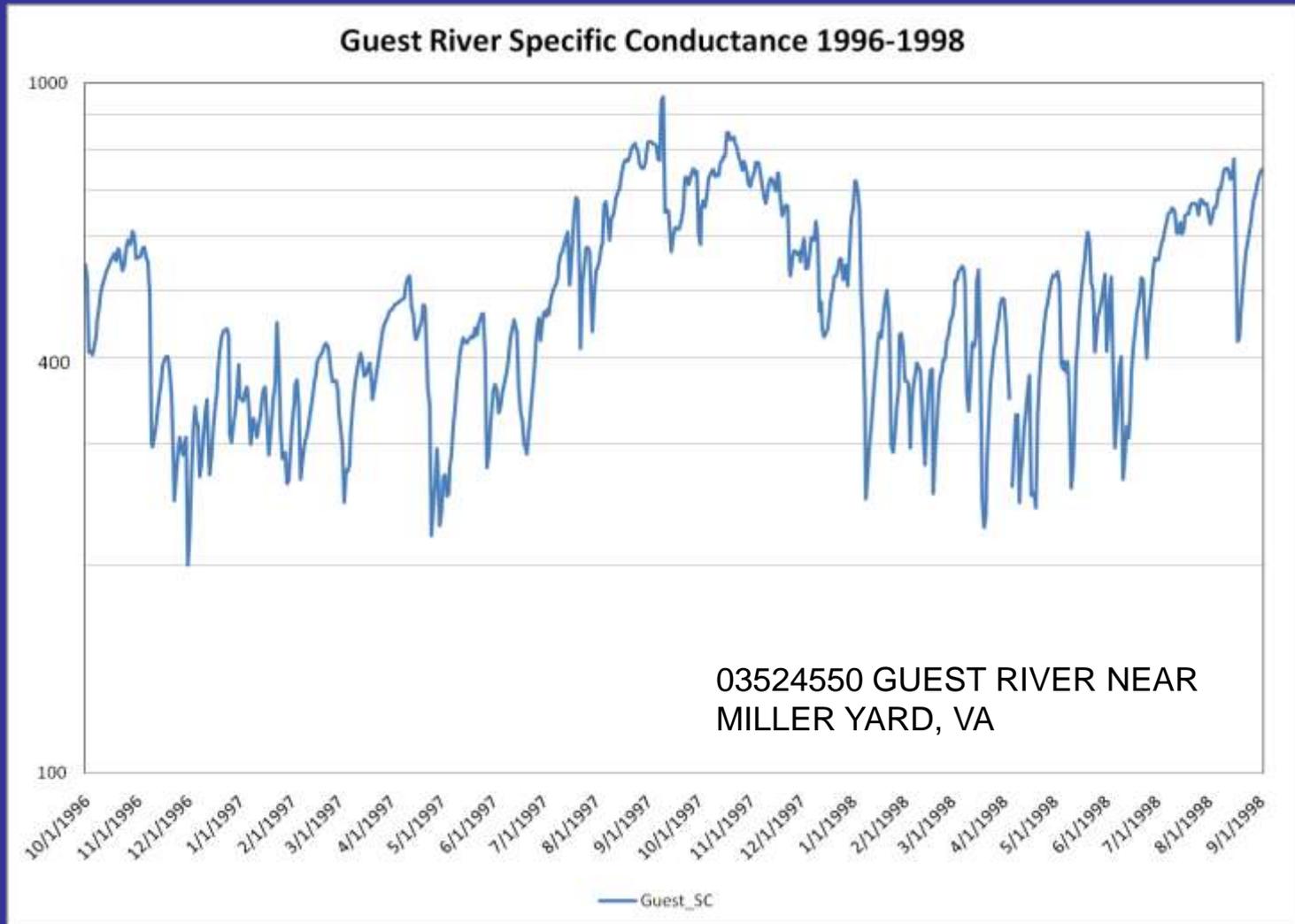


# Specific Conductance by Season

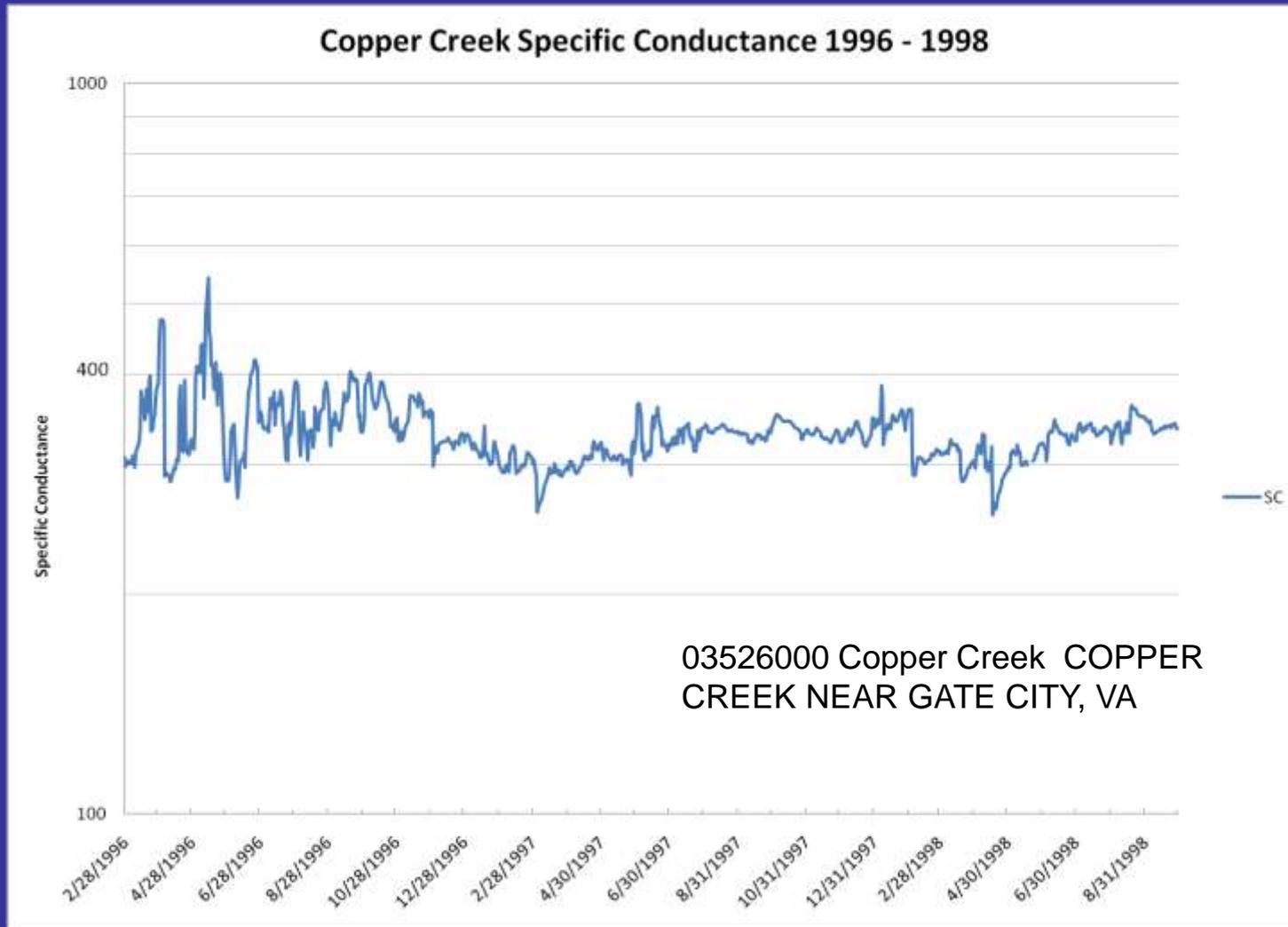


Seasons Start:  
March 21,  
June 21,  
Sept 23  
Dec 21

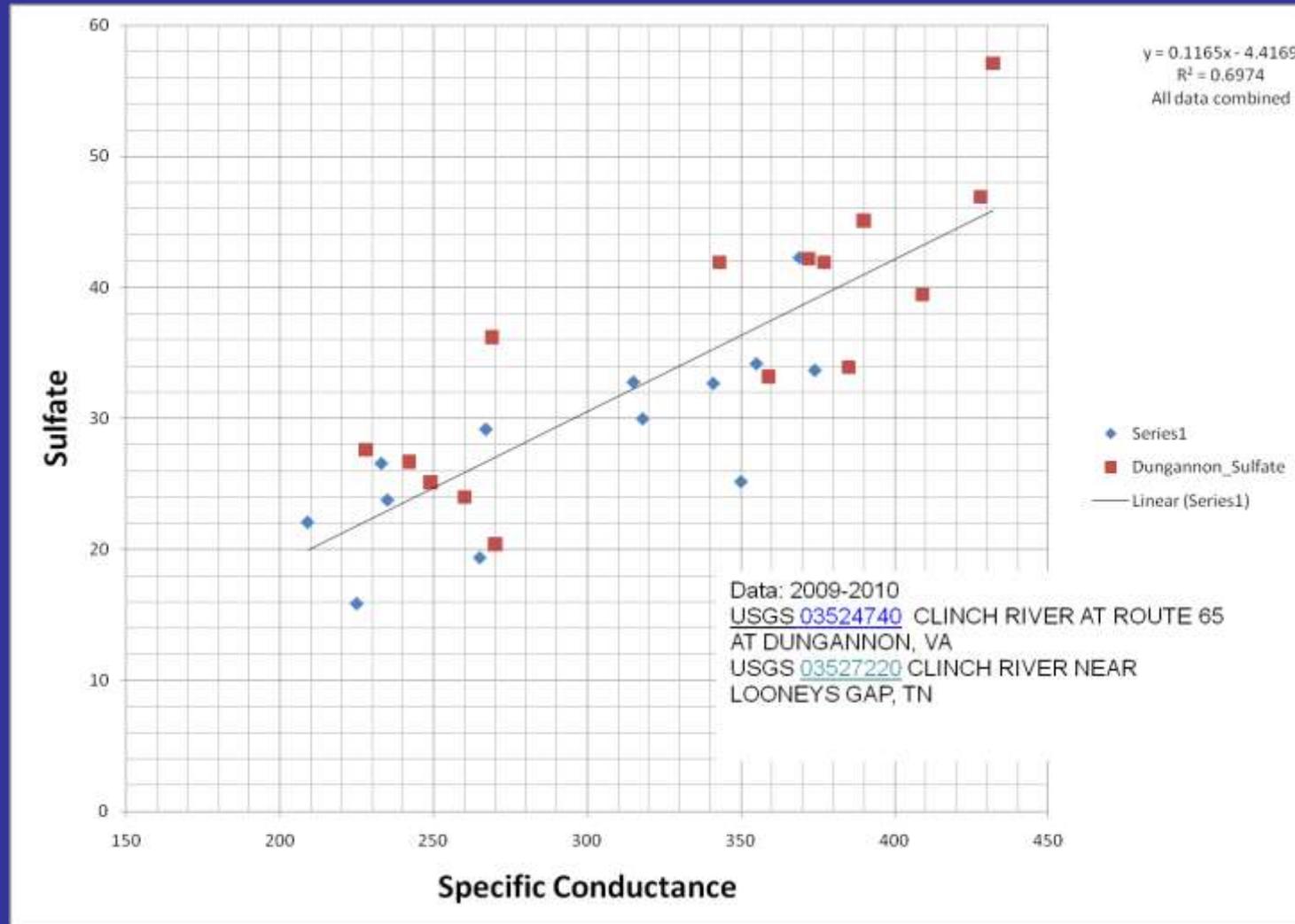
# Historic Specific Conductance



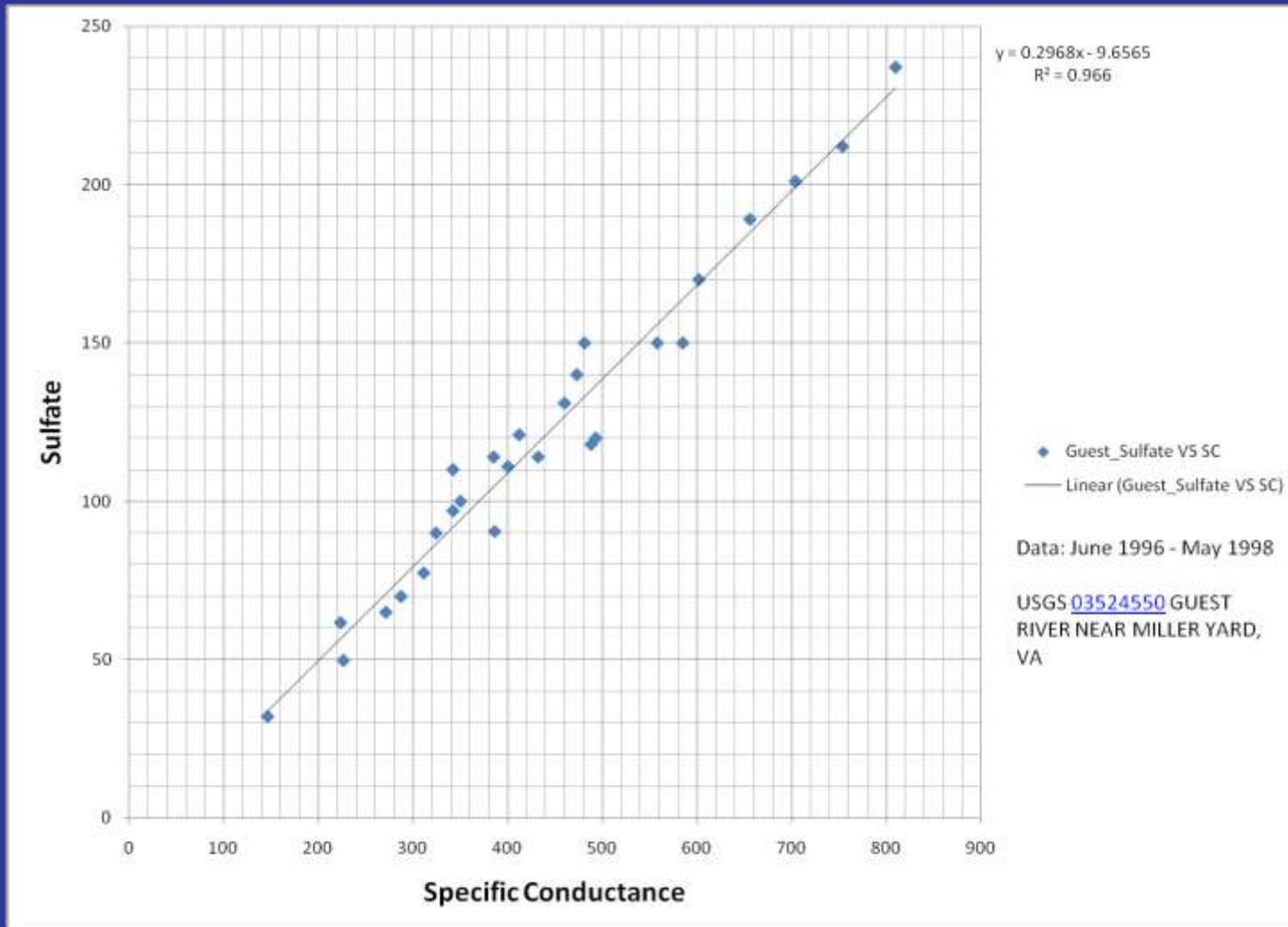
# Historic Specific Conductance



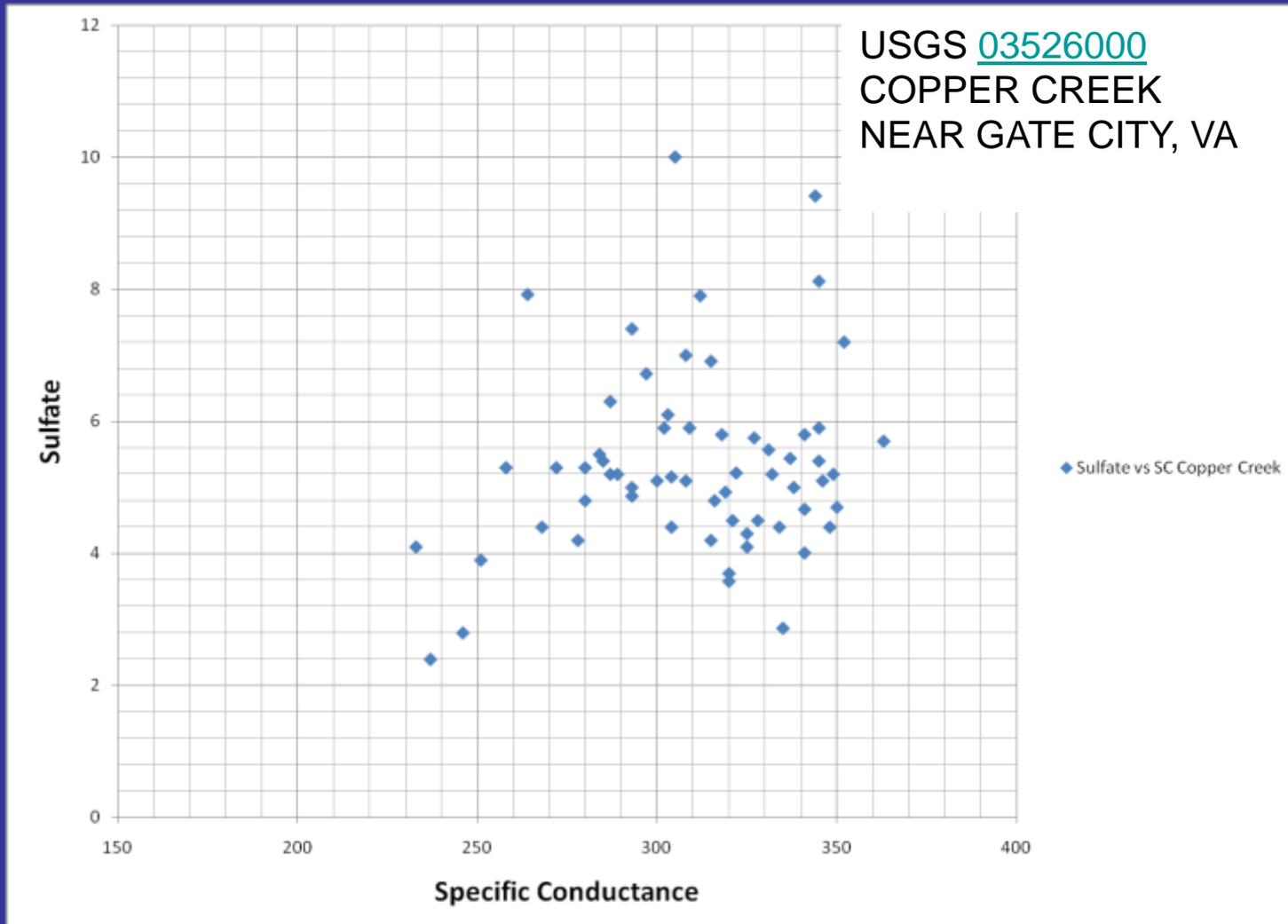
# Sulfate vs. Specific Conductance



# Sulfate vs. Specific Conductance



# Sulfate vs. Specific Conductance



# Water Quality Sampling at Dungannon and Horton Ford

- Collecting samples during base flow and storm events
- Laboratory Analysis for selected Metals, Nutrients, Major Ions, Suspended Sediment concentration and PAHs



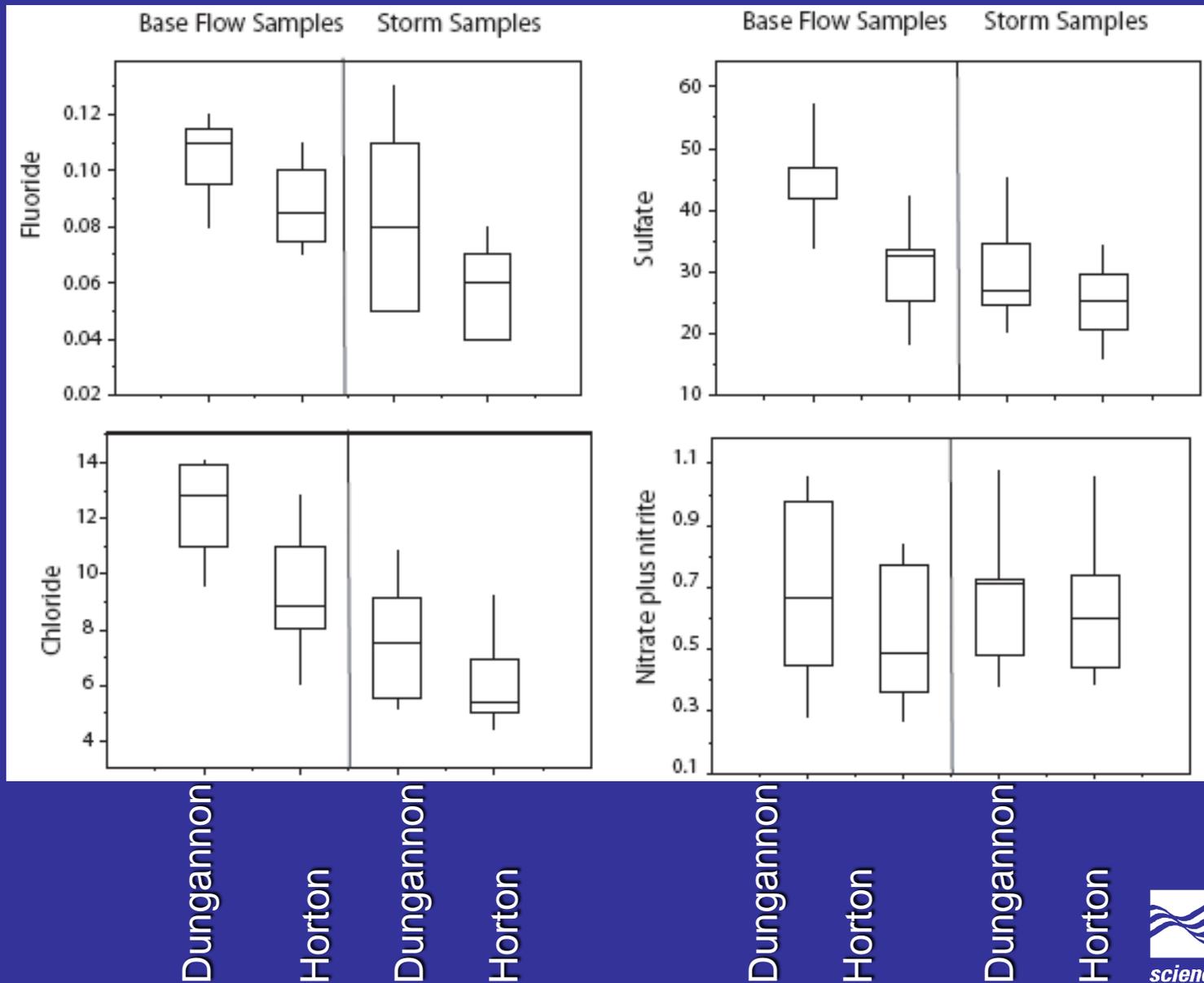
# Clinch River Discrete Sampling 2009-2010

Date	Type	Discharge	Flow Percentile for Month (Cleveland Gage)
4/27/2009	Base	512	25-50
5/4/2009	Storm	1870	90-95
5/8/2009	Storm	4500	95 +
6/18/2009	Storm	6150	95 +
6/19/2009	Blank	QA	Blank
8/27/2009	Blank	QA	Blank
8/28/2009	Base	204	50-75
8/28/2009	Blank	QA	Blank
10/30/2009	Storm	615	90-95
12/10/2009	Storm	4940	95+
1/25/2010	Blank	QA	Blank
1/25/2010	Storm	5510	95+
2/19/2010	Base	737	25-50
4/20/2010	Base	390	10-25
5/4/2010	Storm	2530	95+
5/27/2010	Base	335	25-50
7/8/2010	Base	125	10-25
8/10/2010	Base	275	50-75
8/10/2010	Replicate	QA	Replicate
8/18/2010	Storm	1030	90-95

## Methods:

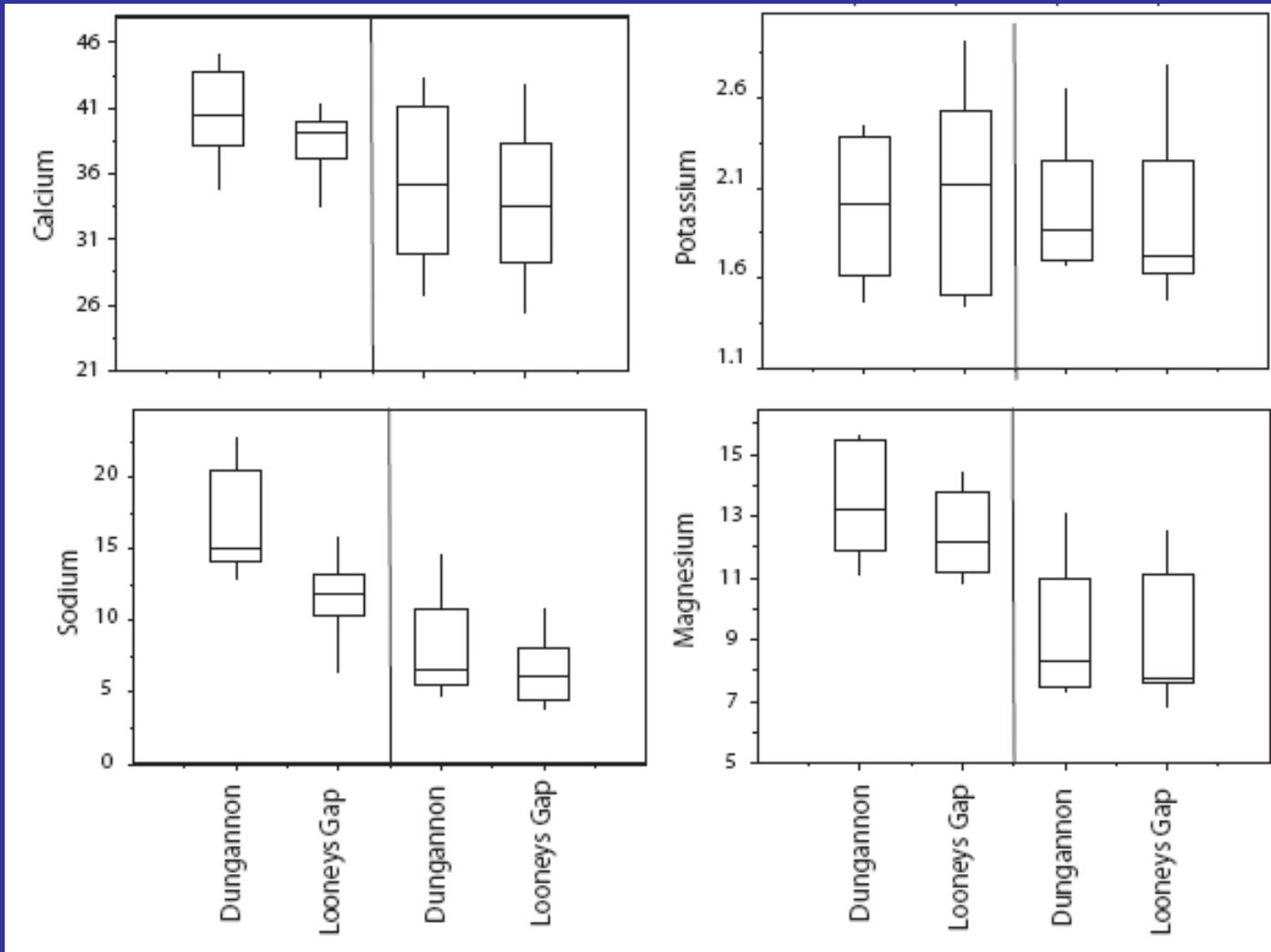
- Paired samples at Dungannon and Horton
- Equal Width Intervals (10)
- Depth Integrated Samples
- Compositing, sub-sampled
- PPB QA techniques

# Major Ion Concentrations



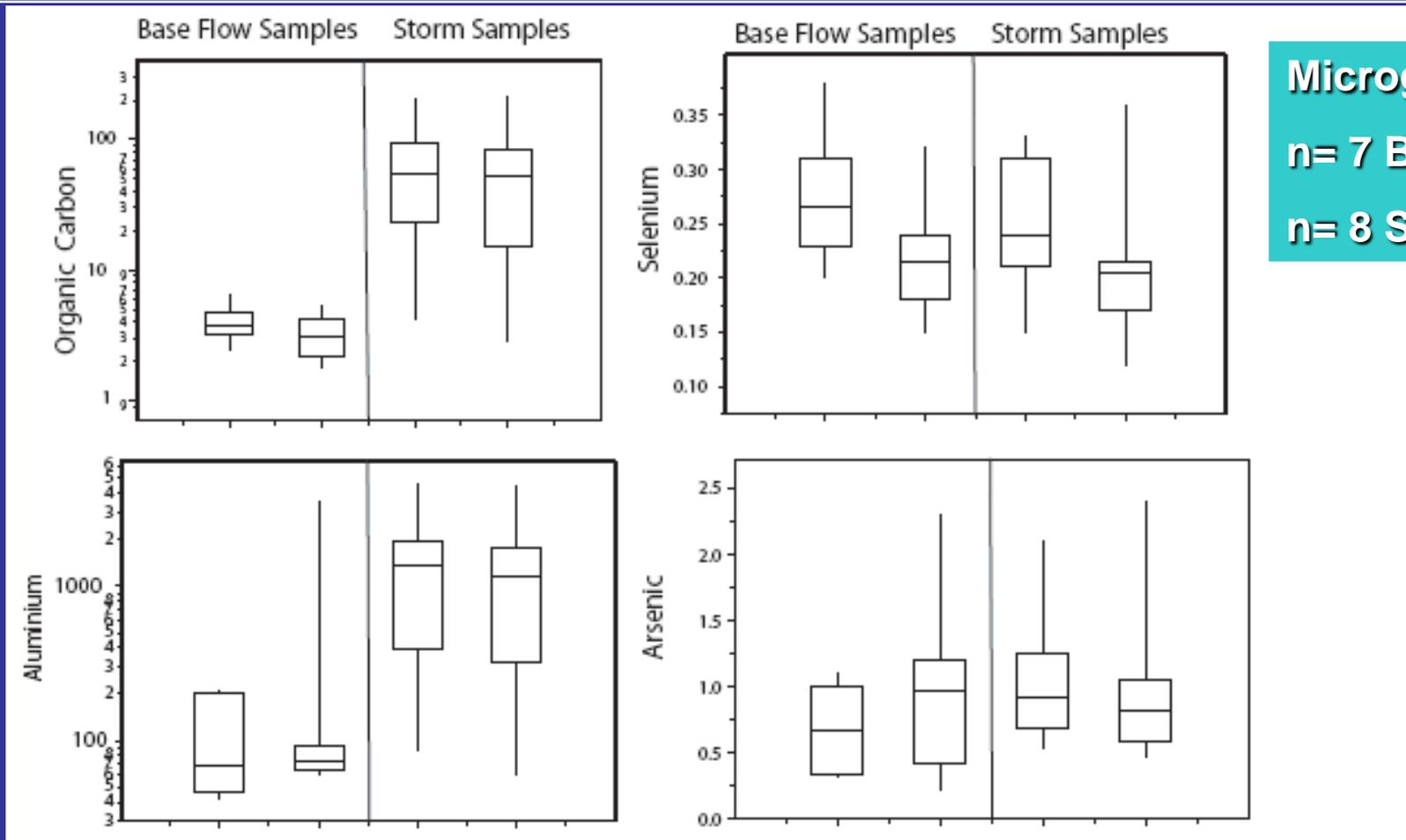
Milligrams/L  
Whole water  
n= 7 Base  
n= 8 Storm

# Major Ion Concentrations



Milligrams/L  
Filtered  
n= 7 Base  
n= 8 Storm

# Metal Concentrations (whole water)



Micrograms/L  
n= 7 Base  
n= 8 Storm

Dungannon

Horton

Dungannon

Horton

Dungannon

Horton

Dungannon

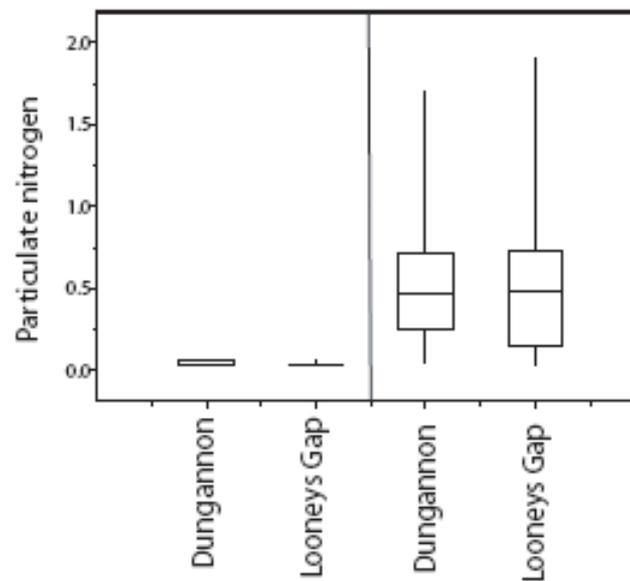
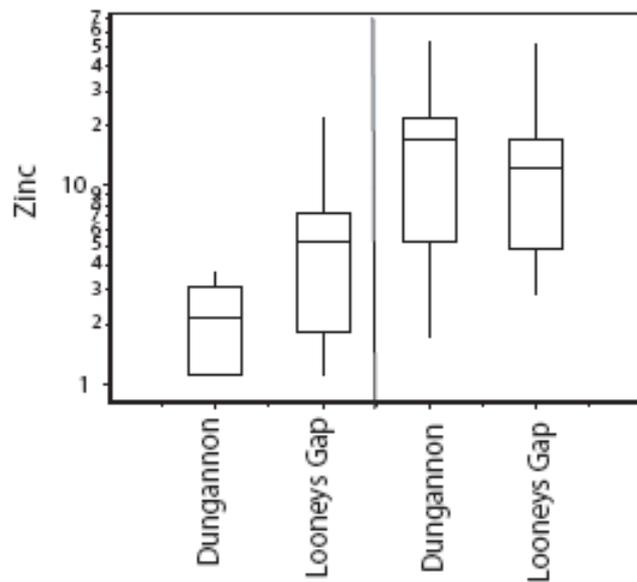
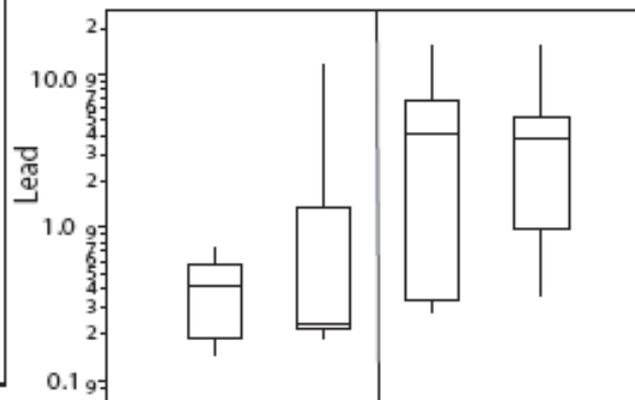
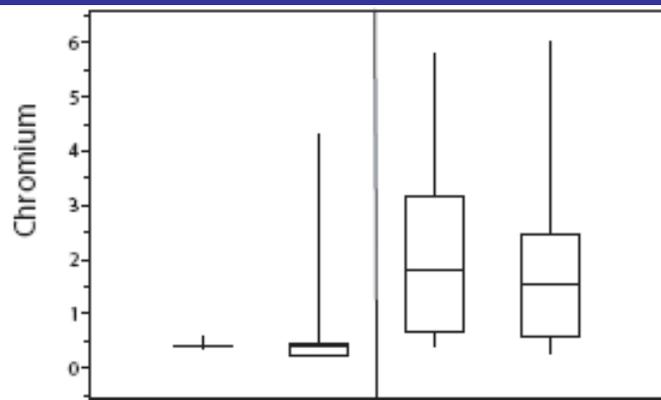
Horton

# Metal Concentrations (whole water)

Micrograms/L

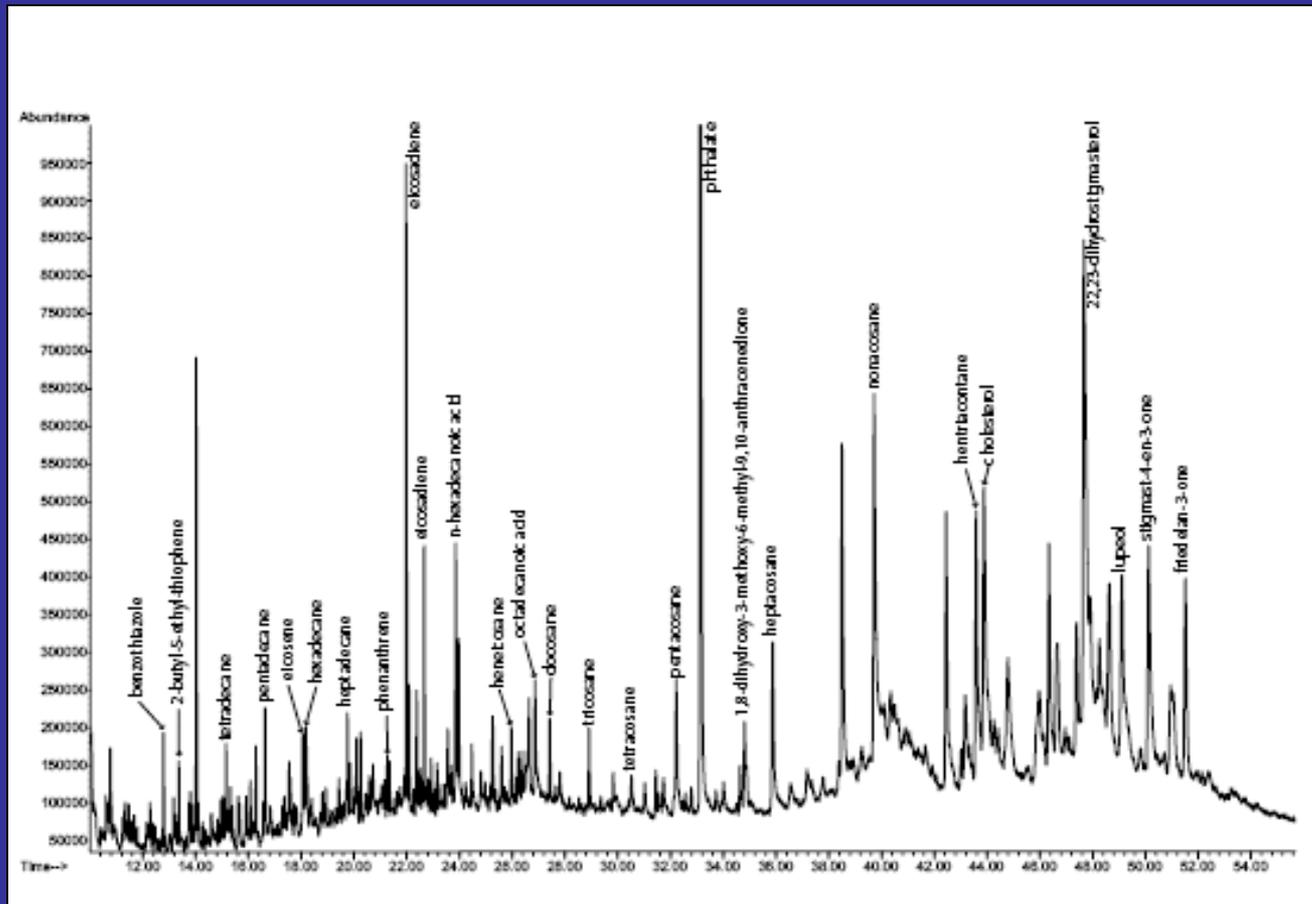
n= 7 Base

n= 8 Storm



# PAH from Storm Sampling: Clinch River at Route 65, Dungannon, VA 5/8/2009

## Extractable Hydrocarbons in Particulates Dichloromethane Extraction Filter Collection

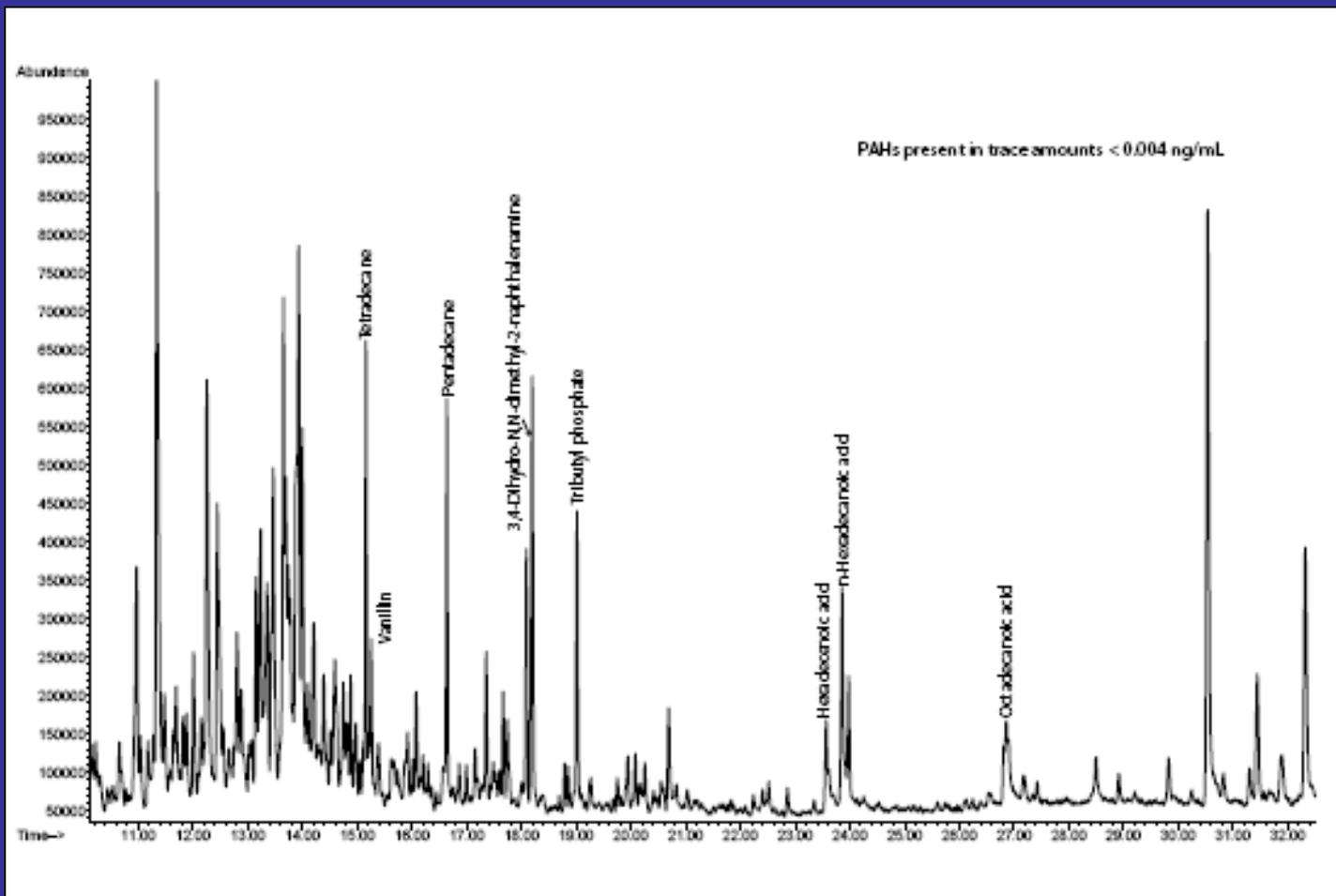


### NOTES

- 35+ compounds present; some indication of UCM at higher RTs
- Sources from biota, such as LC FAs, cholesterol, etc.
- Some PAHs present, possibly coal or petroleum derived
- Long chain alkanes present probably from fuel oil or bitumen

# PAH from Storm Sampling: Clinch River near Loony's Gap, TN 5/8/2009

## Dissolved Extractable Hydrocarbons Filtered and Extracted with Dichloromethane



### Notes

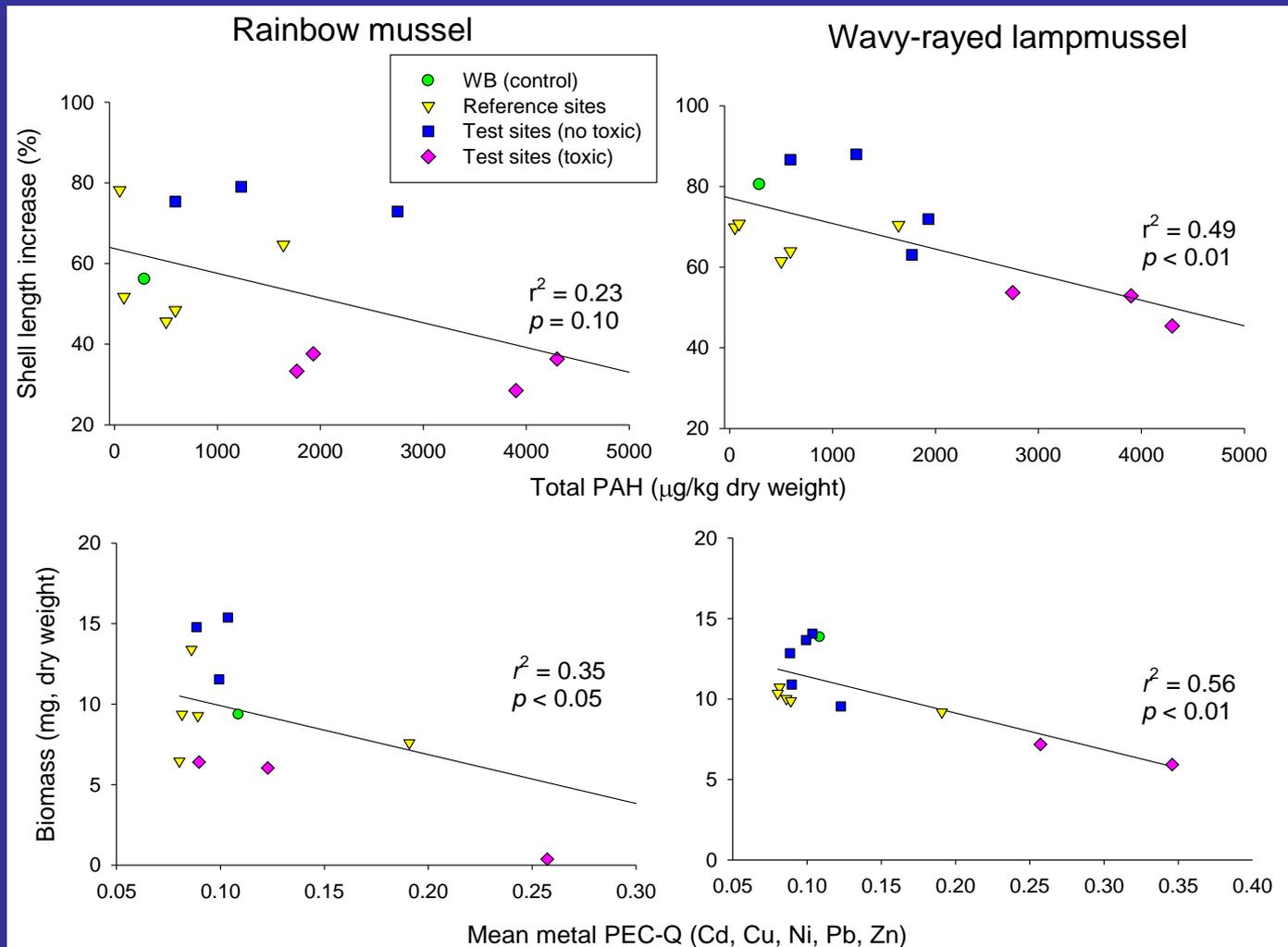
-similar to Rt. 65  
Dungannon  
samples.

-some long chain  
alkanes from fuel  
oil observed.

-very low PAH  
levels; but some  
PAH derivatives  
present.

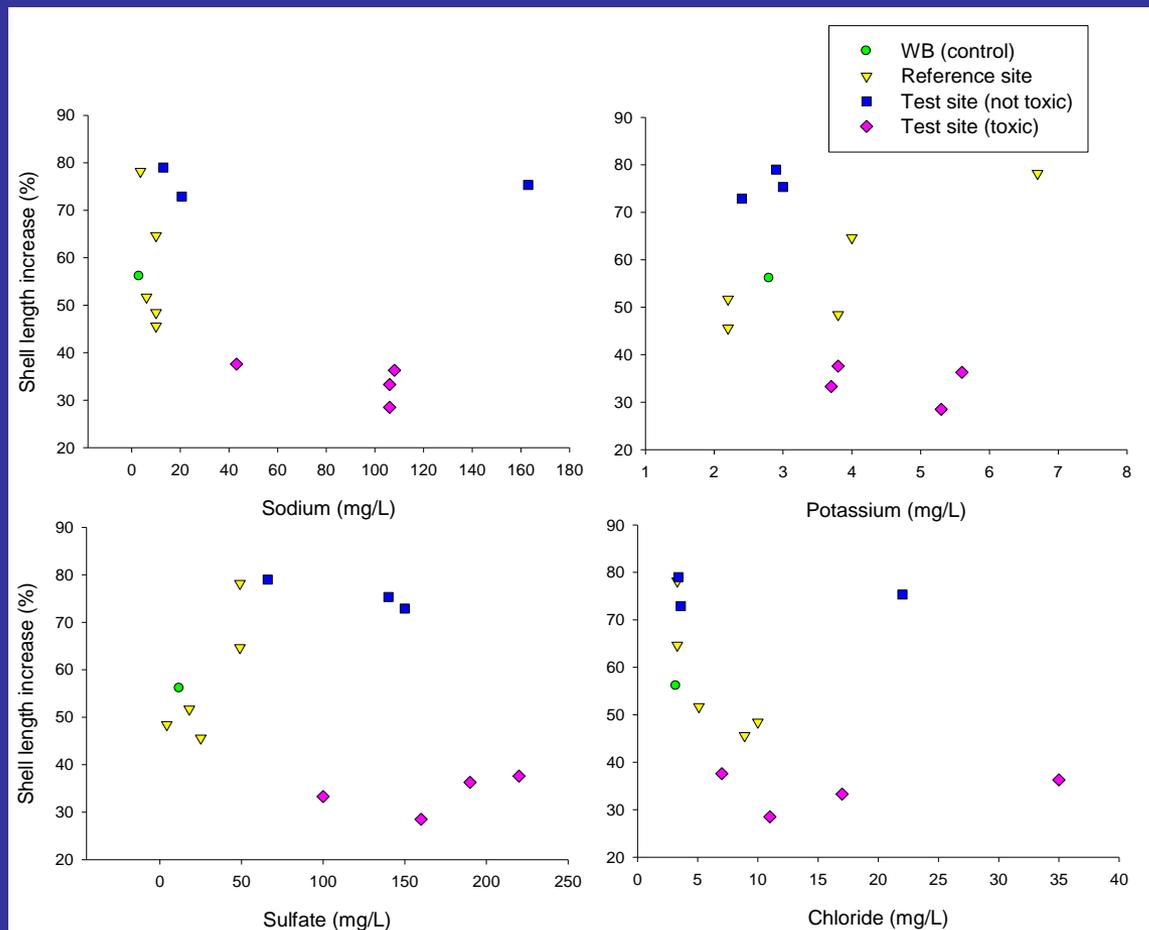
-long chain fatty  
acids present

# Mussel Growth Responses: Total PAHs or Metal probable effect concentration quotient (PEC-Q) in 28-d sediment toxicity tests



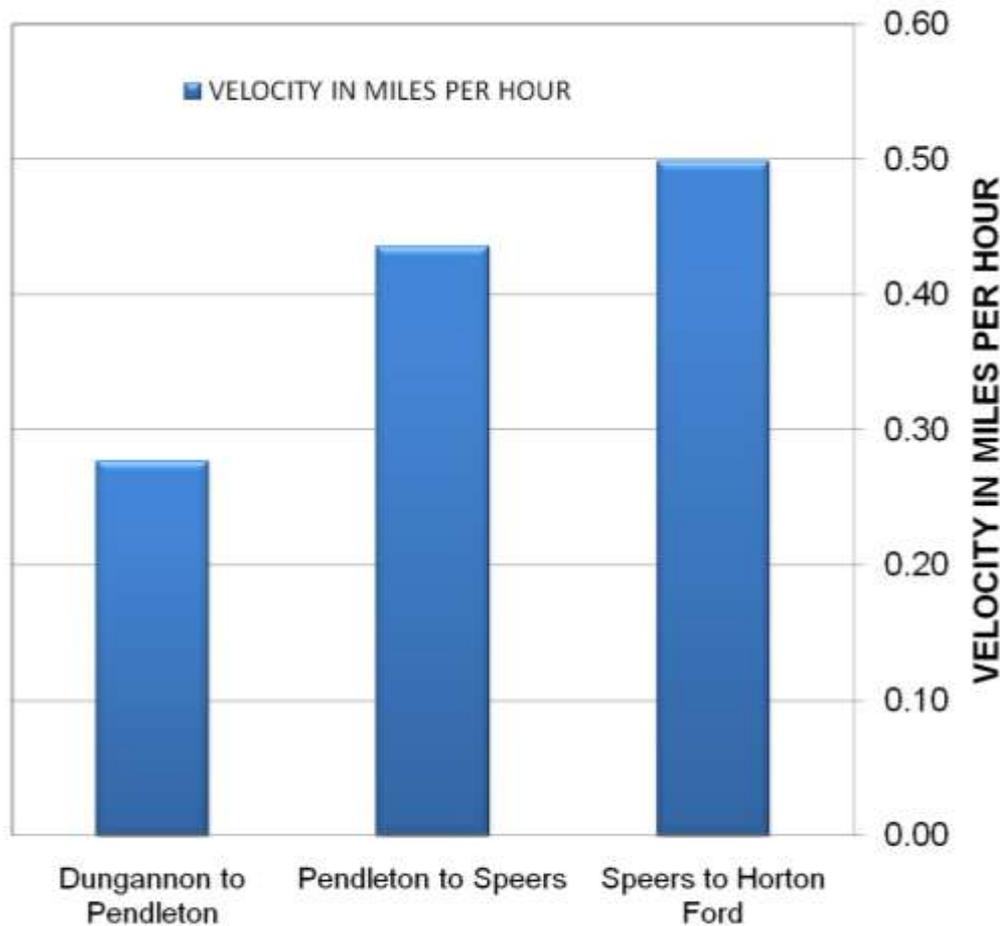
Ingersoll and others, 2010, preliminary data

# Rainbow Mussel Growth Responses: pore-water concentrations of major cations and major anions in 28-d sediment toxicity tests



Ingersoll and others, 2010, preliminary data

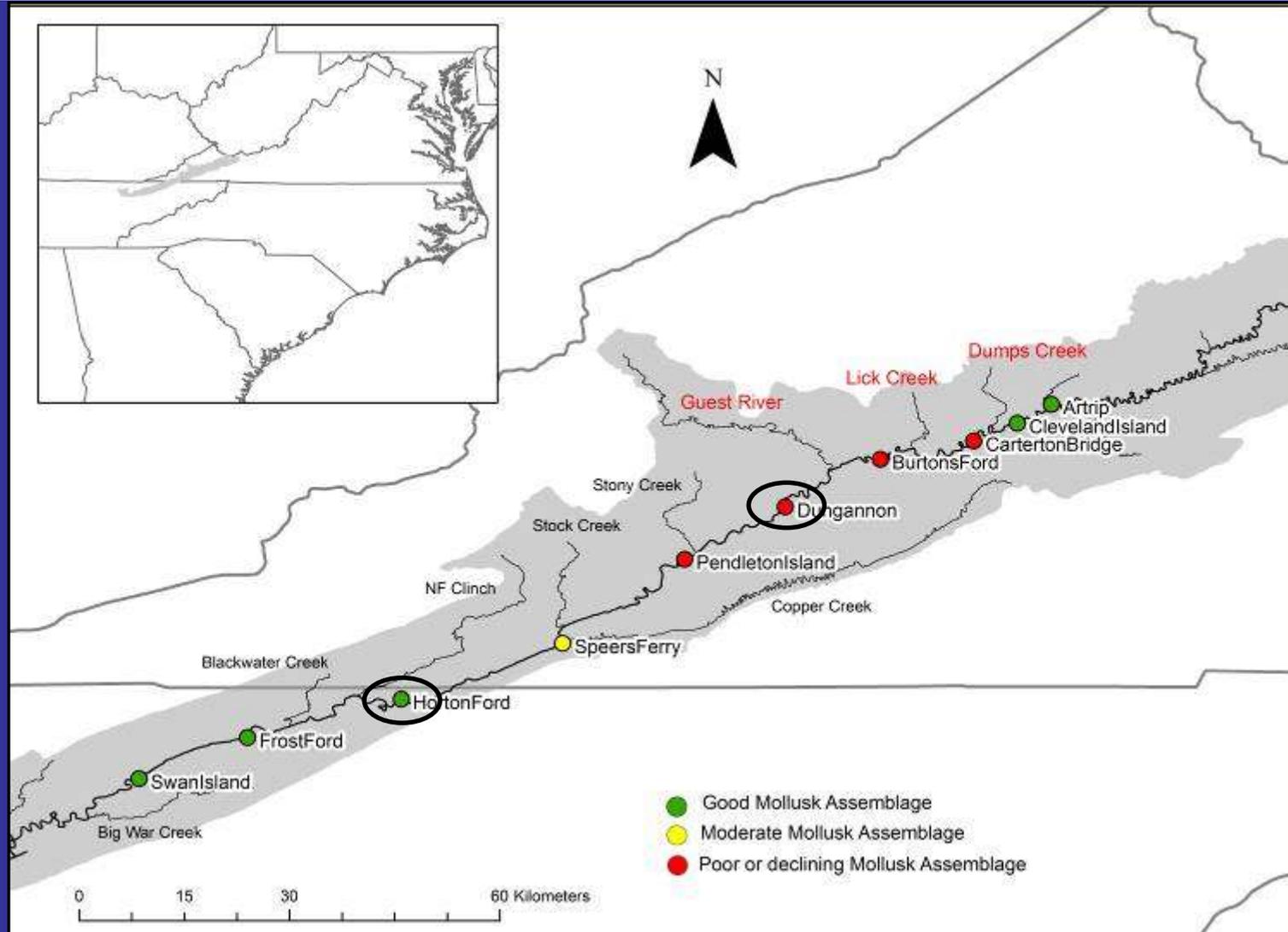
# Clinch River Travel Time



Time of Travel Study Reaches Upstream to Downstream



# Mussel Health Along Study Reach



# USGS Plan for 2011 – 2012

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## Data in review:

- PAH & coal percent from 10 bed sediment samples
- Physical Habitat multiple measures for 10 sites
- Corbicula & snail density 10 sites

## Activities:

- Discrete QW Sampling (fewer samples) through 10/2011
- Maintain Continuous Monitors through 10/2011
- Remove silos and analyze mussel tissue for trace elements
- Norris Lake Sediment coring Spring 2011
- Data analysis, report writing through 10/2012

## Proposals:

- Assessing the Vulnerability of Clinch River Freshwater Mussel Habitat to Flow Regime Alterations Associated with Climate Change, with Implications for the Upper Tennessee River Watershed
- AEP and Dominion discussion to fund continuous monitoring stations in the basin.

# Key Science Questions for CPCRI?

Where do we need more detailed data?????

- Storm characterization?
- Baseflow chemical mass balance?
- Geologic influence on water quality and hydrology?
- Hydrologic Alteration?
- Groundwater influence?
- Emerging Contaminants?
- Tributary silo experiments?
- Tributary QW sampling?



# Thank you!

**Get Water Quality Data:**

**VA:** <http://waterdata.usgs.gov/va/nwis/qw>

**TN:** <http://waterdata.usgs.gov/tn/nwis/qw>

**Stations:**

Station number	Local Name
03524000	Cleveland
03524740	Dungannon
03527220	Horton Ford /Looneys Gap
03524550	Guest River
03526990	Copper Creek ab mouth
03526000	Copper Creek

**Questions about data presented contact:**

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**Brett J.K. Ostby, [bostby@vt.edu](mailto:bostby@vt.edu)**

**Bill H. Orem, [borem@usgs.gov](mailto:borem@usgs.gov)**

**Chris Ingersoll, [cingersoll@usgs.gov](mailto:cingersoll@usgs.gov)**