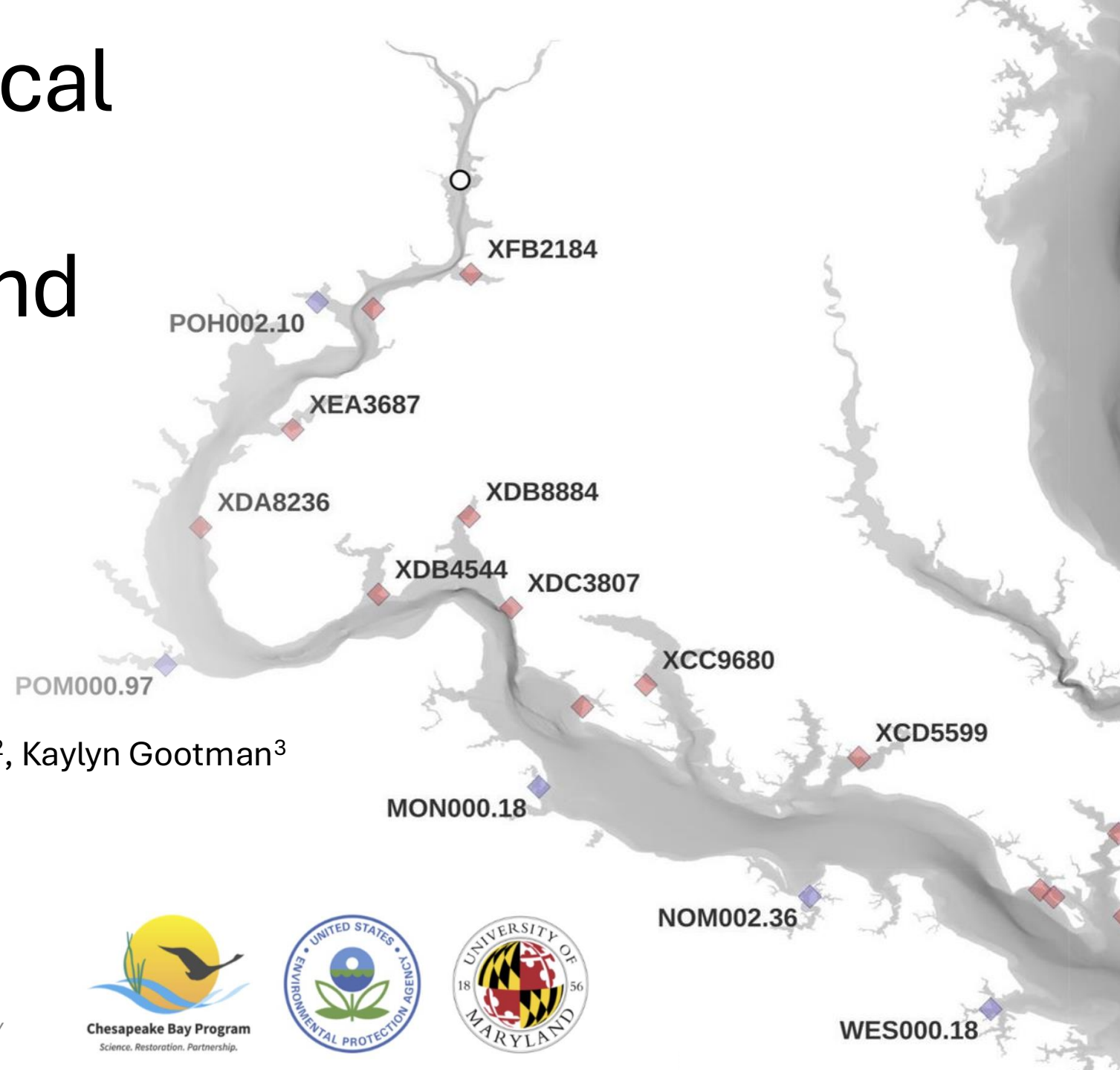


# Physical and Biological Controls on Diel Dissolved Oxygen and Water Quality Dynamics along the River Continuum



Weston Slaughter<sup>1,3,4</sup>, Sujay Kaushal<sup>1</sup>, Paul Mayer<sup>2</sup>, Kaylyn Gootman<sup>3</sup>

<sup>1</sup>University of Maryland Department of Geology, College Park, MD

<sup>2</sup>US EPA Pacific Ecological Sciences Division, Corvallis, OR

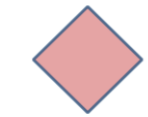
<sup>3</sup>US EPA Chesapeake Bay Program Office, Annapolis, MD

<sup>4</sup>Oak Ridge Institute for Science and Education, Oak Ridge, TN

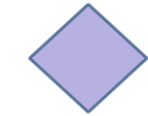


# Potomac River Continuous Monitoring Stations

MDDNR and VECOS Stations 2007-2008, with NOAA Bathymetry



Maryland Department of Natural Resources (MDDNR) Eyes on the Bay ([EOTB](#))

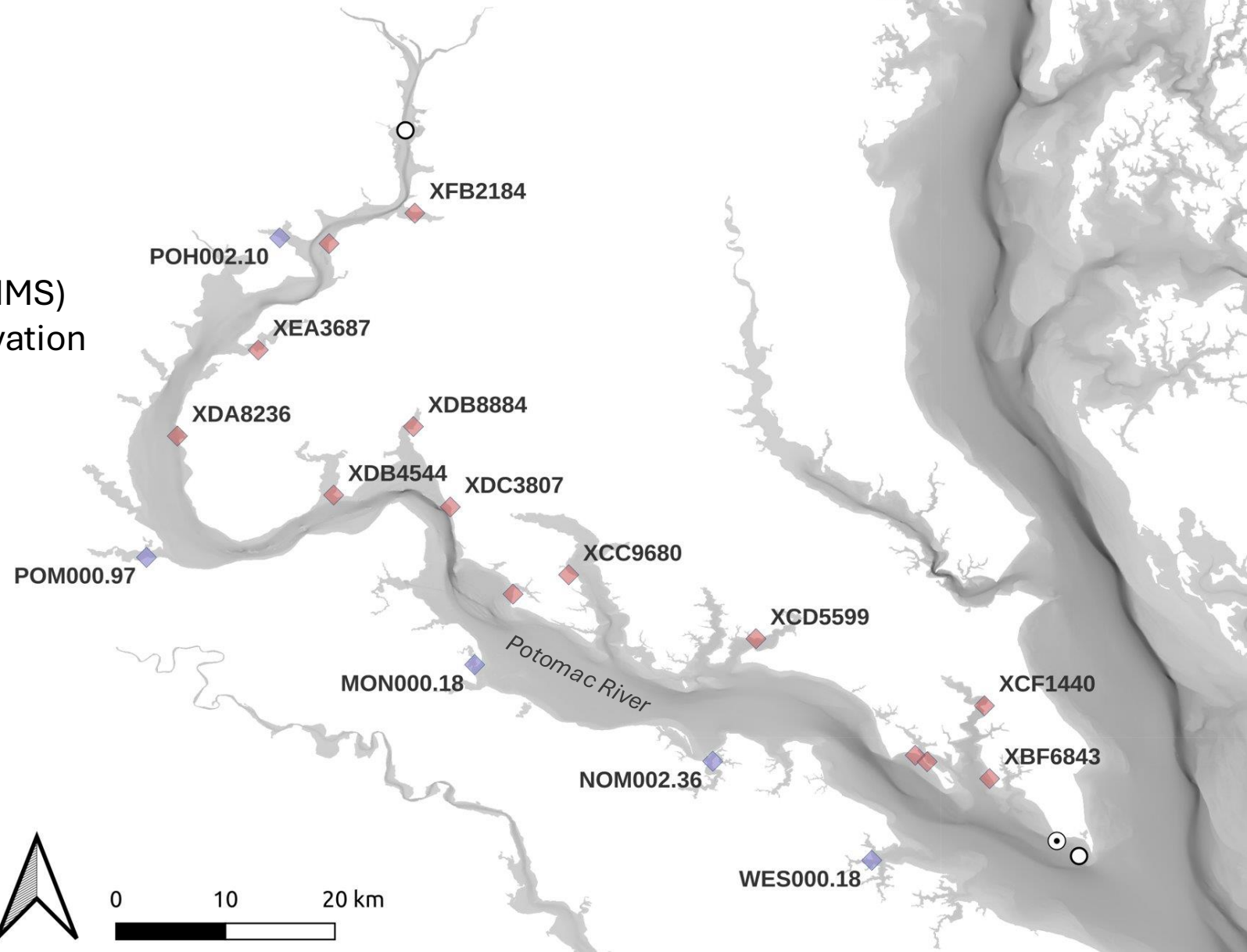


Virginia Institute of Marine Science (VIMS) Virginia Estuarine and Coastal Observation System ([VECOS](#))

**Bathymetry**



0 10 20 km





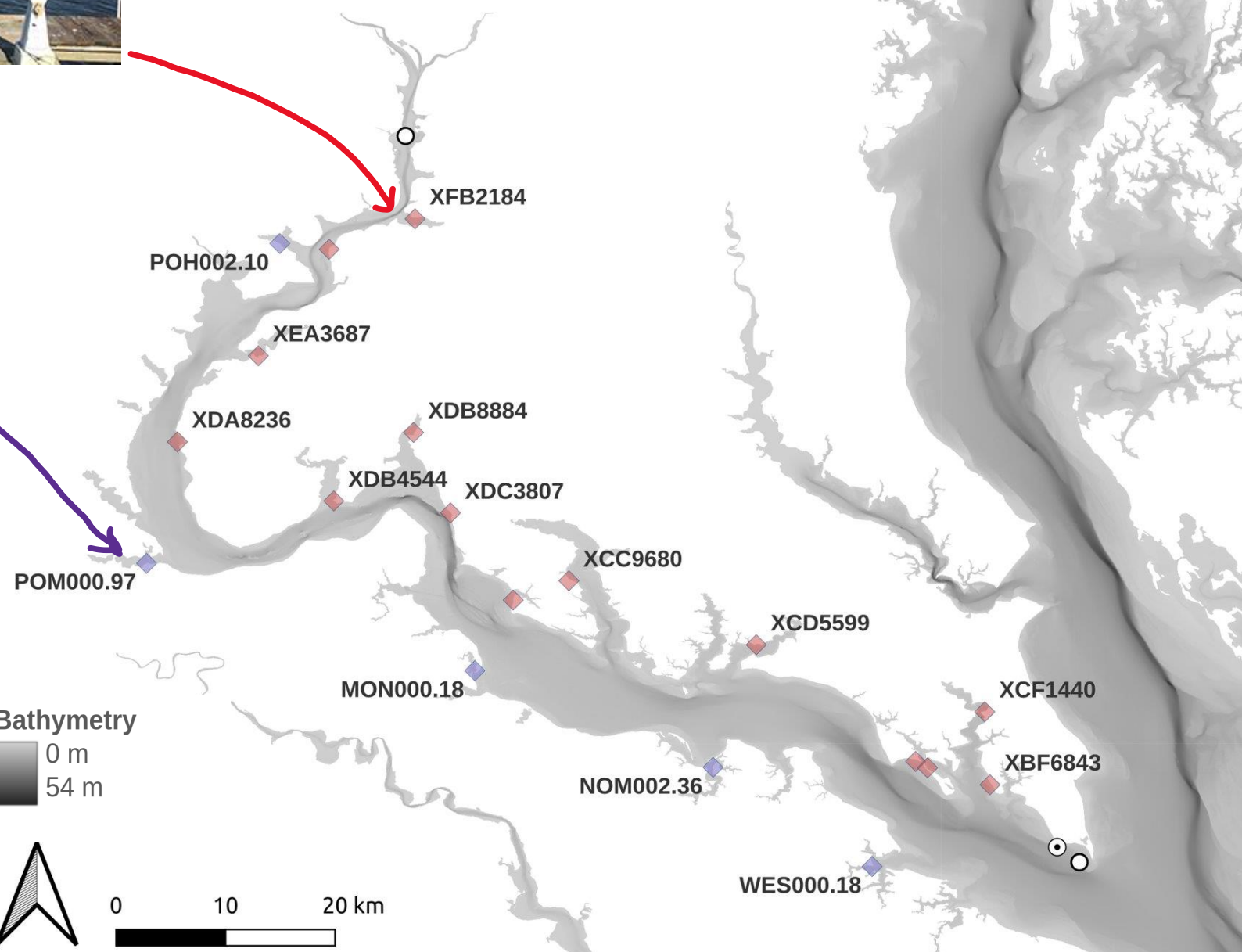
Dissolved Oxygen  
Chlorophyll-a  
Turbidity  
Temperature  
Salinity  
Depth

2024-04-12

Bathymetry



0 10 20 km



## **Chemical Gradients**

What are the longitudinal gradients in pH, salinity, and other parameters along the river-estuary continuum? Does high-frequency data corroborate "textbook" freshwater and estuarine values?

## **Ecosystem Productivity**

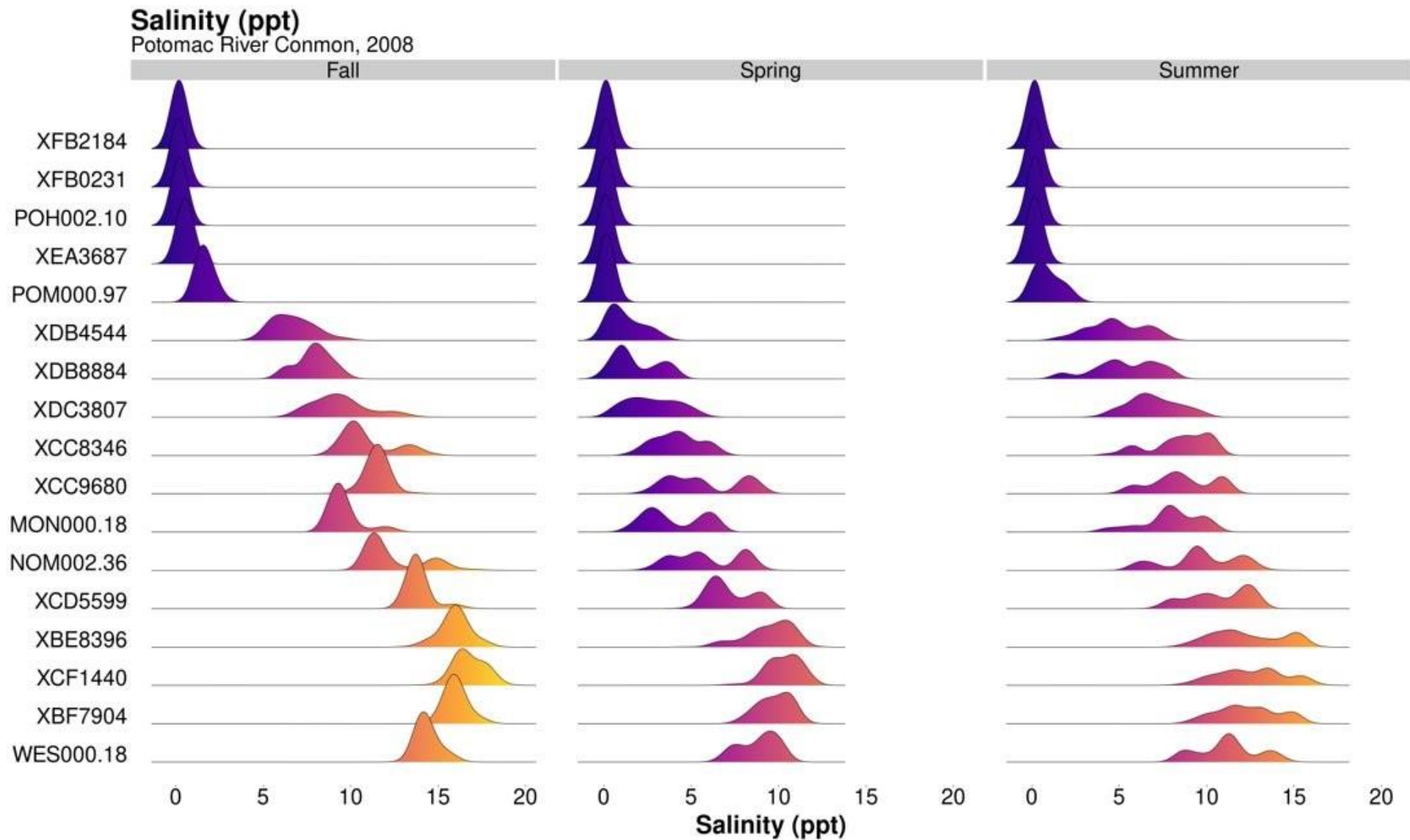
Is there evidence of longitudinal gradients in autotrophy and heterotrophy along the river-estuary continuum?

## **What Does Water Do in the Dark?**

Are there longitudinal trends in diel patterns in water quality? Can water quality timing give insights about ecosystem dynamics?

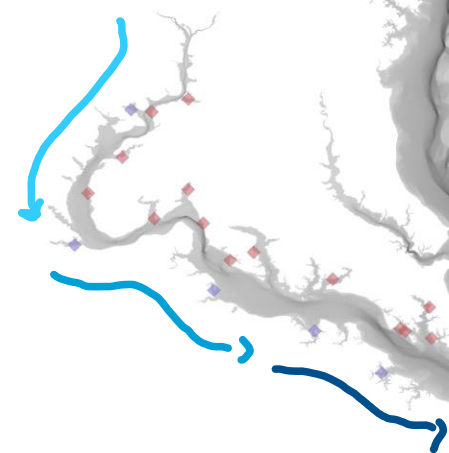
# Chemical Gradients

What is the distribution of daily mean salinity from the head of tides to the bay?

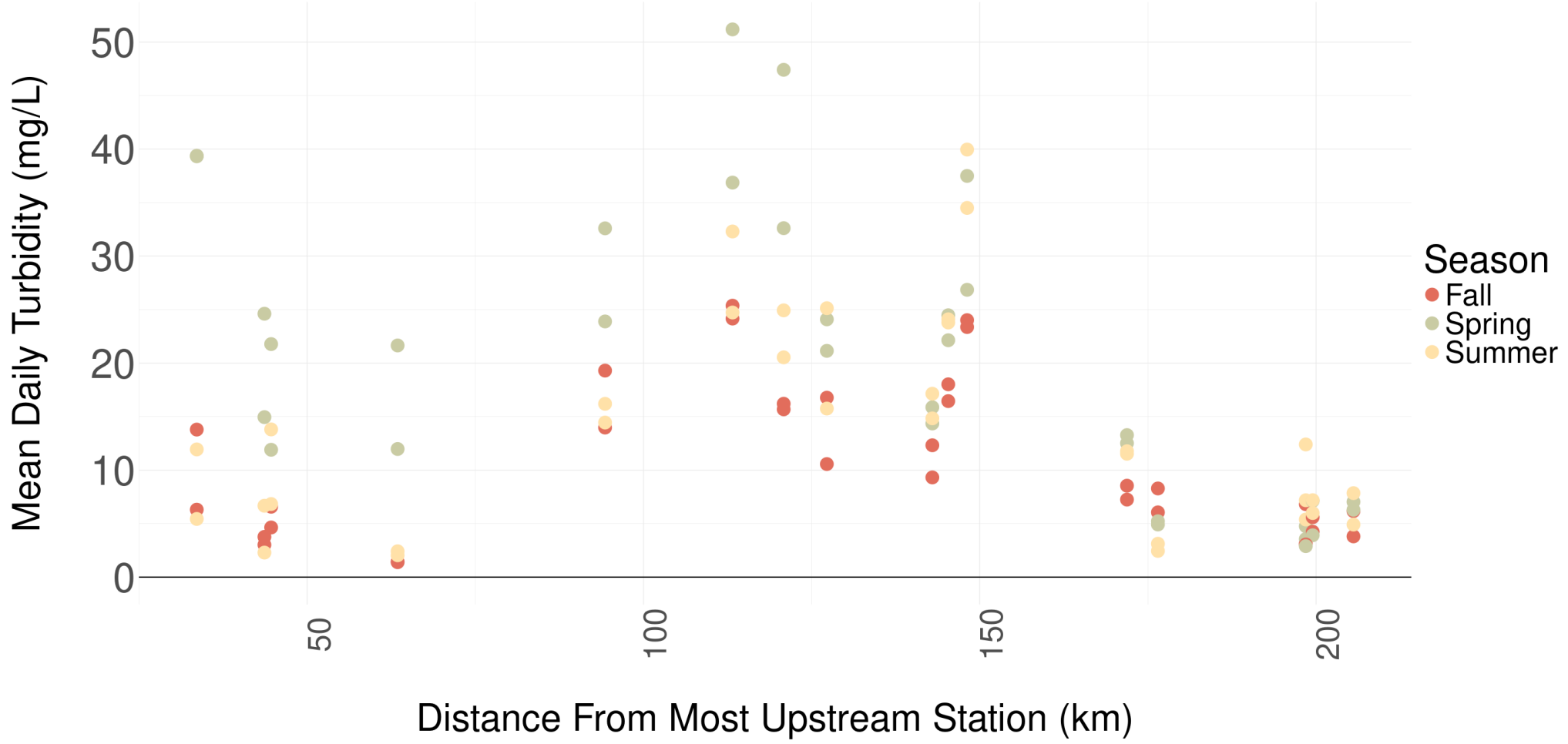


# Chemical Gradients

Turbidity, and non-linear gradients and interactions along the tidal river

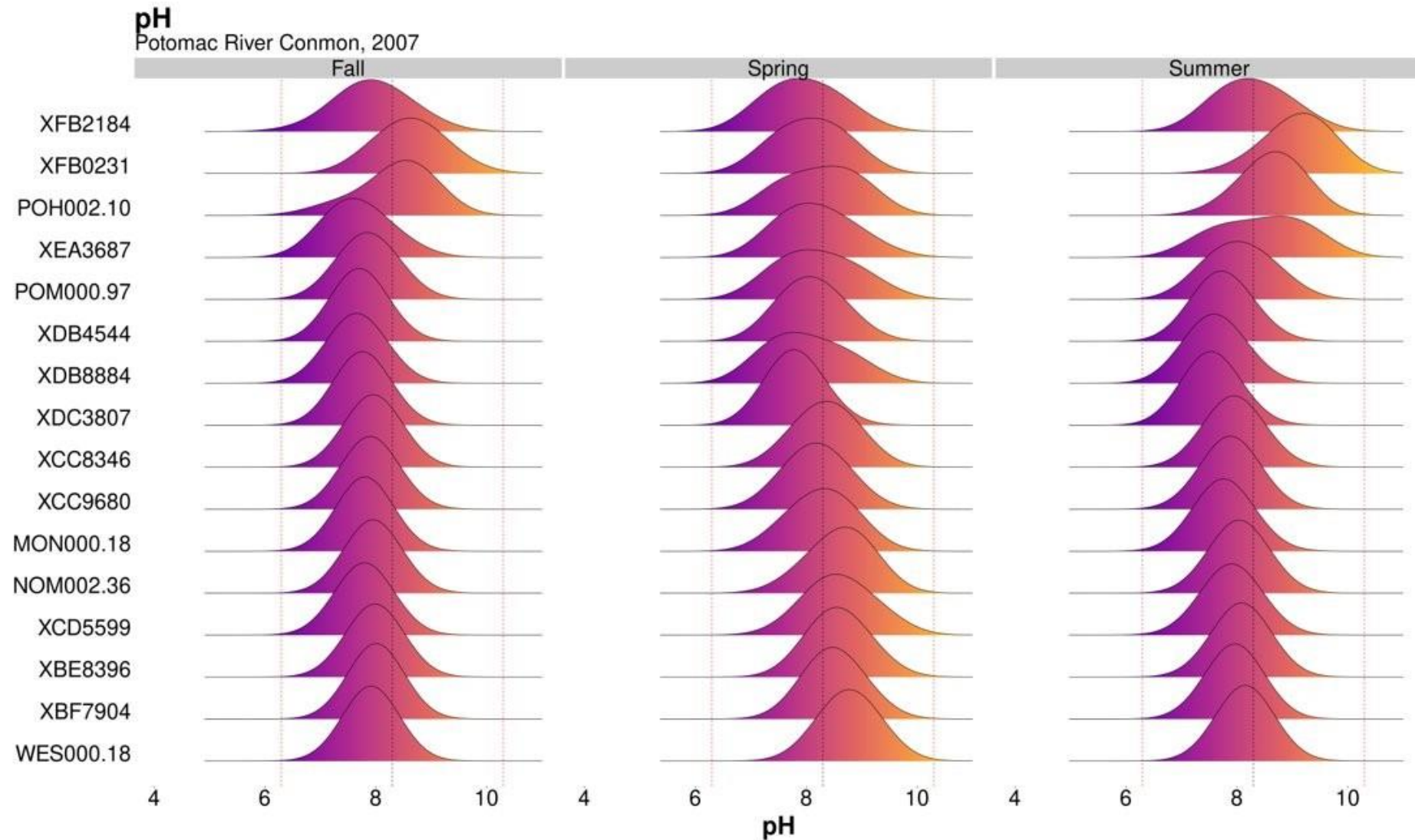


Mean Daily Turbidity by Distance Downstream at Potomac River Common Stations 2007 and 2008



# Chemical Gradients

What is the distribution of pH values along the tidal river?

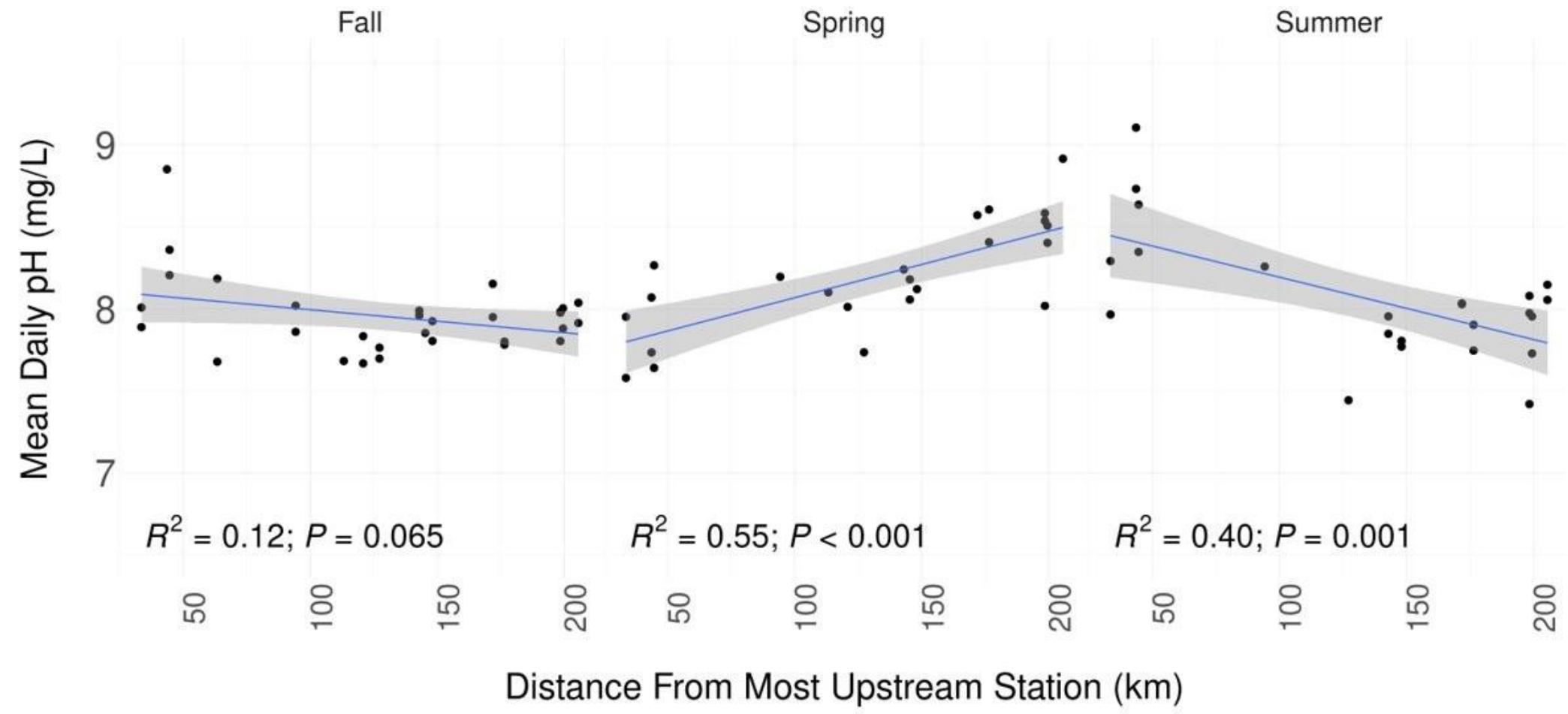


# Chemical Gradients

Is there a linear gradient in pH?



Mean Daily pH by Distance Downstream  
at Potomac River Common Stations 2007 and 2008



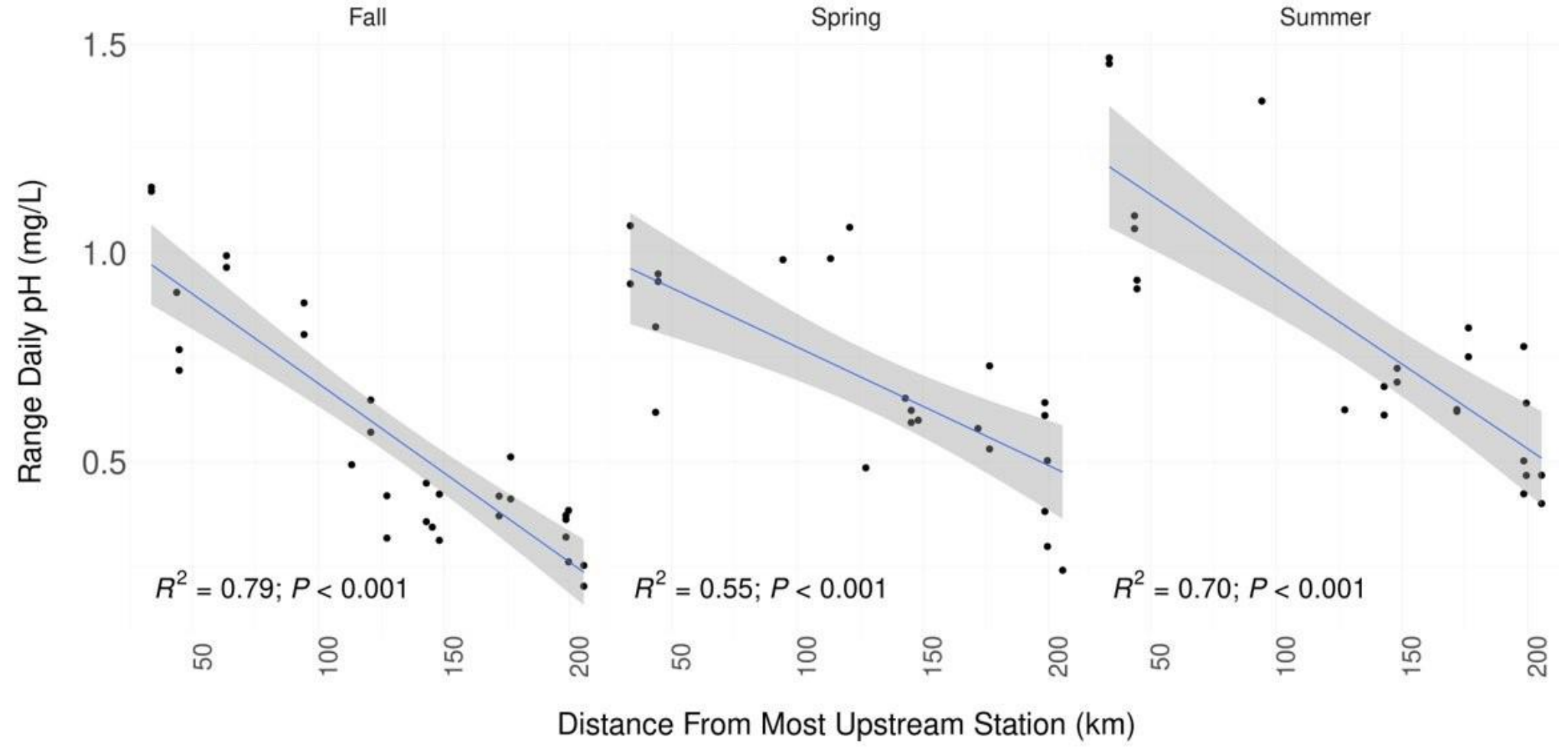


# Chemical Gradients

Is there a linear gradient in pH?

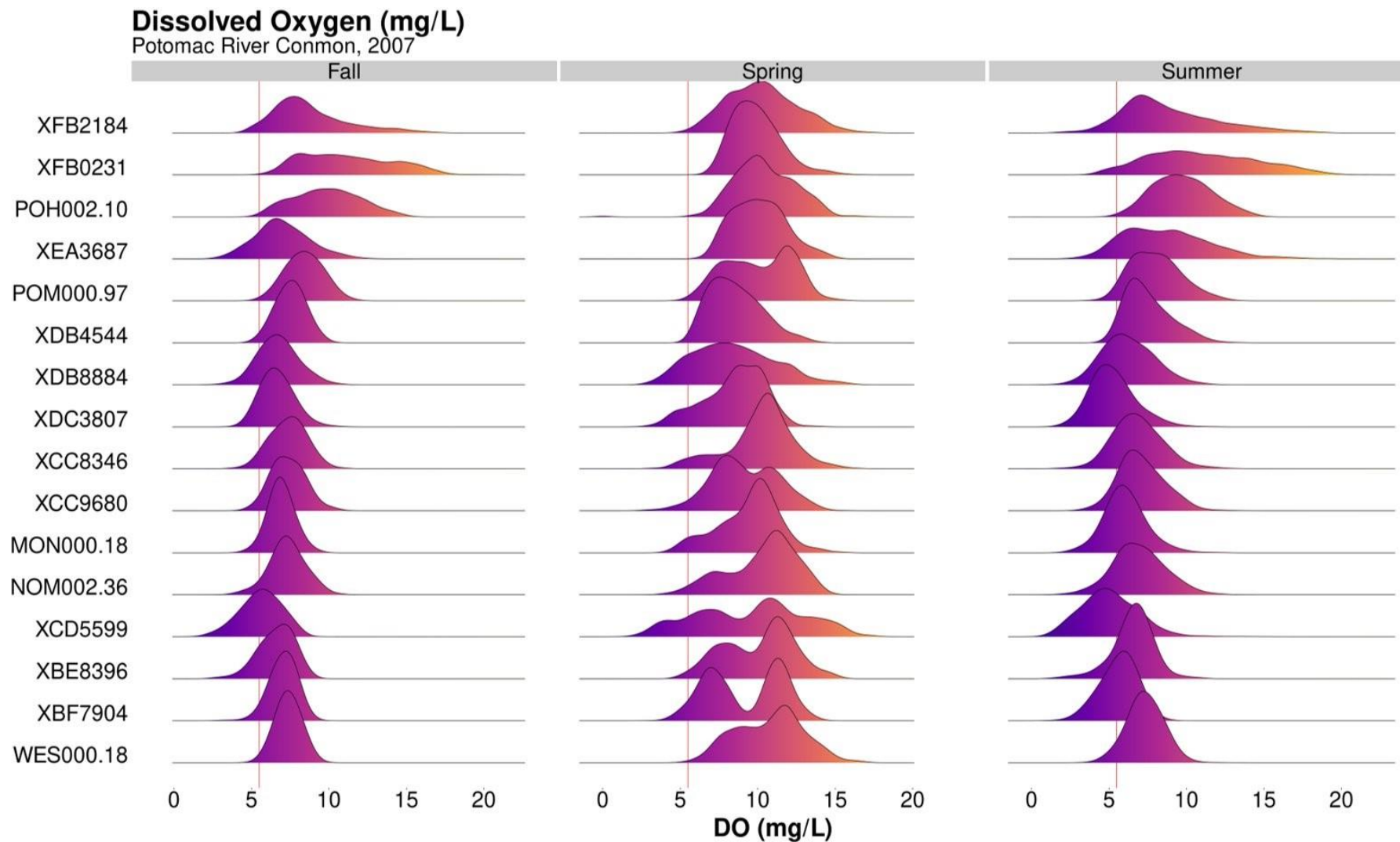
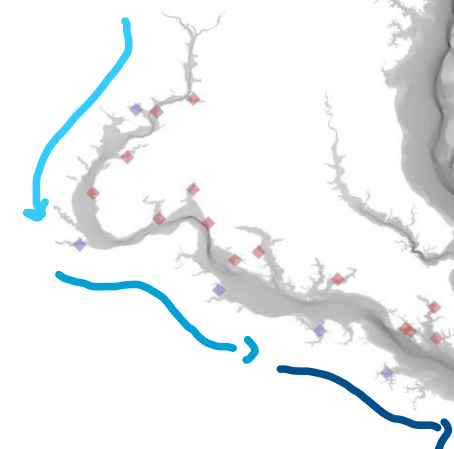


Range Daily pH by Distance Downstream  
at Potomac River Common Stations 2007 and 2008



# Chemical Gradients

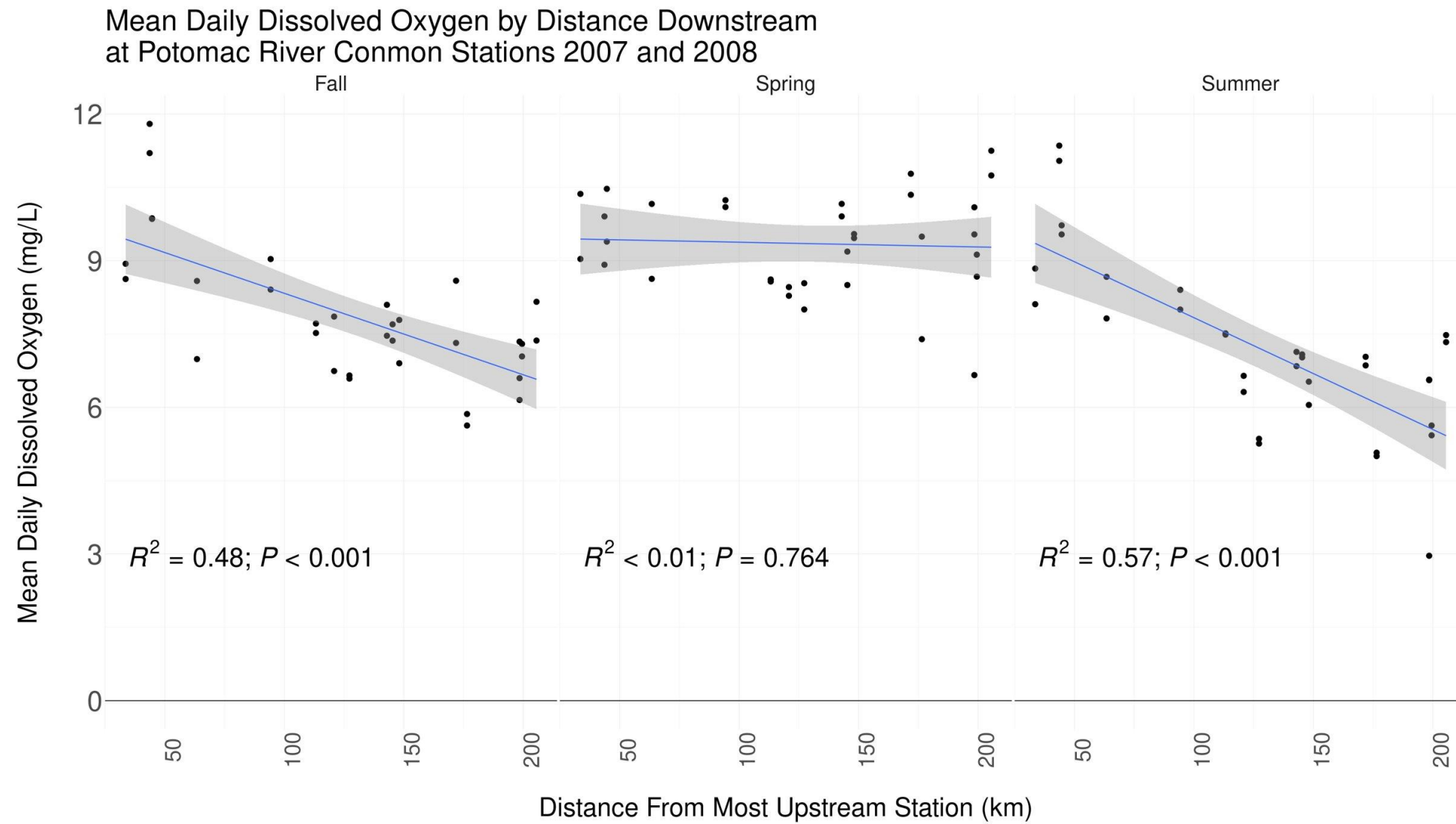
What is the distribution of DO along the river?



The Chesapeake Bay Program's dissolved oxygen criteria for shallow/open water zones is **5 mg/L over 30 days**, and **3.2 mg/L short term exposure** (several hours) (US EPA 2003)

# Chemical Gradients & Ecosystem Productivity

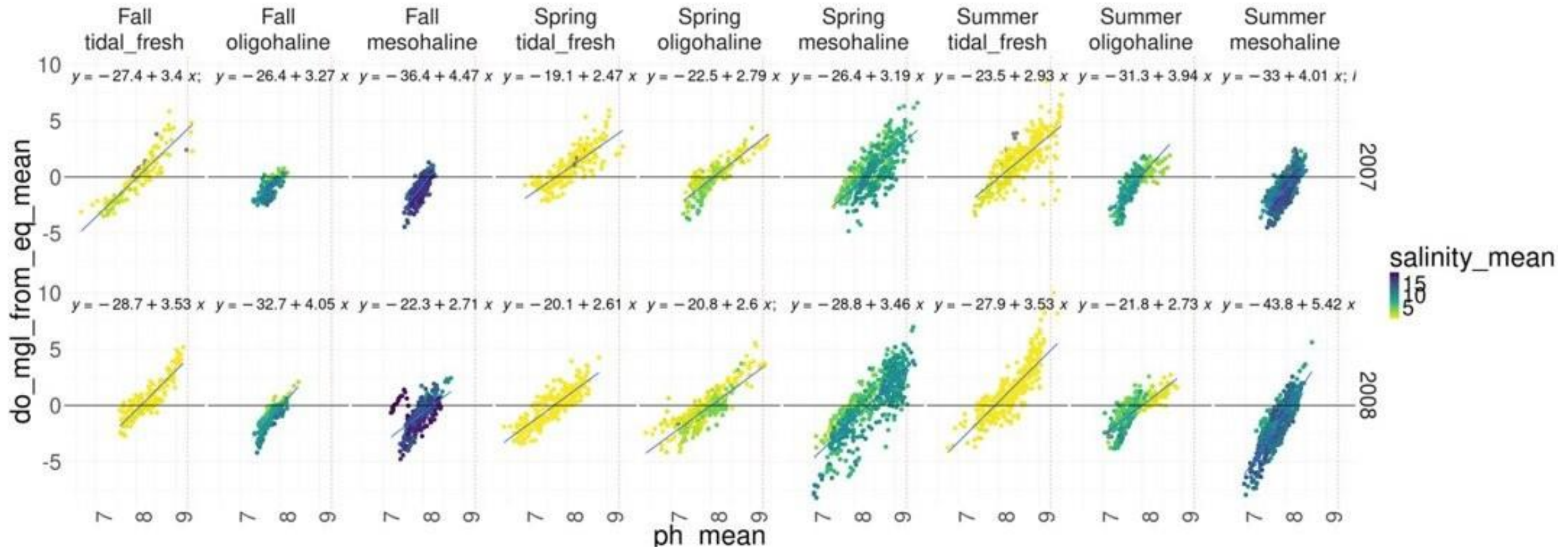
## Is there a longitudinal gradient in mean daily DO?



The Chesapeake Bay Program's dissolved oxygen criteria for shallow/open water zones is **5 mg/L over 30 days**, and **3.2 mg/L short term exposure** (several hours) (US EPA 2003)

# Ecosystem Productivity

Is there evidence of a gradient of net autotrophy to heterotrophy along the river-estuary continuum?

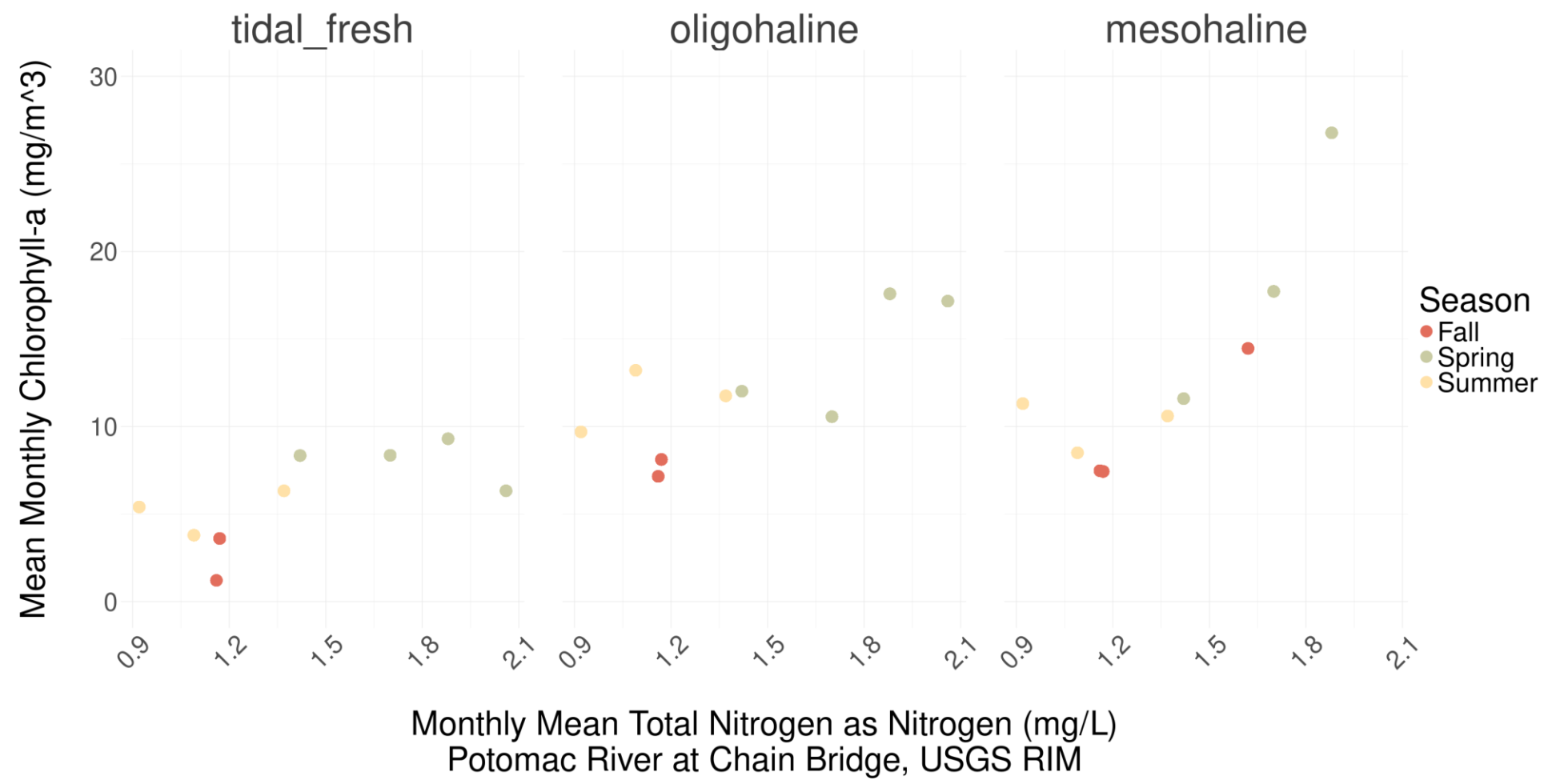


# Non-tidal Inputs and Ecosystem Productivity

Do biological and chemical responses to freshwater input vary along the estuarine gradient?

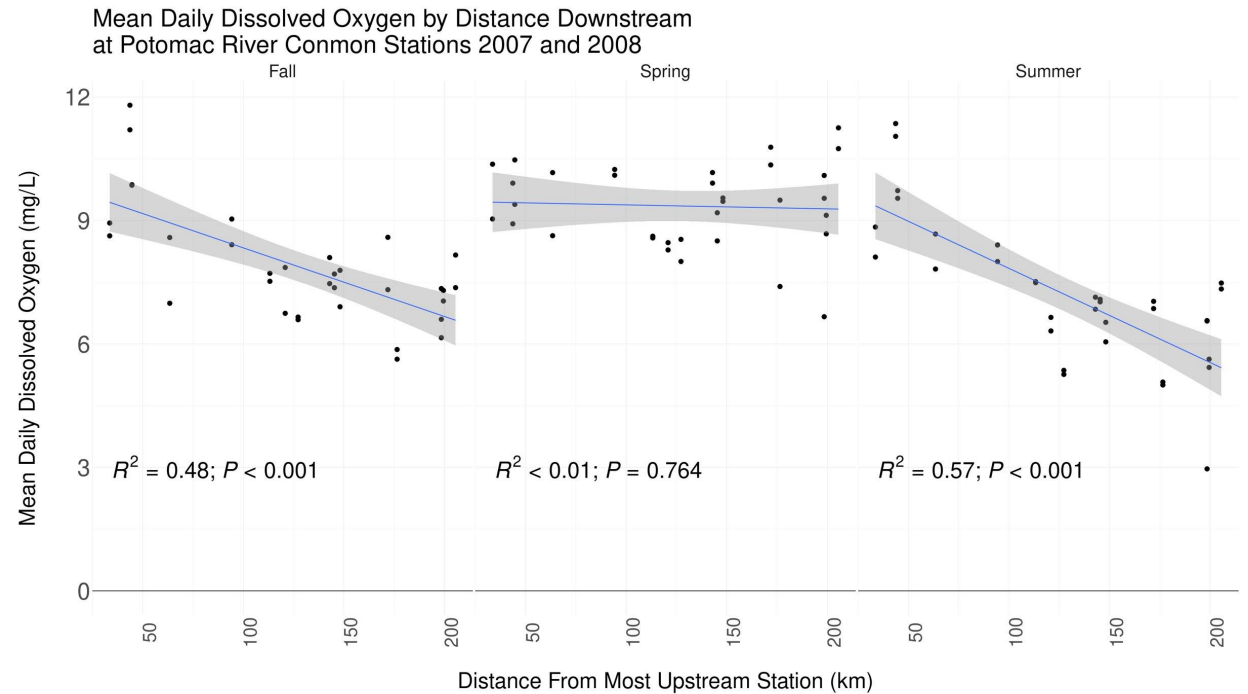
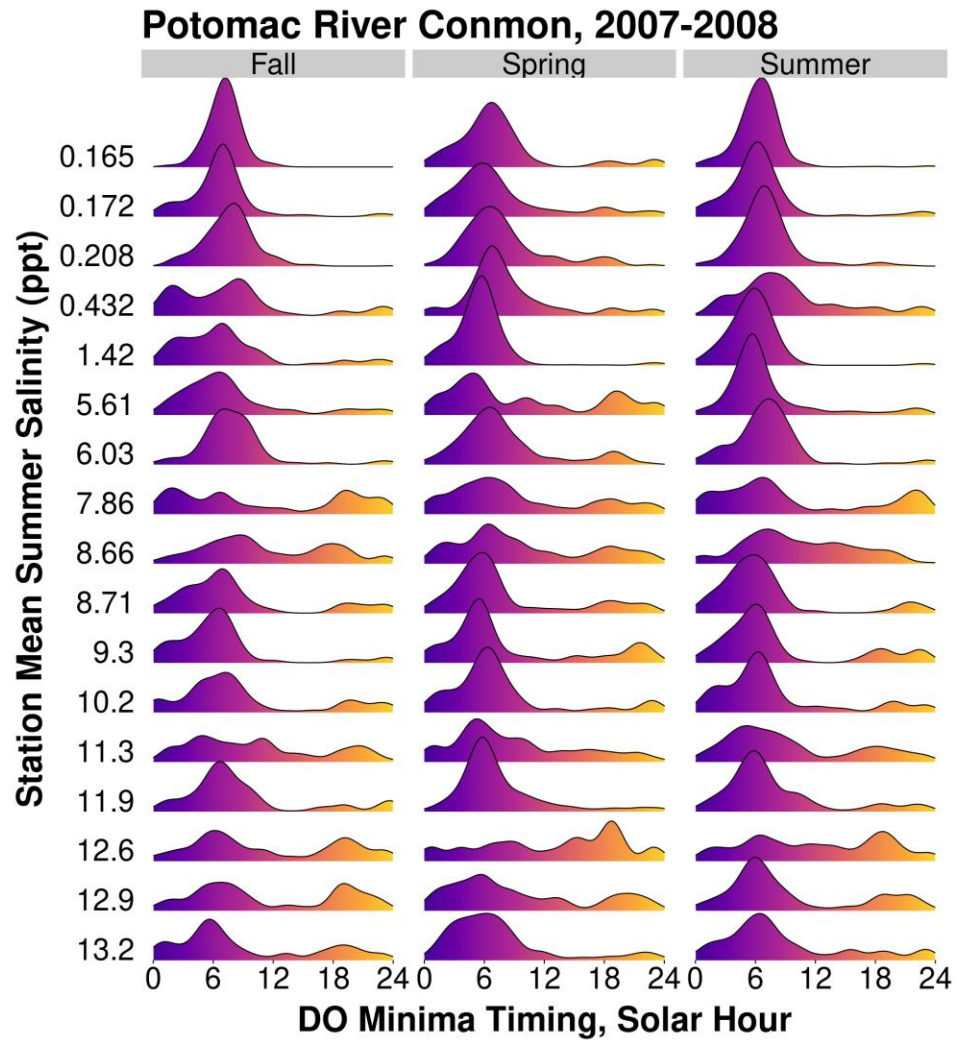


Tidal Potomac Common Chlorophyll vs Freshwater Nitrogen Input  
Monthly Means March-November 2008



# What Does Water Do in the Dark?

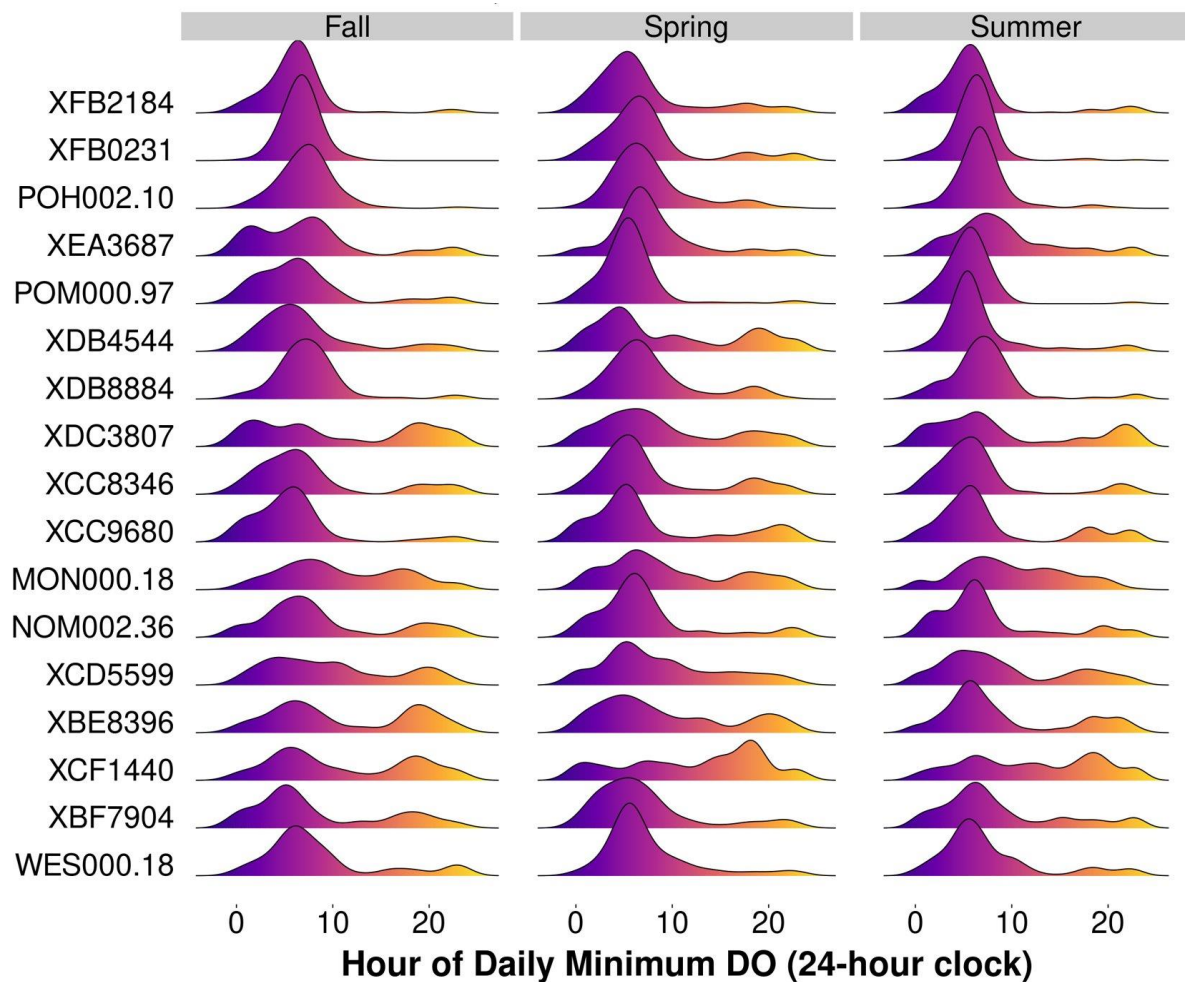
Are the longitudinal dynamics of water quality parameters different in the night and day?



# What Does Water Do in the Dark?

## Daily Minimum DO Timing

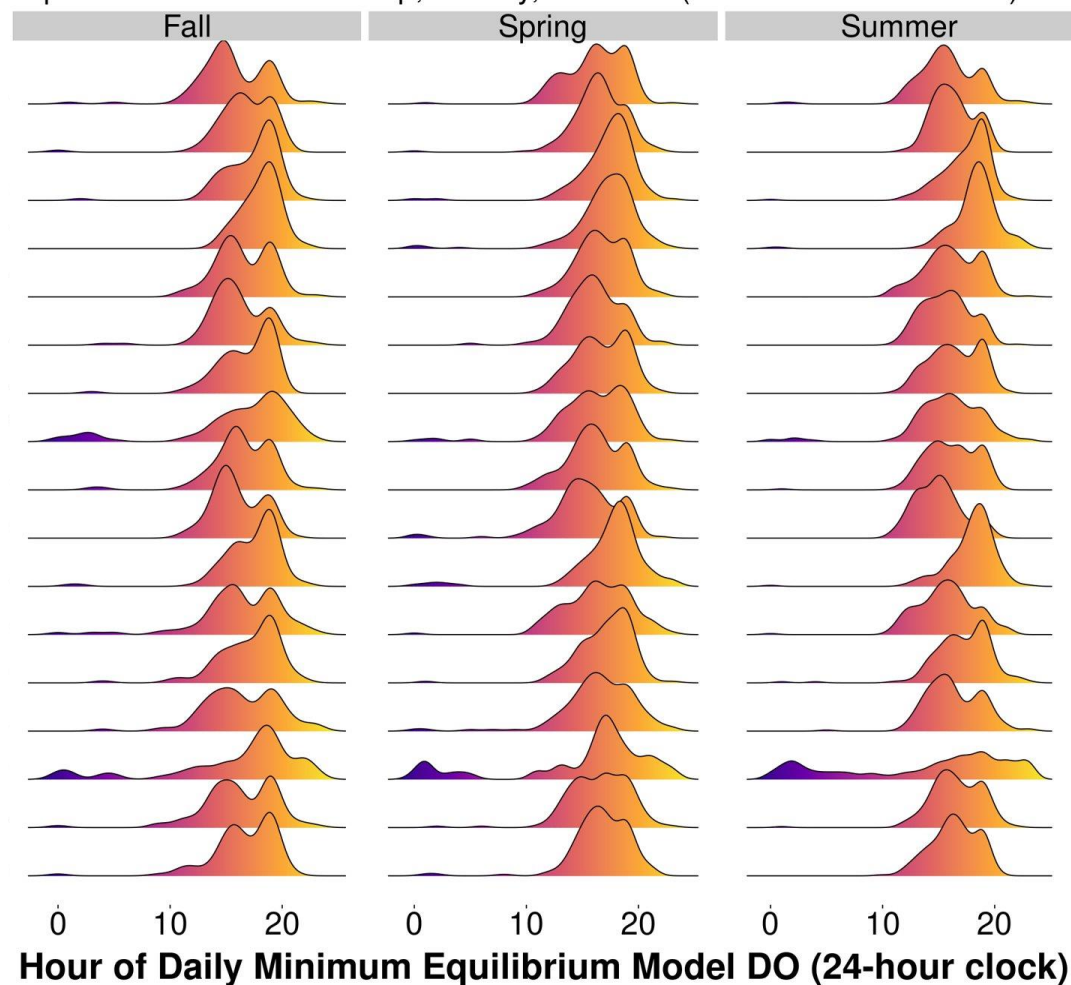
Potomac River Connon, 2007-2008



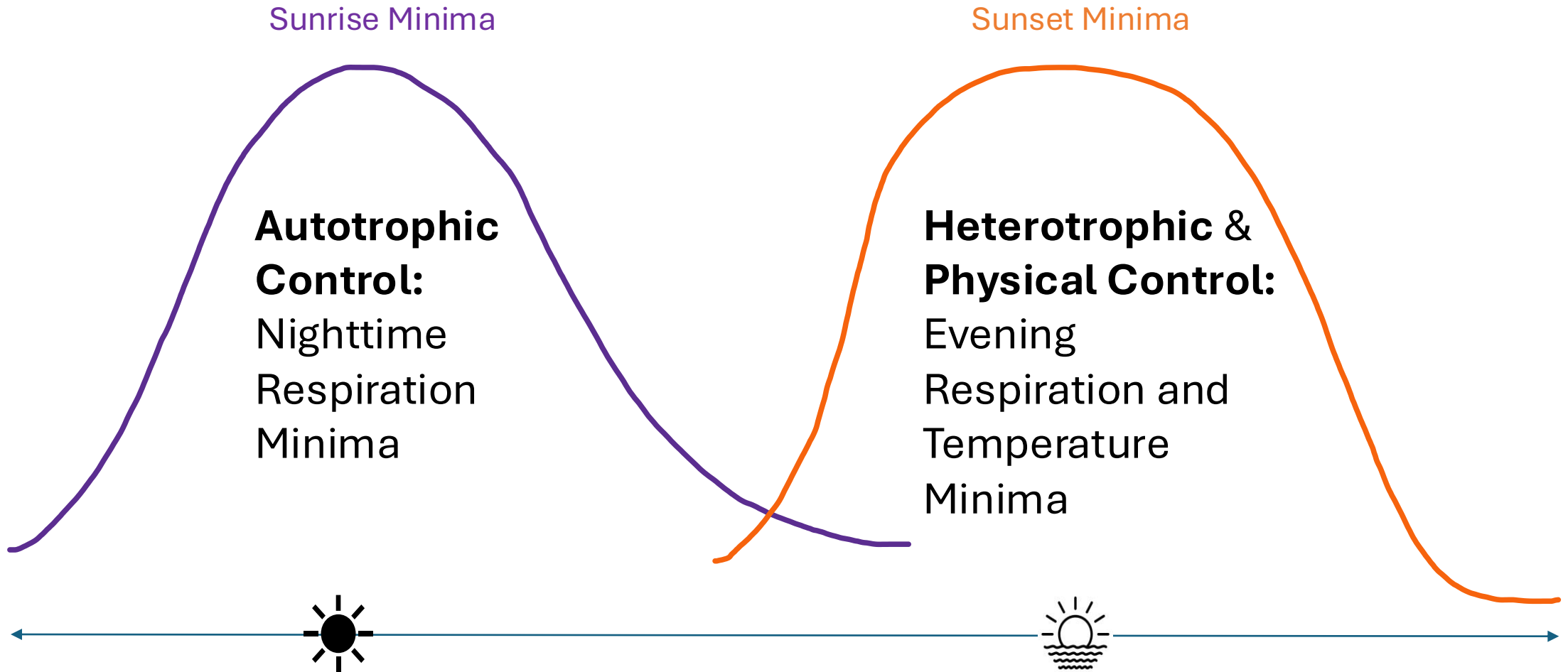
## Daily Minimum DO Timing, Equilibrium Model

Potomac River Connon, 2007-2008

Equilibrium Model from Temp, Salinity, Pressure (Benson & Krause 1984)



# Does DO minima timing give clues about drivers of DO?





# Expanding the Study

## Patuxent River, 2003-2005 ([MDDNR](#))

- 7 stations from June 2003-October 2005

## Rappahannock River 2007-2023 ([VECOS](#))

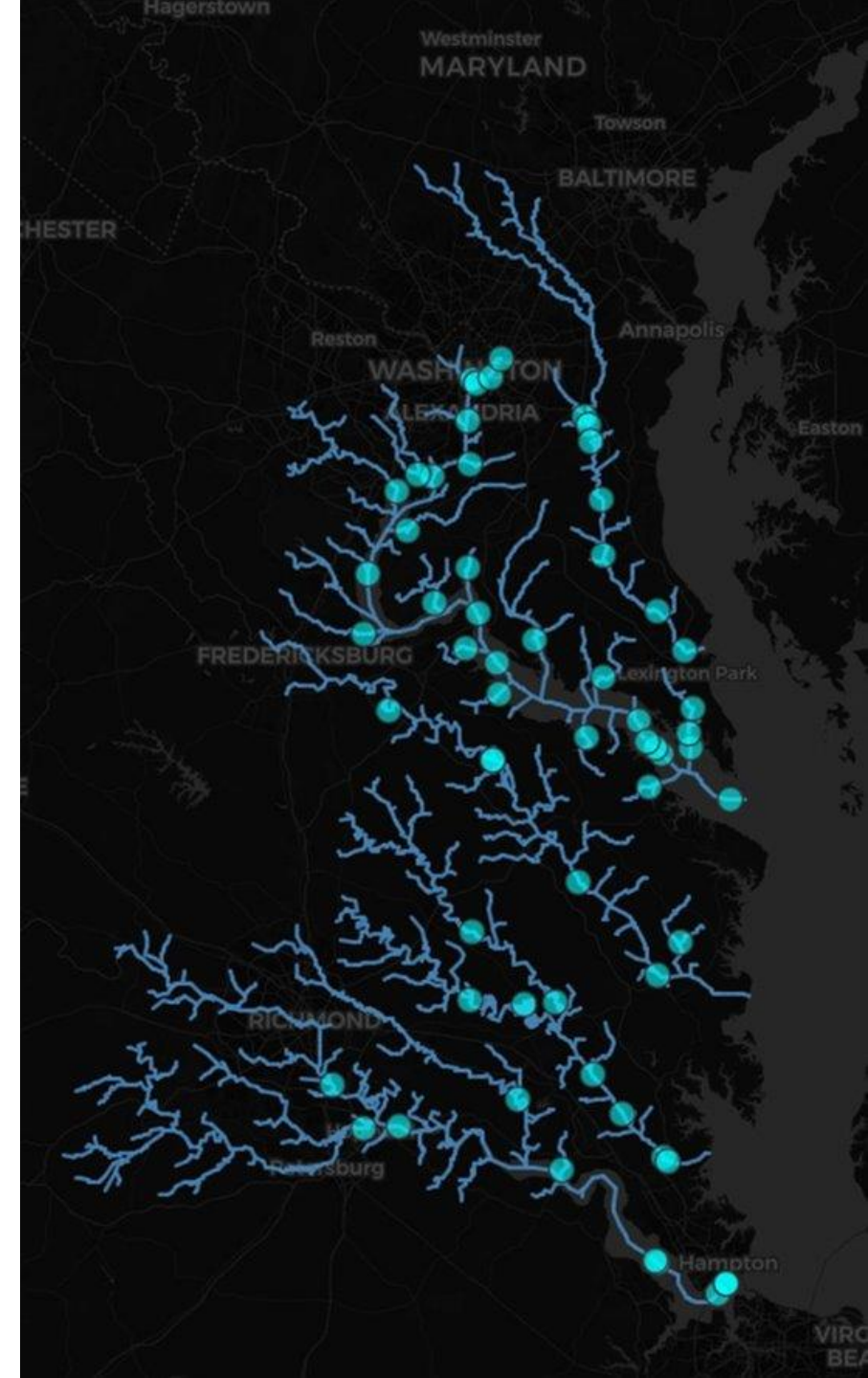
- 5 stations

## York River 2003-2005 ([VECOS](#))

- 8 stations

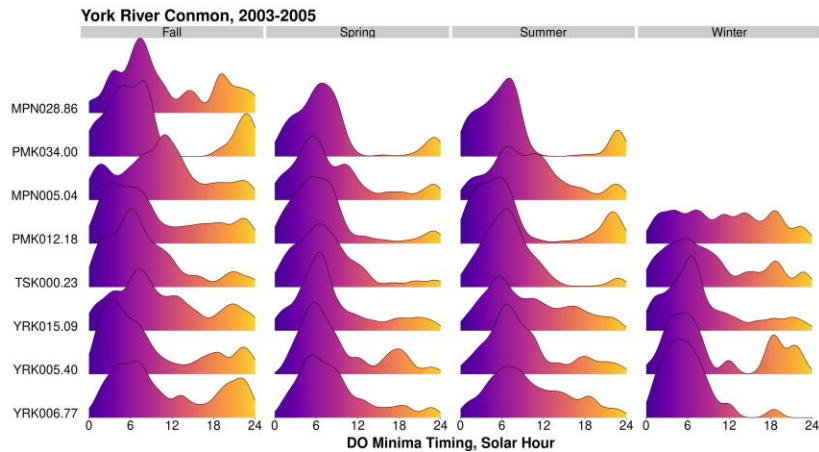
## James River 2006-2008([VECOS](#))

- 7 stations

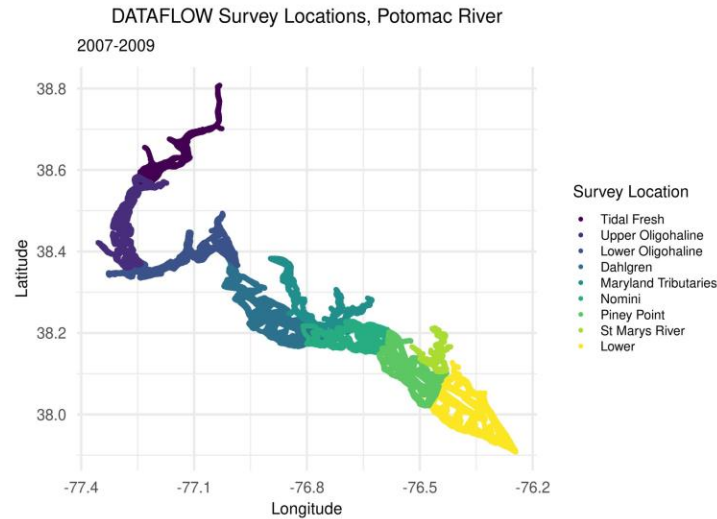


# Next Steps (and current steps not discussed)

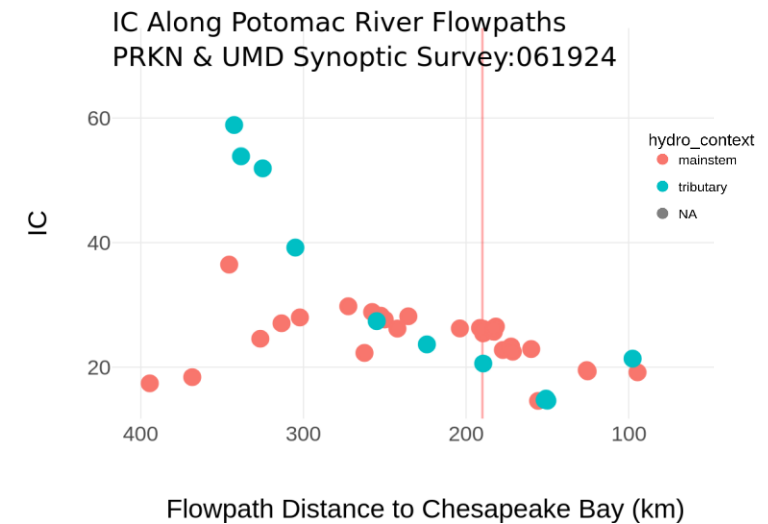
Expanded analysis to include case study years which range from 2003-2023, and analyze trends in stations along the Patuxent, Rappahannock, York, and James Rivers



Integrating analysis of MDDNR and VECOS boat cruise survey data from DATAFLOW instrument suite



Collaboration with community science groups to analyze water chemistry in samples spanning the non-tidal and tidal Potomac





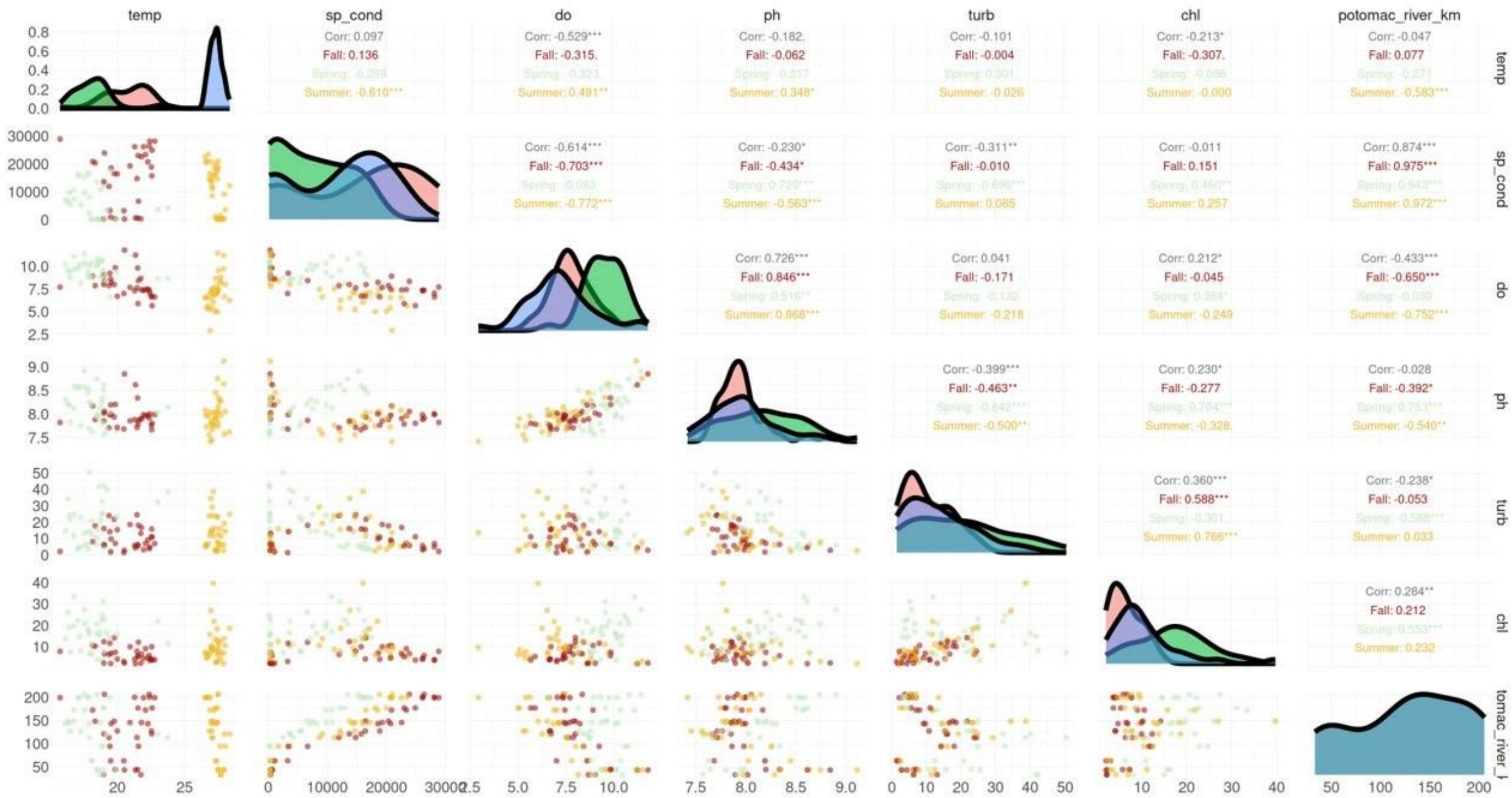
**Thank you!**  
**Questions?**

Thank you to Ashley B. Dann, Ashley Mon, and Sydney Shelton of the UMD Biogeochemistry lab, Karen Prestegaard and Mike Evans at UMD Geology, and Rebecca Murphy, John Harcum, Elgin Perry and Breck Sullivan at the Chesapeake Bay Program, and Lisa Wu, Catherine Gaudlip, and Morgan Bench at Potomac and Upper Potomac Riverkeepers for invaluable feedback, collaboration and support in this and related projects

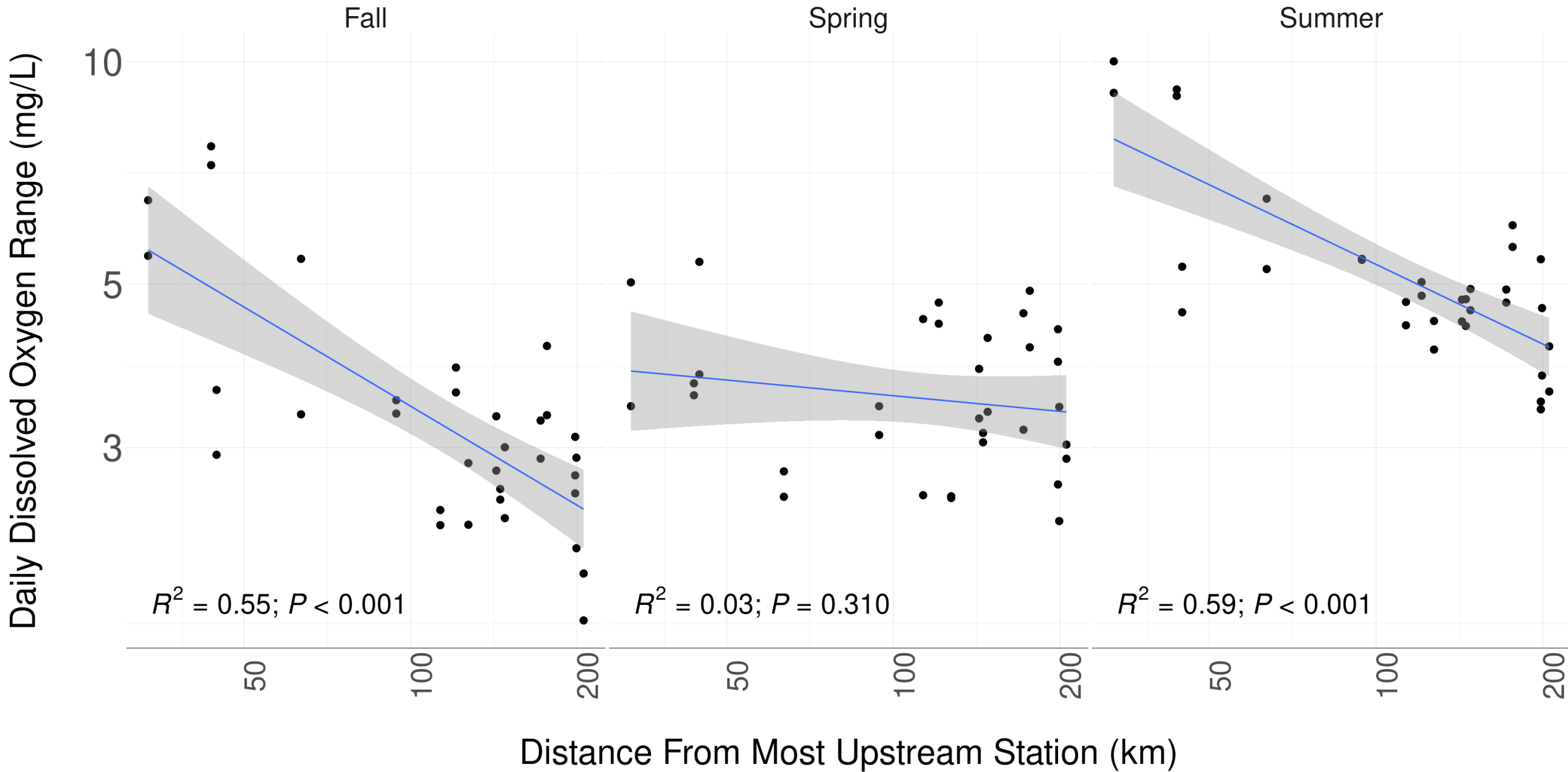
Thank you to MDDNR, VECOS and all other public data providers

**Supplemental**

# Seasonal Water Quality Daily Means Regression Matrix at Potomac River Common Stations 2007 & 2008

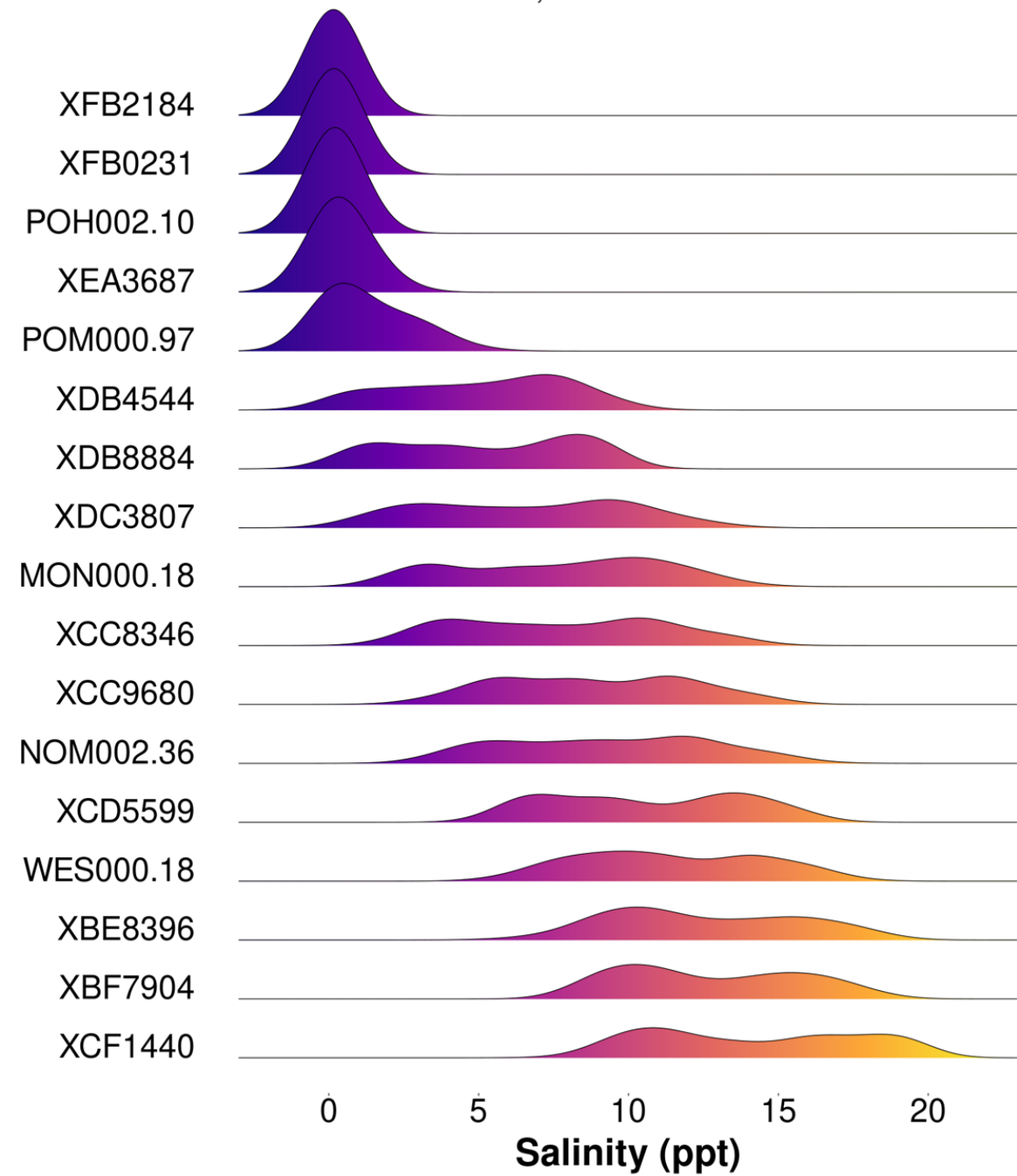


# Mean Daily Dissolved Oxygen Range by Distance Downstream at Potomac River Common Stations 2007 and 2008



# Salinity (ppt)

Potomac River Connon, 2007-2008



# Water Temperature (C)

Potomac River Conmon, 2007

Fall

Spring

Summer

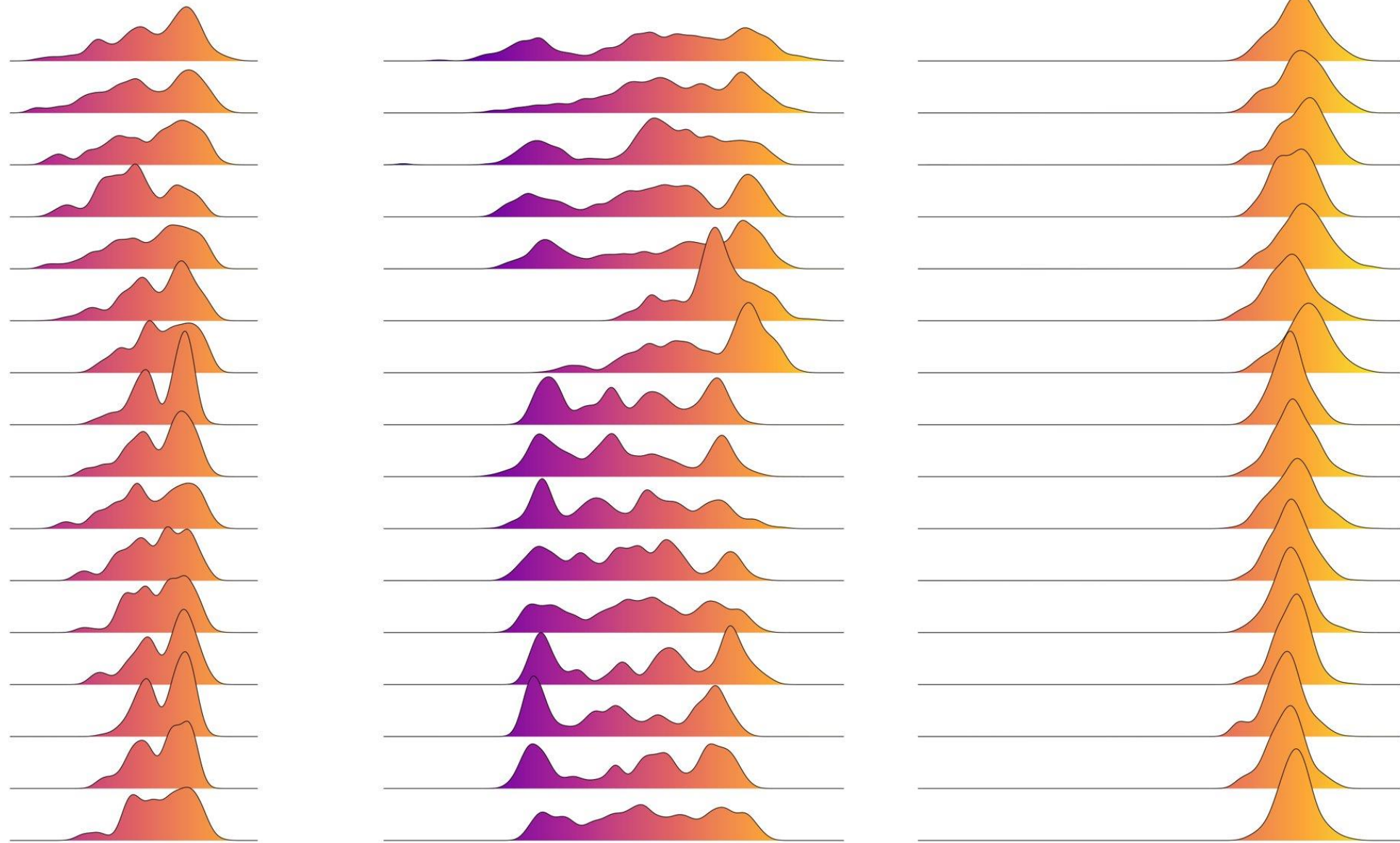
XFB2184  
XFB0231  
POH002.10  
XEA3687  
POM000.97  
XDB4544  
XDB8884  
XDC3807  
XCC8346  
XCC9680  
MON000.18  
NOM002.36  
XCD5599  
XBE8396  
XBF7904  
WES000.18

0 10 20 30

0 10 20 30

0 10 20 30

Temp (C)





# Water Temperature (C)

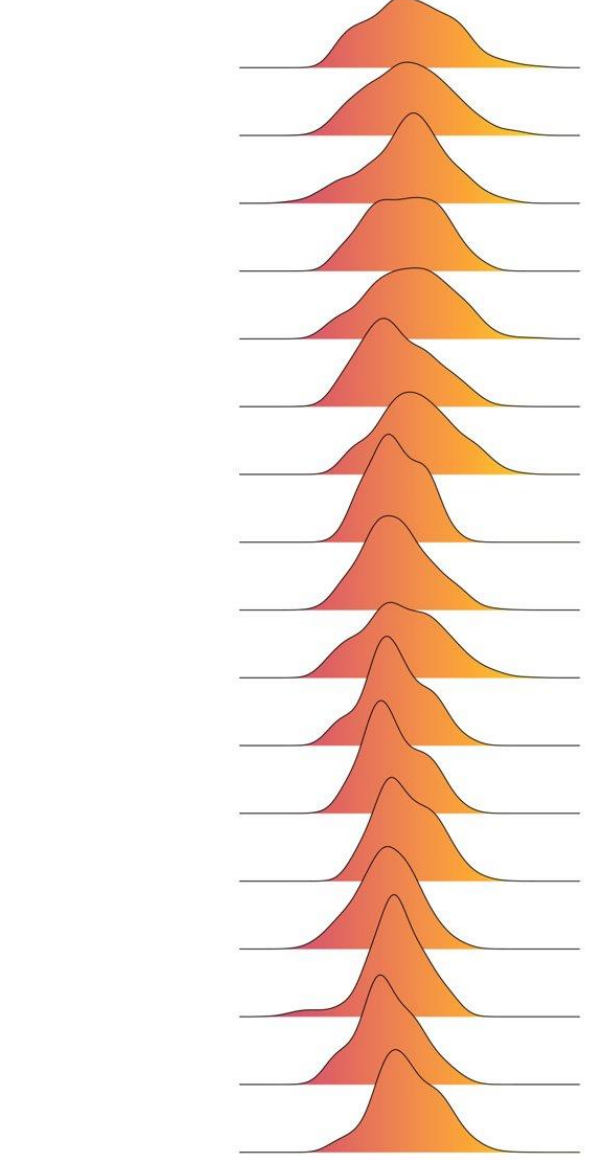
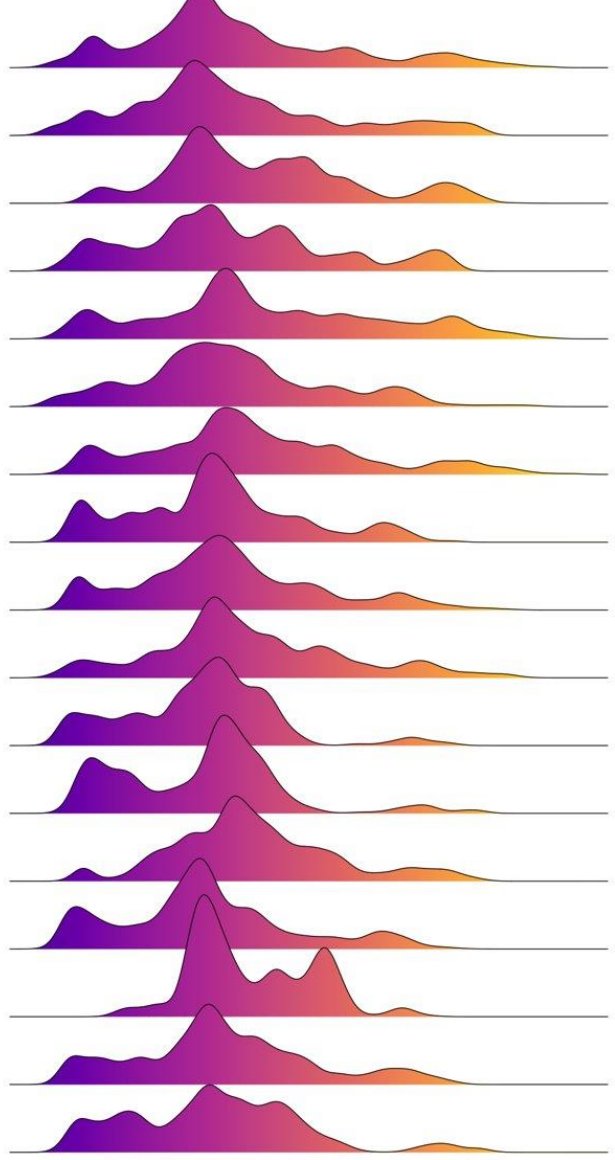
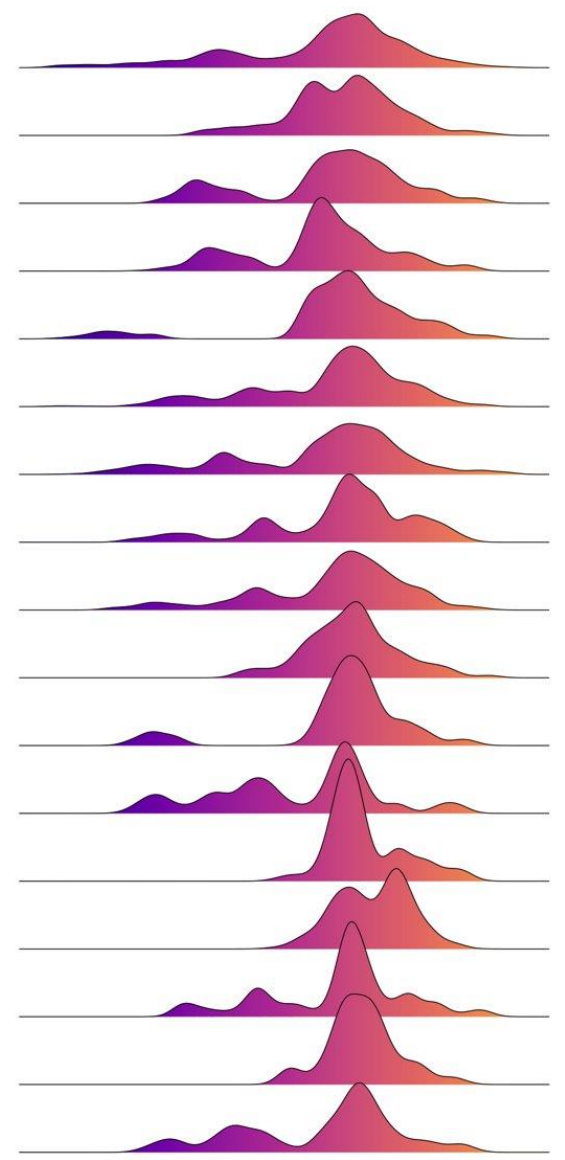
Potomac River Connon, 2008

Fall

Spring

Summer

- XFB2184
- XFB0231
- POH002.10
- XEA3687
- POM000.97
- XDB4544
- XDB8884
- XDC3807
- XCC8346
- XCC9680
- MON000.18
- NOM002.36
- XCD5599
- XBE8396
- XCF1440
- XBF7904
- WES000.18



10 20 30

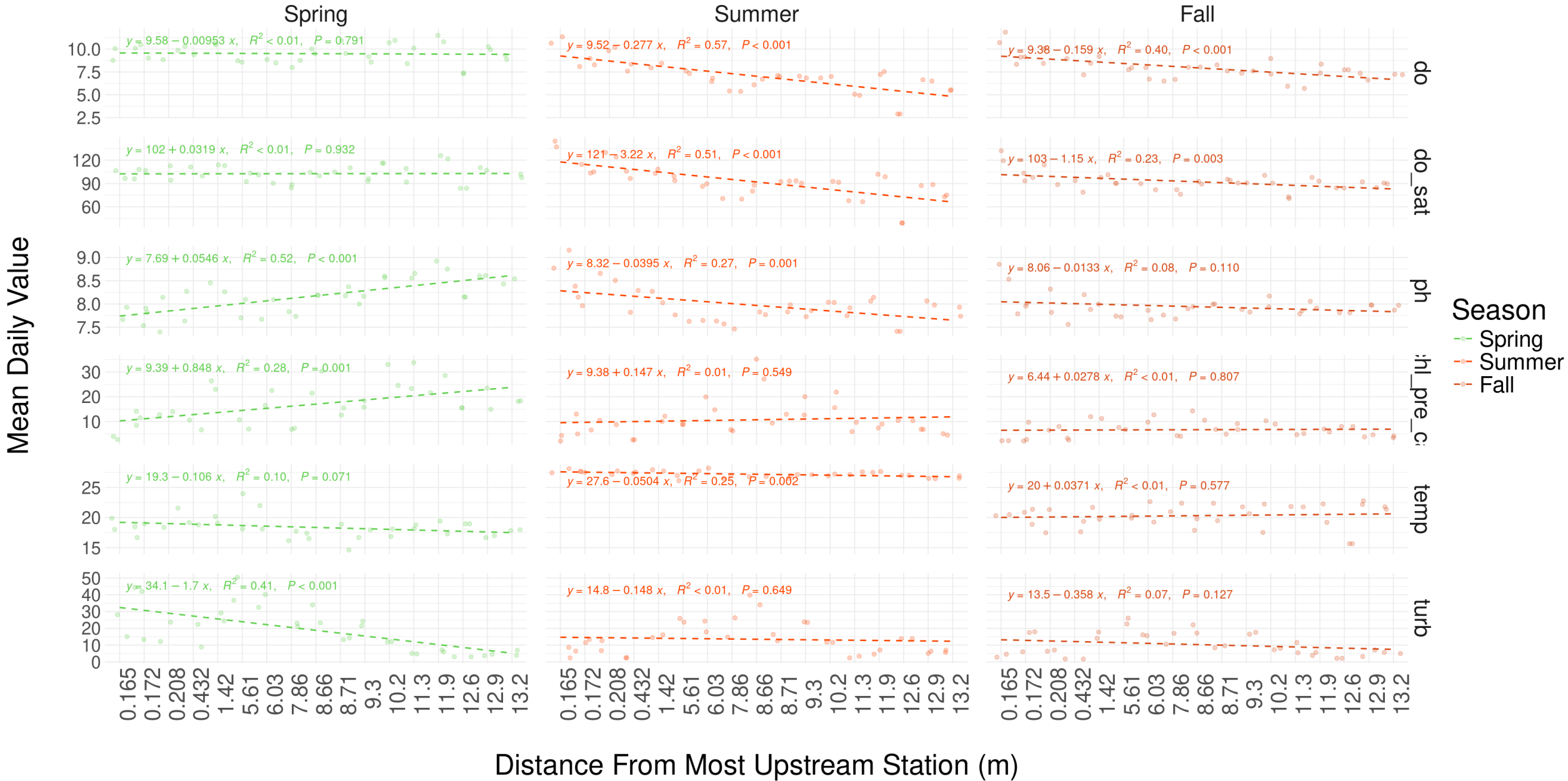
10 20 30

10 20 30

Temp (C)

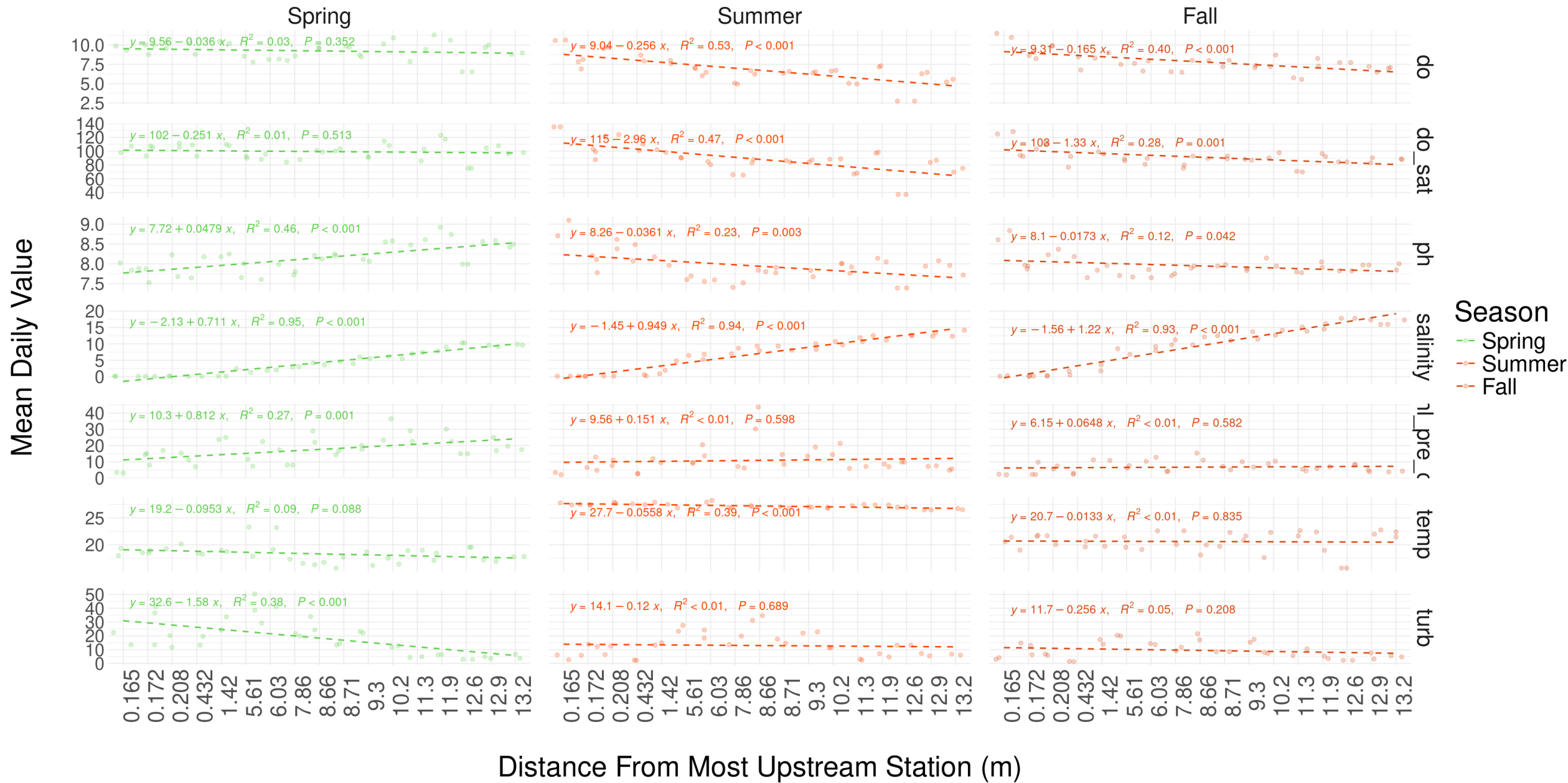
# Seasonal Water Quality Daily Means by Distance Downstream

## Potomac River Common Stations 2007-2008



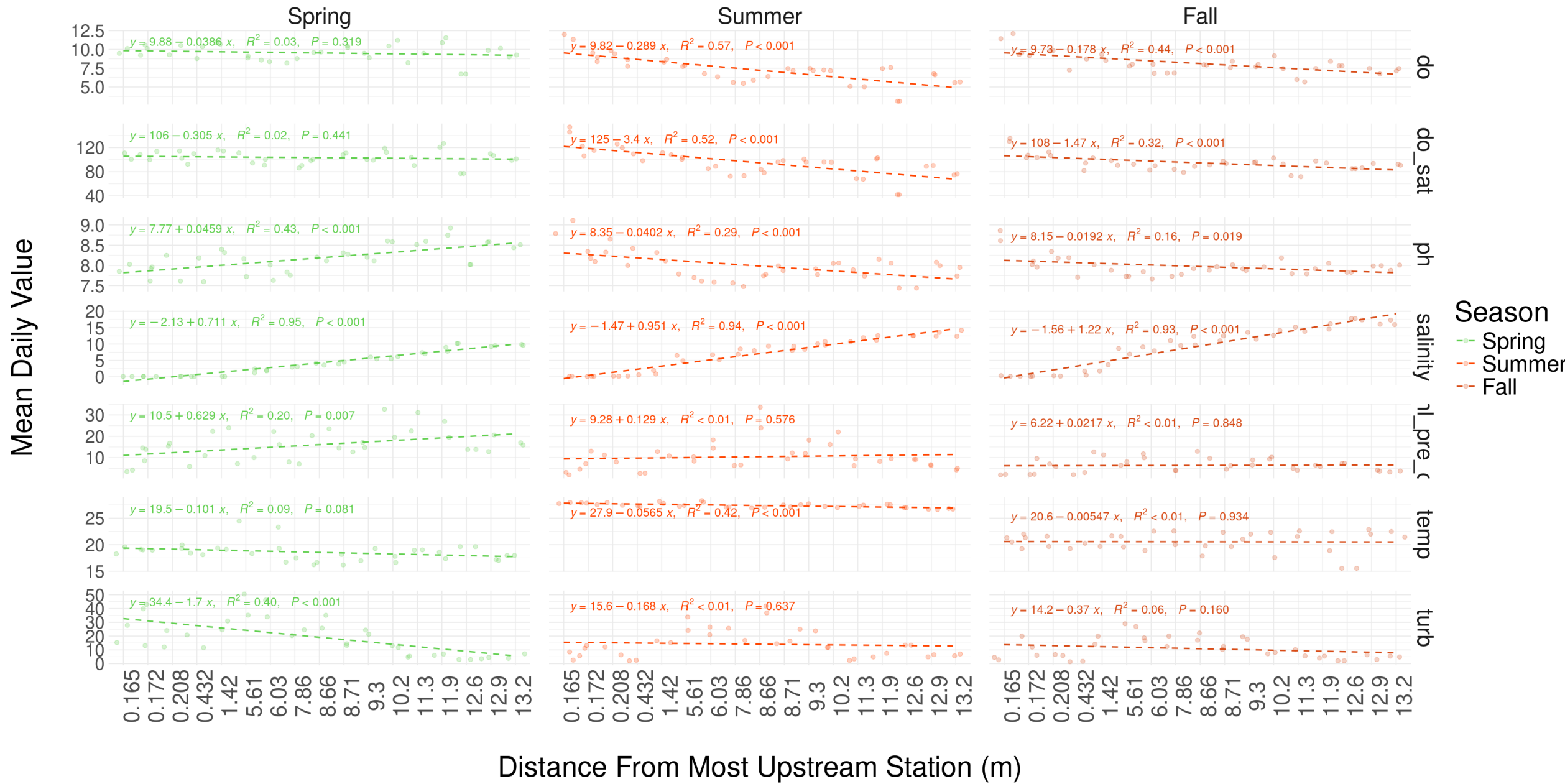
# Seasonal Water Quality Nightly Means by Distance Downstream

## Potomac River Common Stations 2007-2008

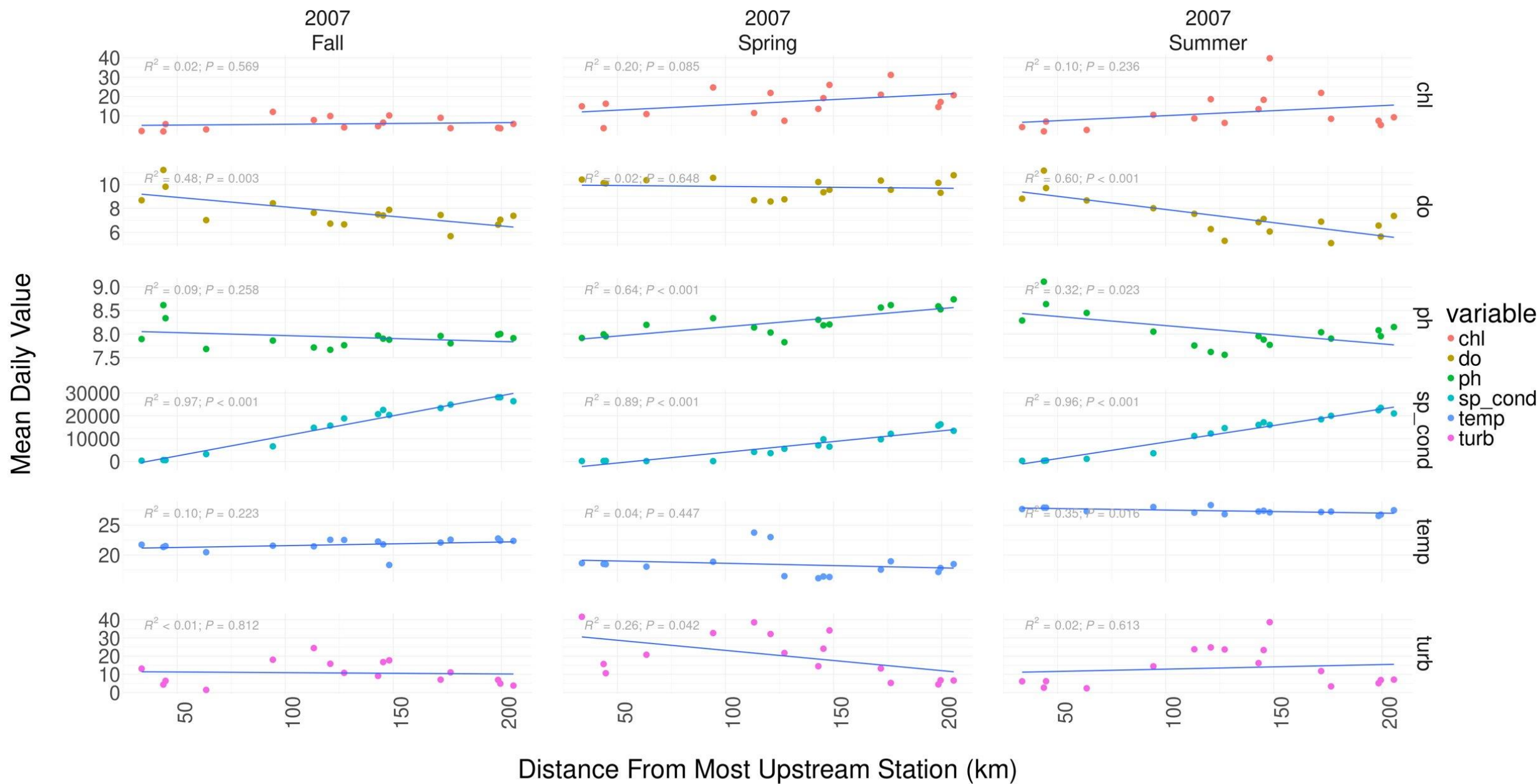


# Seasonal Water Quality Daytime Means by Distance Downstream

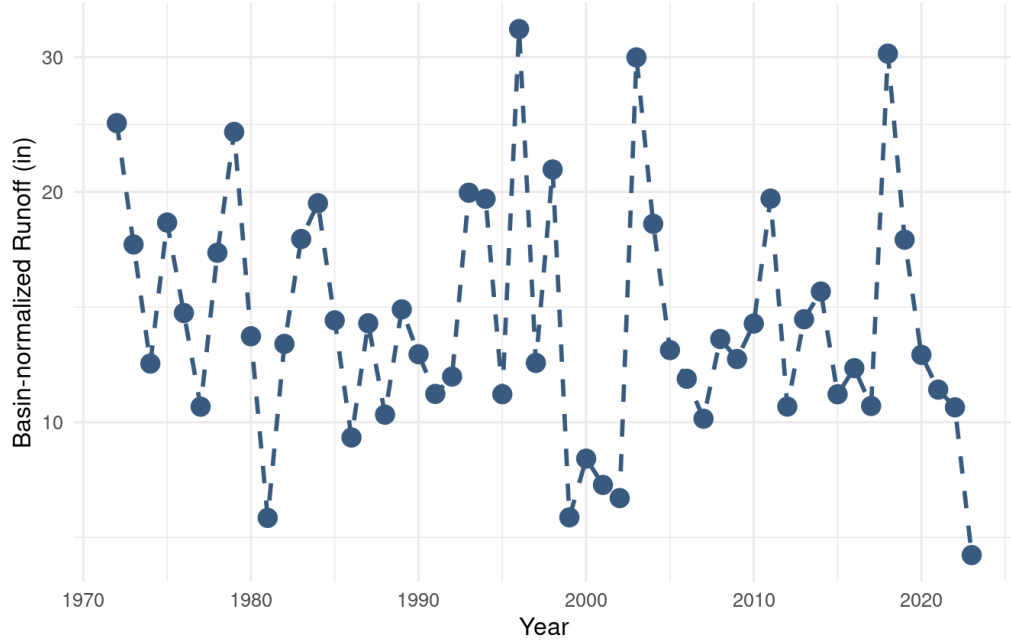
## Potomac River Common Stations 2007-2008



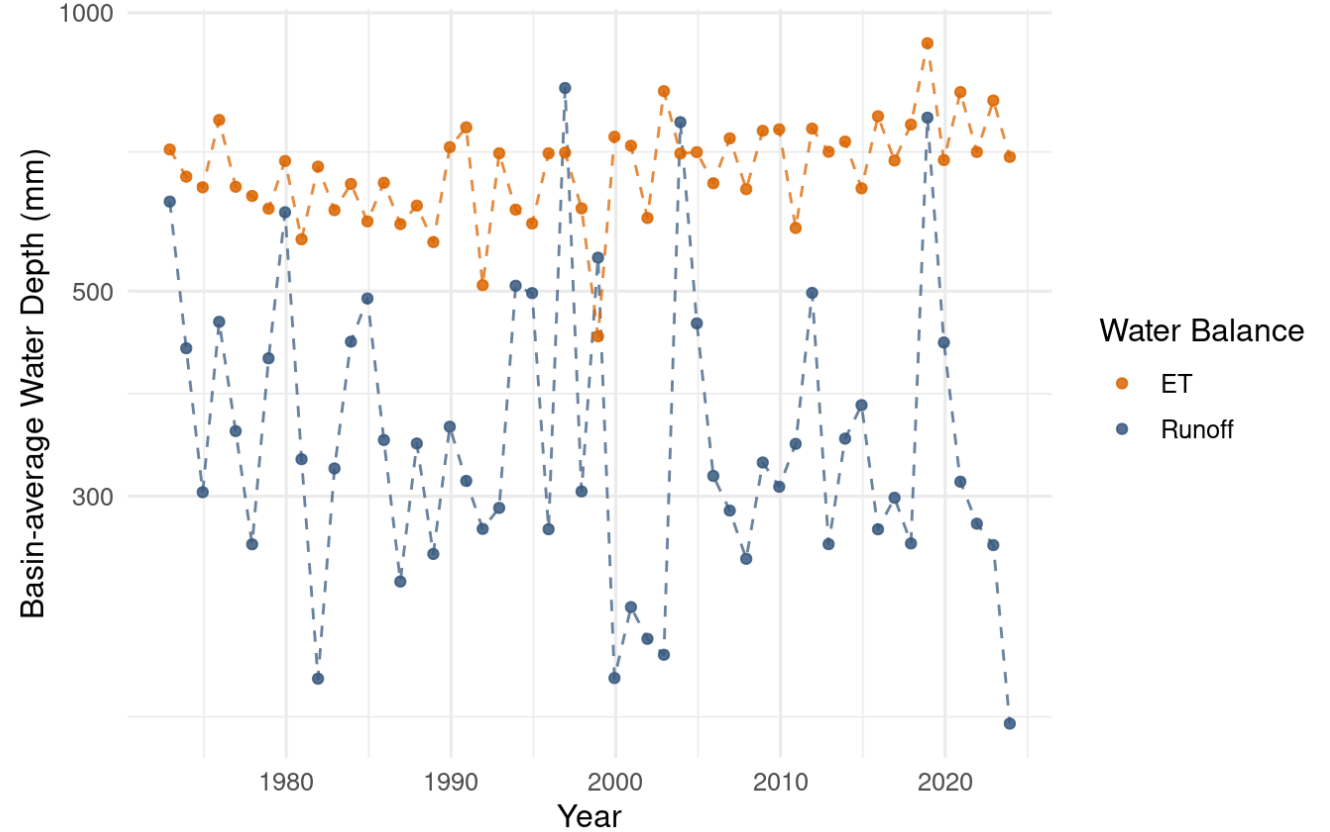
# Seasonal Water Quality Daily Means by Distance Downstream at Potomac River Common Stations



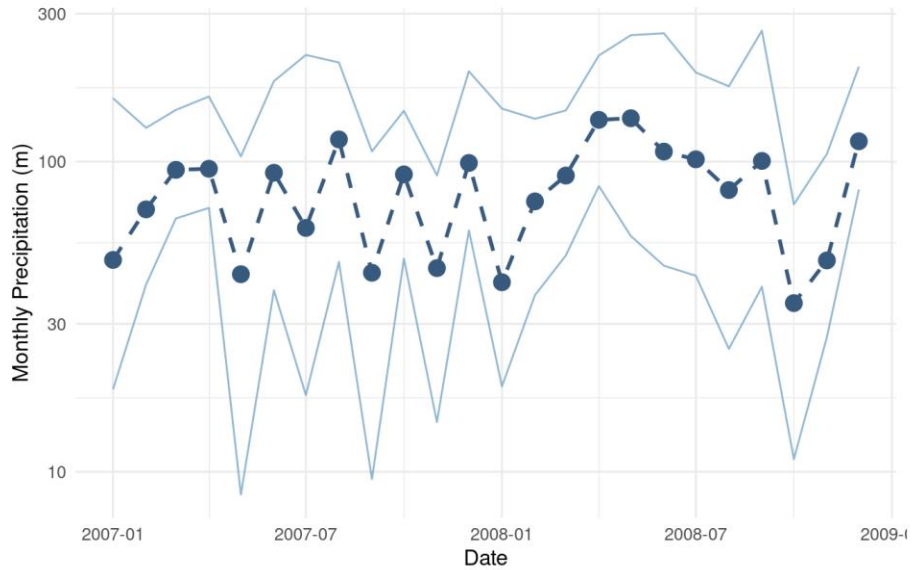
Potomac River at Little Falls USGS Gage  
Basin Runoff (in) 1972-2023



Potomac River at Little Falls USGS Gage  
Basin Runoff (in) 1972-2023

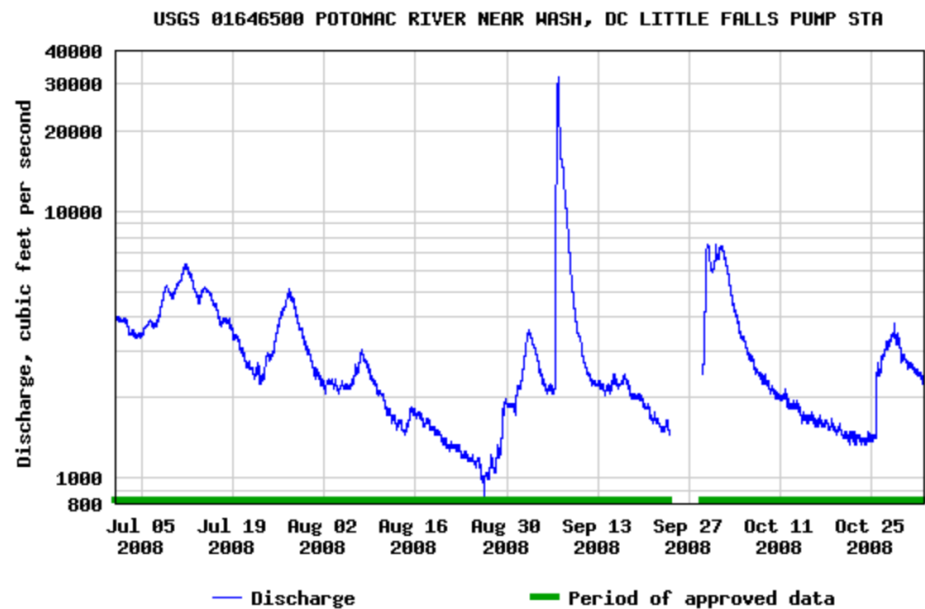


Potomac River Basin Upstream of Little Falls  
PRISM Monthly Precipitation 2007-2008 Mean Basin Precipitation, Bounc





Most recent instantaneous value: 7910 12-14-2024 17:45 EST



Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius, 7.1 ft from riverbed (top), |

Most recent instantaneous value: 406 10-01-2019 12:30 EDT

