Trends in Potomac River Salt Concentrations, 1992-2021

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- Analysis
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  - Sodium
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Introduction

Sodium & Chloride Standards

- Drinking Water Standards (Non-Enforceable)
  - Sodium: EPA Health-Based Advisory Level of 20 mg/L for individuals on sodium-restricted diets
  - Chloride: EPA Secondary Maximum Contaminant Level (SMCL) of 250 mg/L

- Water Quality Criteria
  - Chloride:
    1. VA Chronic: 230 mg/L as 4-day average
    2. VA Acute: 860 mg/L as 1-hour average

Salt Sources & Associated Challenges

- Sources
  - Road salt and deicing chemicals
  - Wastewater (residential and industrial)
  - Fertilizers and agricultural runoff
  - Mineral dissolution

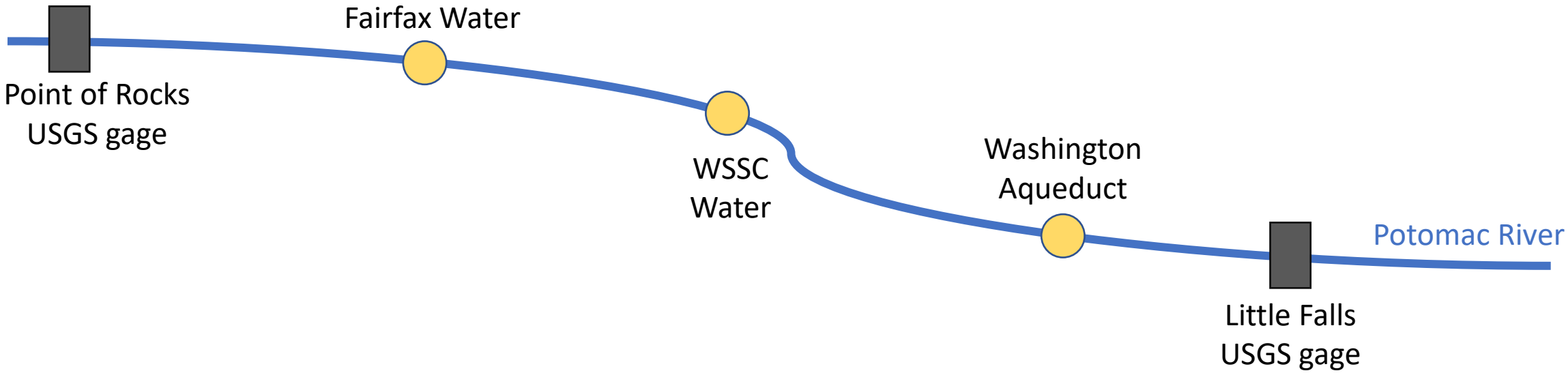
- Challenges
  - Drinking water
    1. Cardiovascular health issues for customers on low-sodium diets; salty taste
    2. Conventional water treatment ineffective for salt removal
    3. Possible loss of groundwater sources
  - Corrosion of infrastructure, vehicles, and home plumbing
  - Aquatic life toxicity

Approach

Data Sources

- Raw water sodium and chloride data, 1992-2021
  - Fairfax Water
  - WSSC Water
  - Washington Aqueduct
- USGS
  - Flow gage at Point of Rocks
  - Specific conductivity comparison between Point of Rocks and Little Falls
- US Census population data by HUC-8

Data Collection Site Schematic




Tuscarora Creek
Point of Rocks USGS Gage
Monocacy River
Little Monocacy
Limestone Branch
Broad Run, MD
Goose Creek
Horsepen Branch MD
Seneca Creek
Muddy Branch
Watts Branch
Broad Run, VA
Sugarland Run
Nichols Run
Difficult Run
Damascus
Clarksburg
Germantown
Montgomery Village
Montgomery Co Airpark
MARYLAND
Poolesville
Gaithersburg
Leesburg
Leesburg Executive Airport
Darnestown
Rockville
Potomac
Sterling
GreatFalls
Herndon
Reston
Bethesda
Little Falls USGS Gage
McLean
USGS Gage
Streams
N
0
12
Km

Statistical Methods

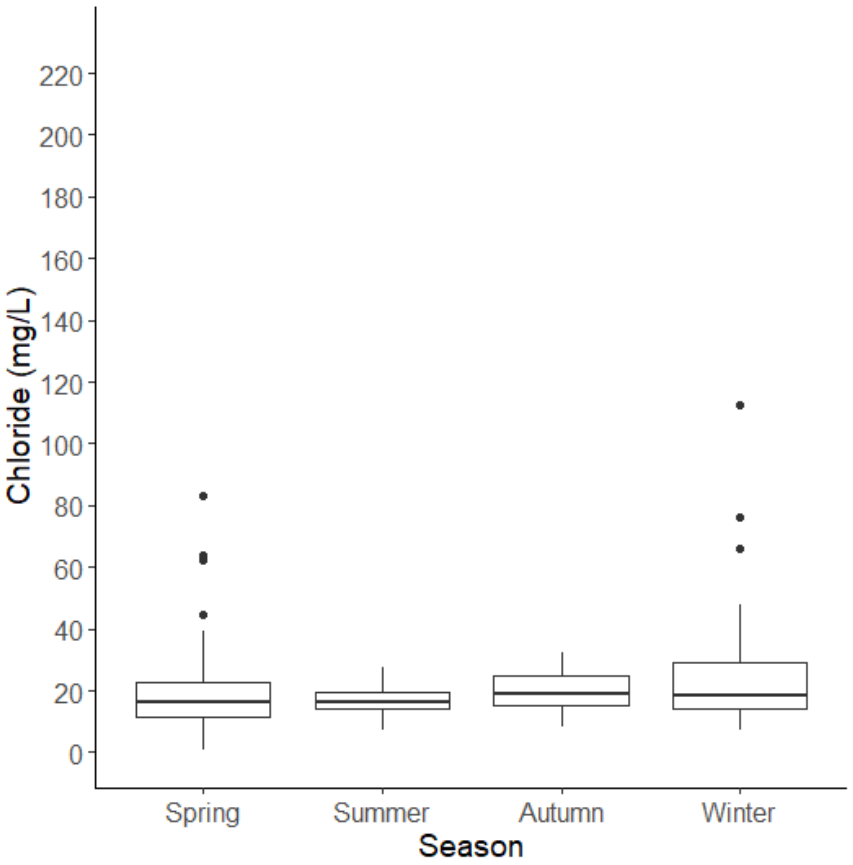
- Analysis timeframe: 1992 to 2021
- Data averaged by month
- Scatterplots with LOESS curves for visualization
- Mann-Kendall analysis used to determine trend significance
- For parameters with large monthly gaps, visual representation only
- Discharge data from Point of Rocks USGS gage was used to flow correct when appropriate

Results

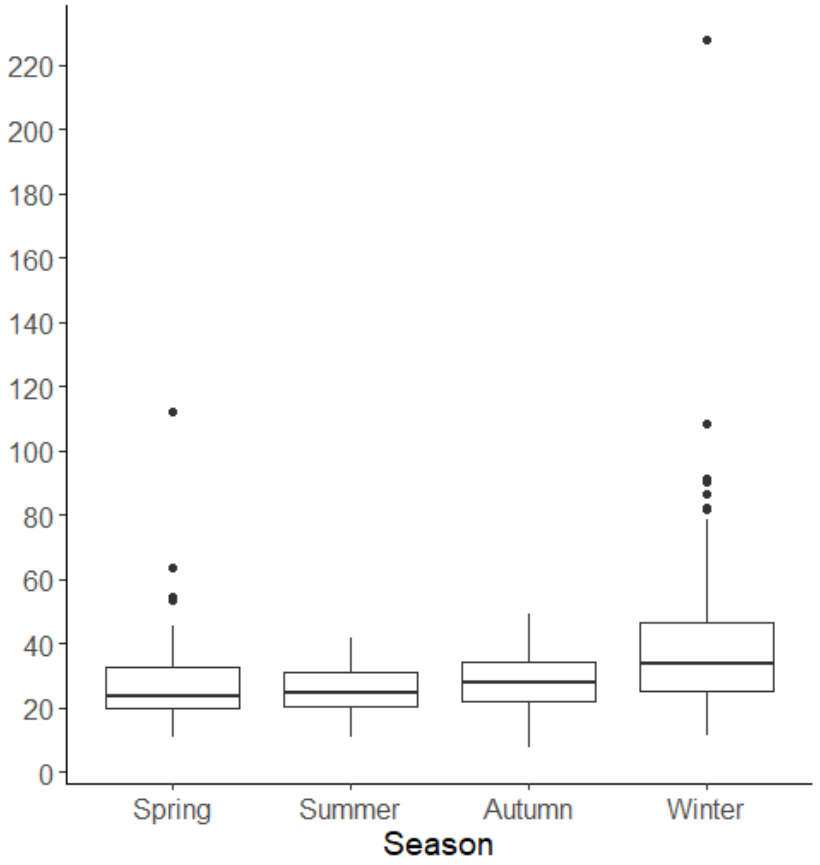
Water Supplier Comparison – Monthly Chloride

Seasons
Spring: Mar, Apr, May
Summer: Jun, Jul, Aug
Autumn: Sep, Oct, Nov
Winter: Dec, Jan, Feb

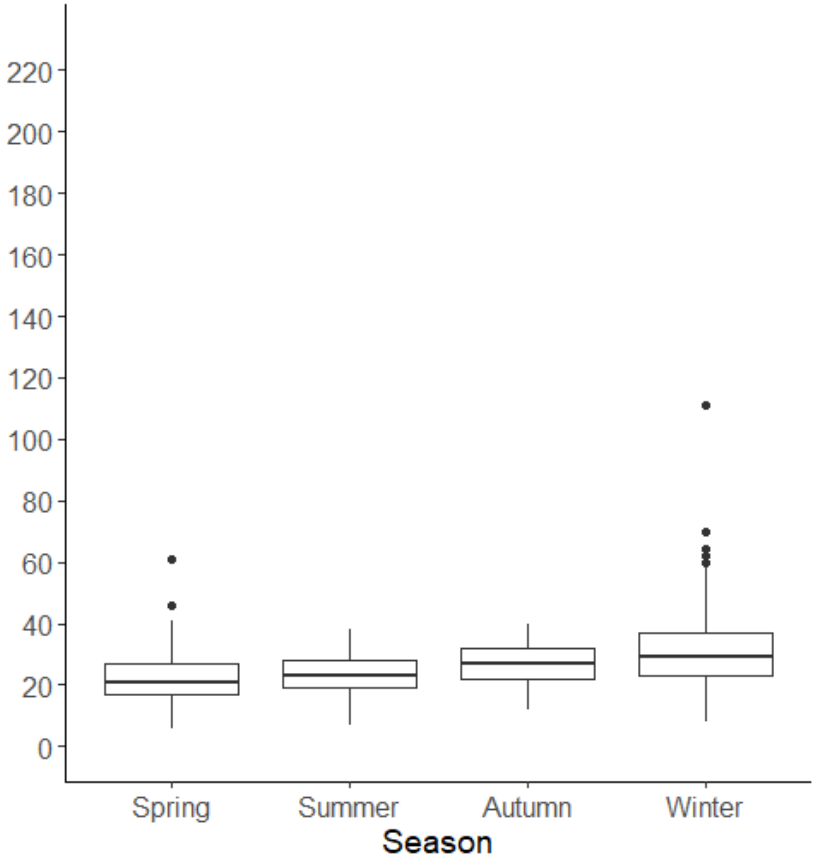
Fairfax Water



WSSC Water



Washington Aqueduct

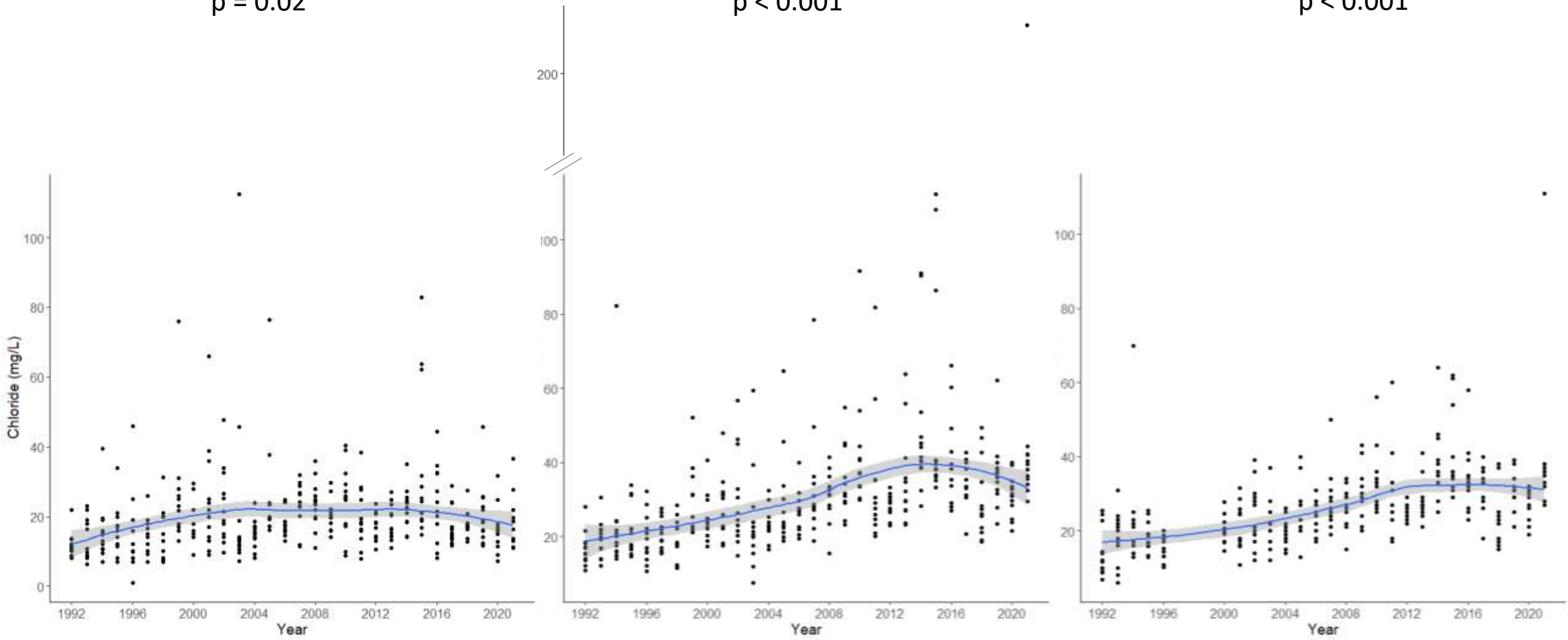


Water Supplier Comparison – Chloride (No Flow Correction)

Fairfax Water
p = 0.02

WSSC Water
p < 0.001

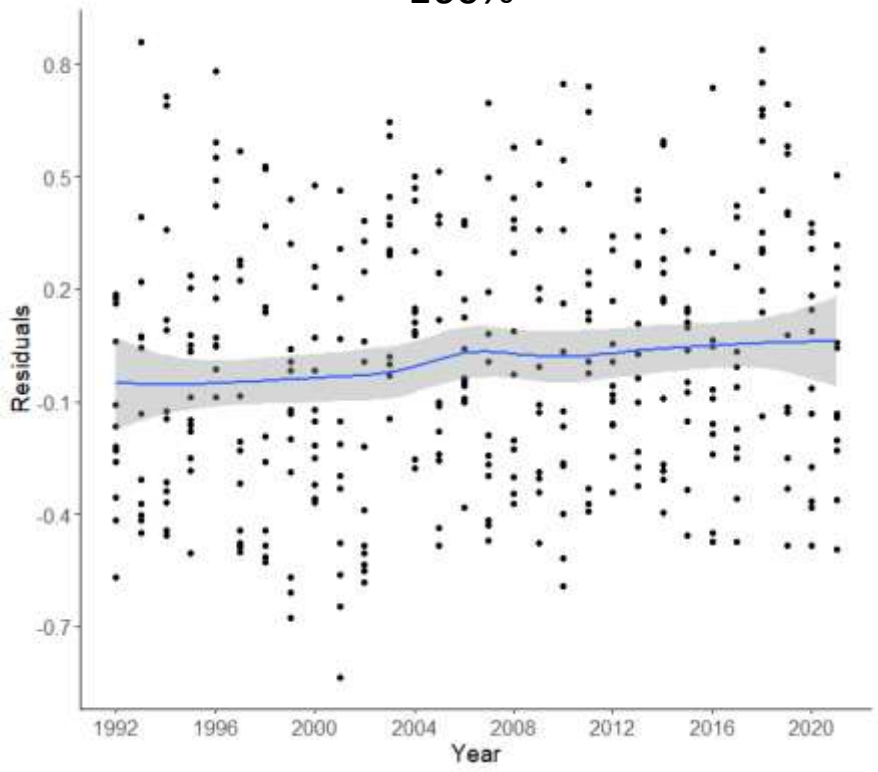
Washington Aqueduct
p < 0.001



Water Supplier Comparison – Chloride (Flow Corrected)

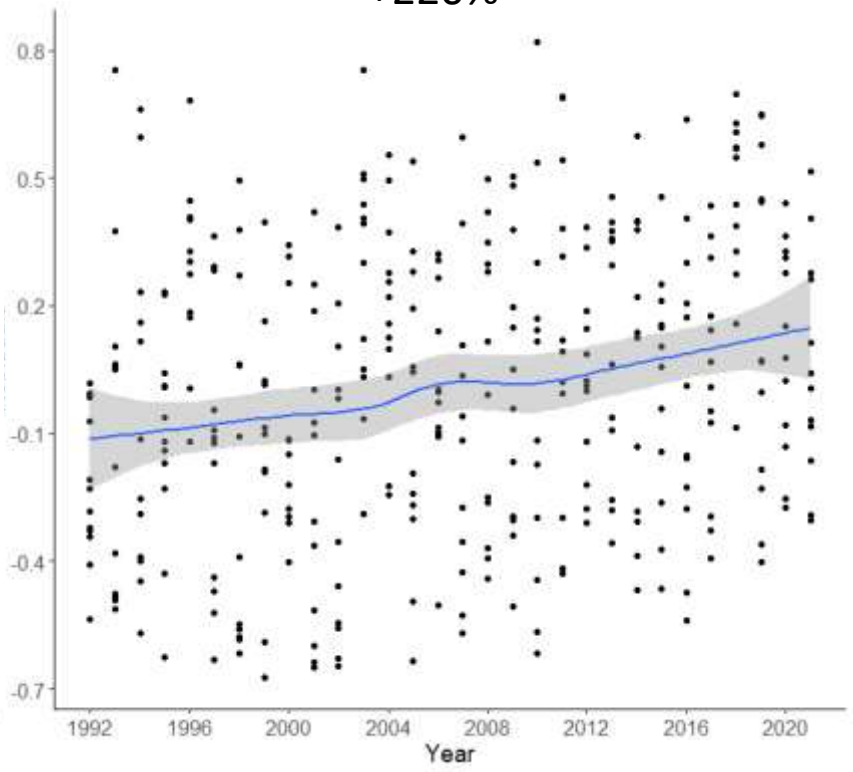
Fairfax Water
p = 0.01

~ +160%



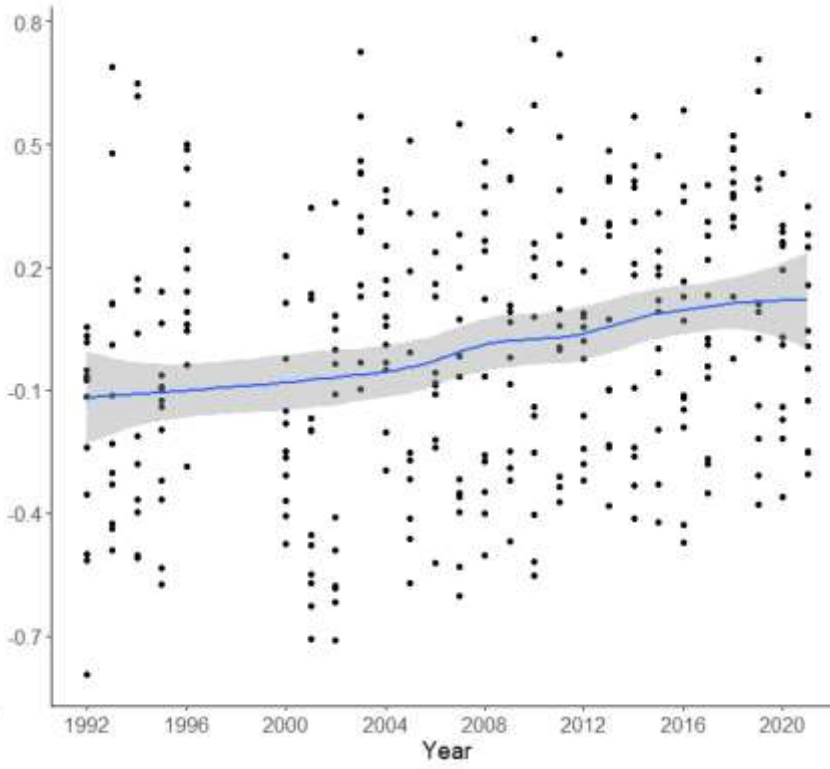
WSSC Water
p < 0.001

~ +220%



Washington Aqueduct
p < 0.001

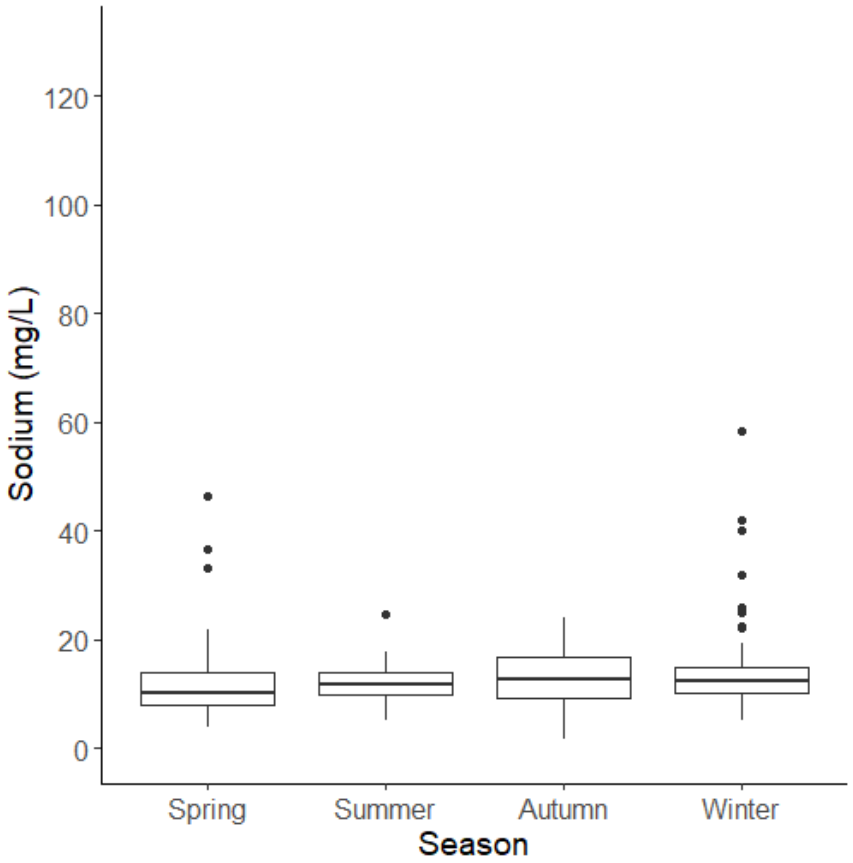
~ +200%



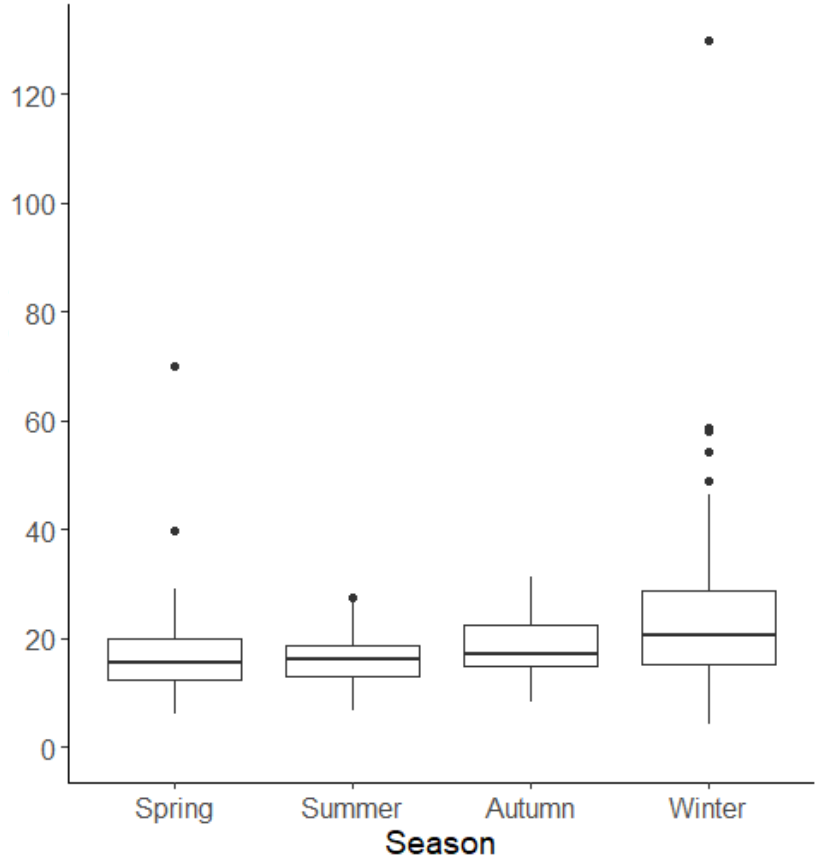
Water Supplier Comparison – Monthly Sodium

Seasons
Spring: Mar, Apr, May
Summer: Jun, Jul, Aug
Autumn: Sep, Oct, Nov
Winter: Dec, Jan, Feb

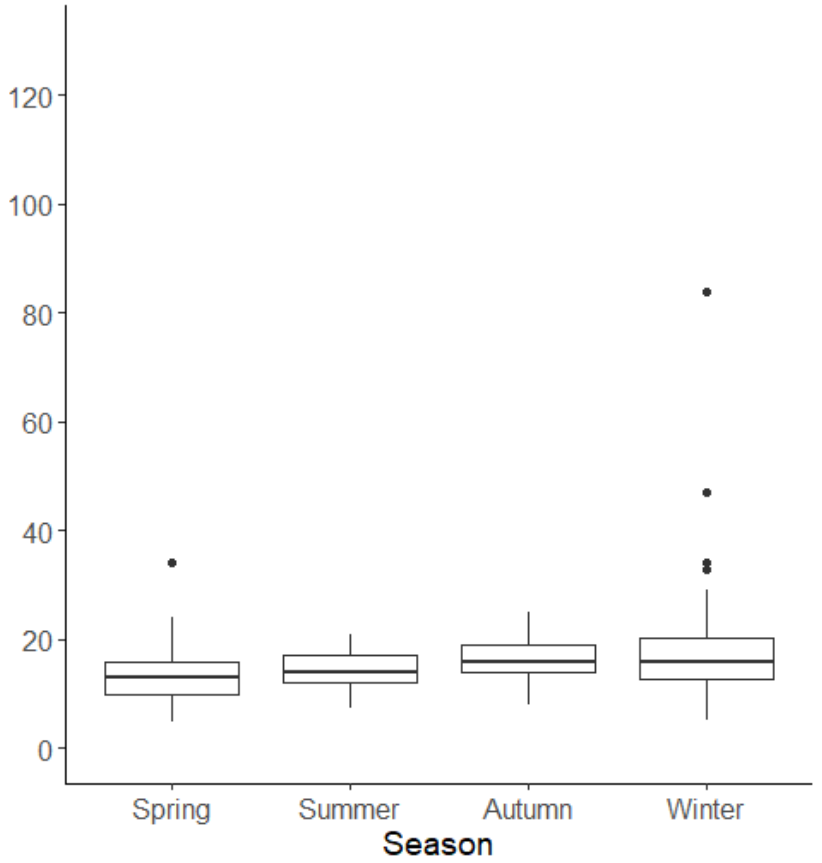
Fairfax Water



WSSC Water



Washington Aqueduct



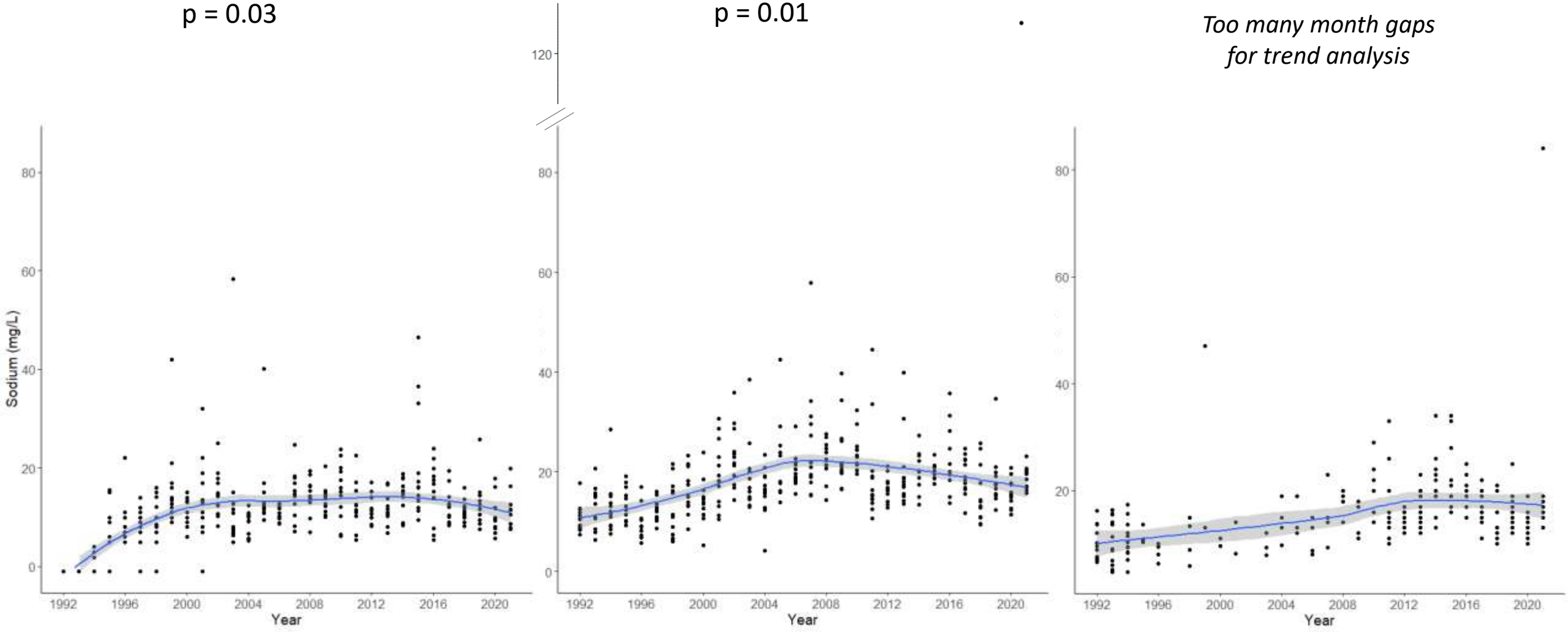
Water Supplier Comparison – Sodium (No Flow Correction)

Fairfax Water
p = 0.03

WSSC Water
p = 0.01

Washington Aqueduct

Too many month gaps for trend analysis



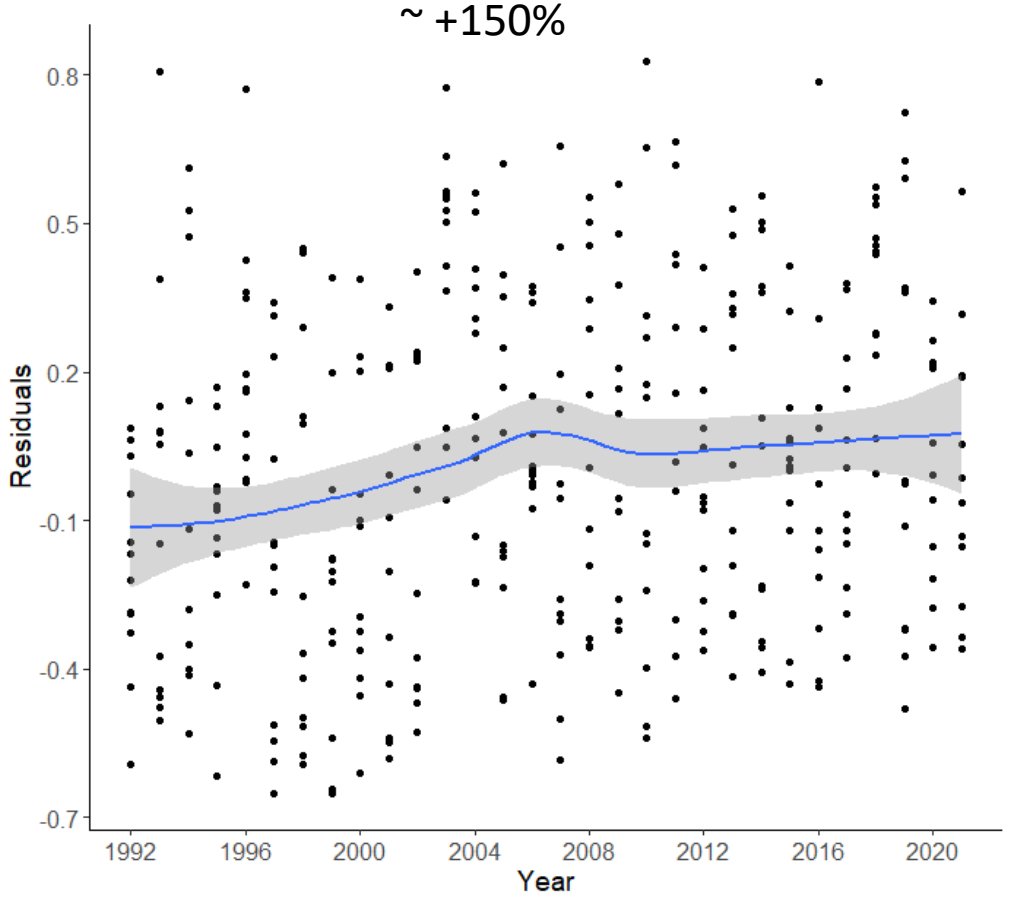
Water Supplier Comparison – Sodium (Flow Corrected)

Fairfax Water

Flow correction method used not appropriate for censored data

WSSC Water
p = 0.001

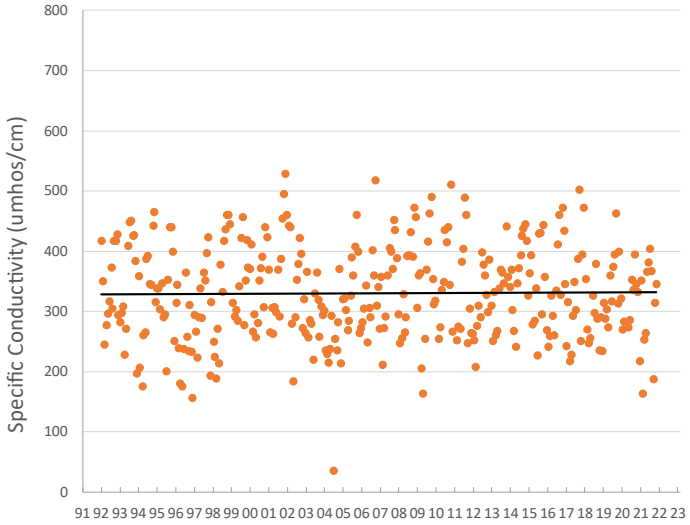
~ +150%



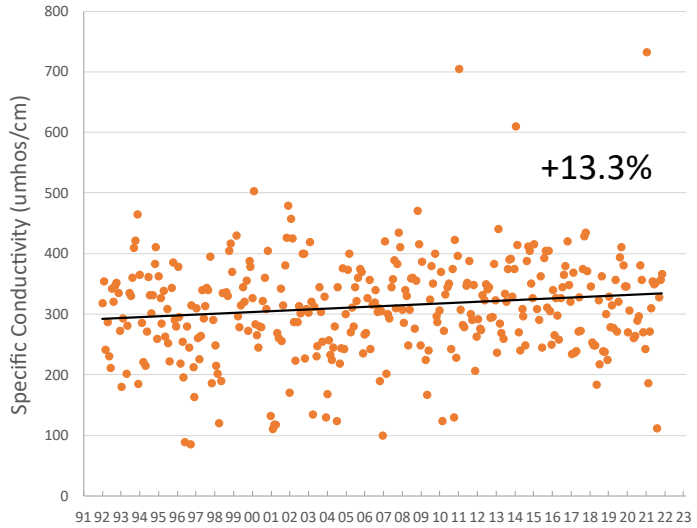
Washington Aqueduct

Too many month gaps for trend analysis

No trend in Specific Conductivity at Point of Rocks...



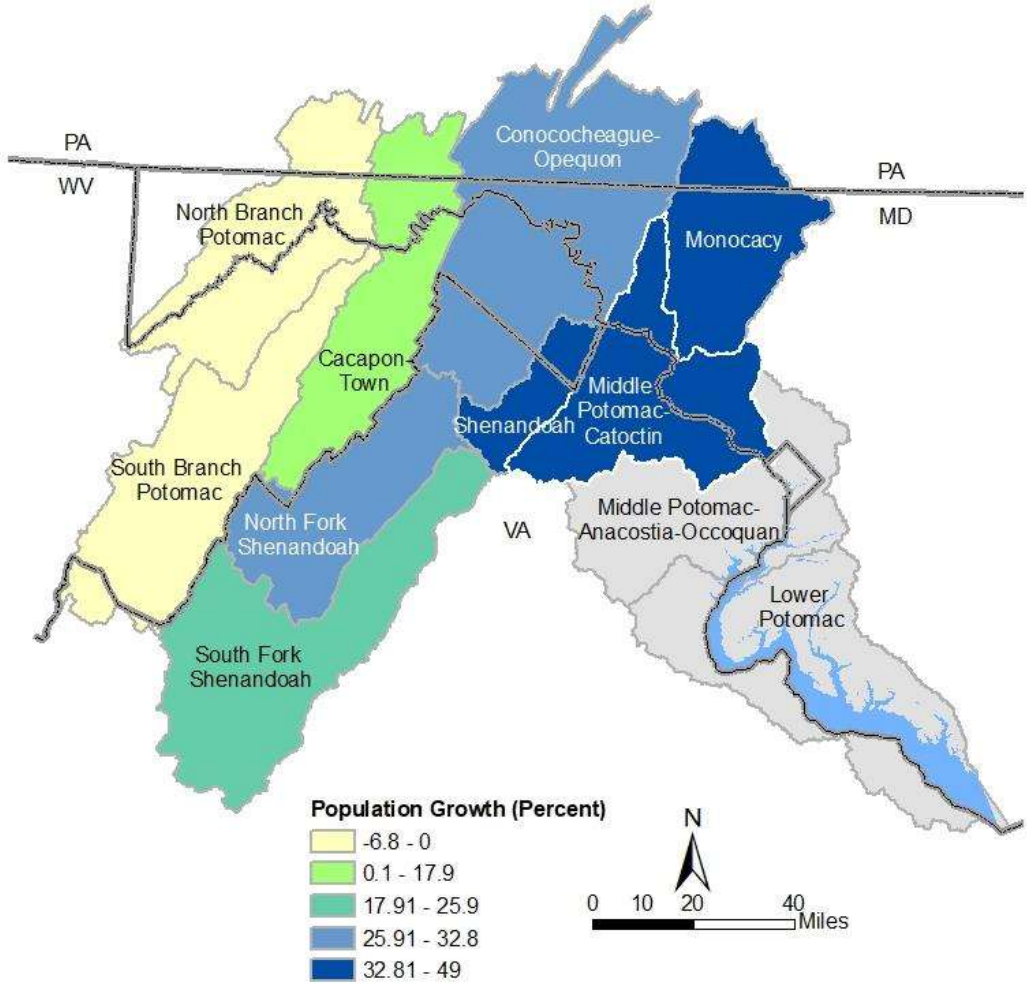
...and a significant increasing trend at Little Falls



Maryland Core/Trend monitoring data for POT1595 (POR) and POT1184 (LF)

Population Growth Upstream of Intakes, 2000-2020

HUC8	2000 Population	2020 Population	Change in Population
South Branch Potomac	31,054	30,127	-2.98%
North Branch Potomac	115,056	107,165	-6.86%
Cacapon-Town	27,176	30,002	10.40%
South Fork Shenandoah	225,881	266,428	17.95%
North Fork Shenandoah	71,605	90,167	25.92%
Shenandoah	49,379	72,202	46.22%
Conococheague-Opequon	437,932	567,505	29.59%
Monocacy	261,125	346,912	32.85%
Middle Potomac-Catoctin	845,938	1,219,850	44.20%
Total	**2,065,146**	**2,730,358**	**32.21%**



Opportunities for Future Research

Additional Research Questions

- What are the relative positions and flow rates of permitted discharges and drinking water intakes?
- What is the relationship between tributary flow and salt concentrations at drinking water intakes?
- To what extent do stormwater and runoff affect salinity?
- How do river geography and morphology influence salt concentrations?

Additional Research Questions

- Is there a significant correlation between increasing salinity and increasing urbanization, as indicated by changes in:
  - population
  - impervious surface
  - forest and tree cover
- In addition to winter salt programs implemented by Maryland and Virginia, what programs or actions are needed to reverse the trend of increasing salinity in the Potomac River?

Acknowledgements

- Raw water data were provided by Washington Aqueduct, WSSC Water, and Fairfax Water
- Funding: EPA Region 3
- Photo credit: ICPRB