Trends in Water Quality in the Kiskiminetas River System

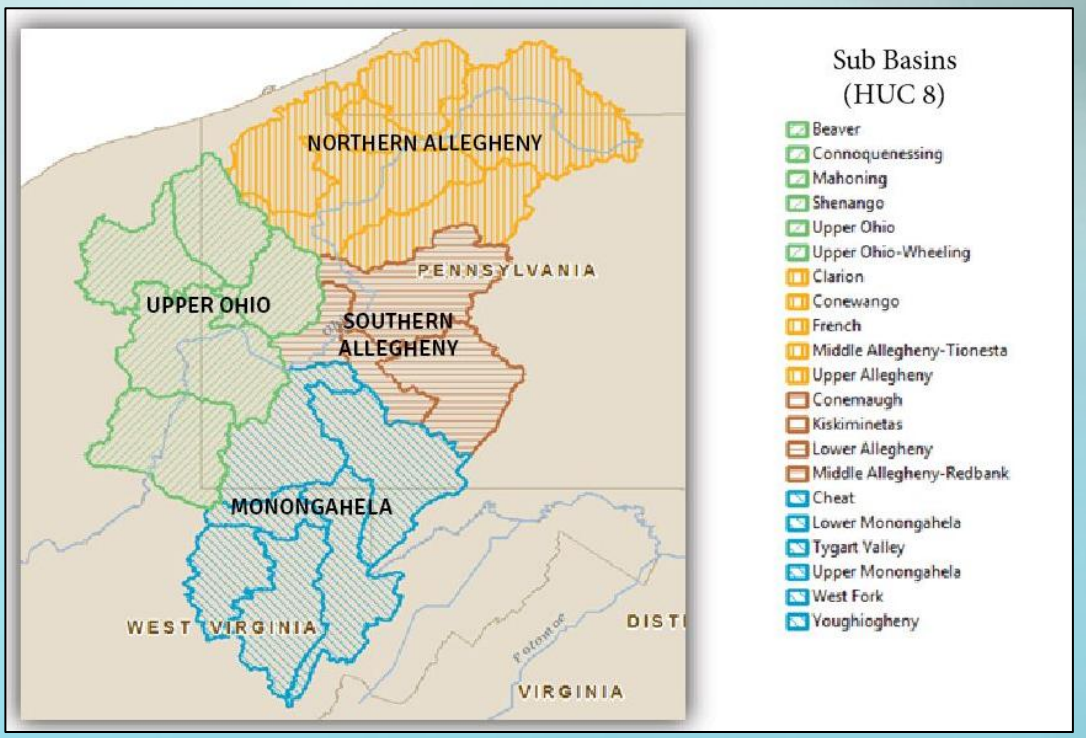
Beth Dakin
Duquesne University

3 Rivers QUEST

- "Quality Useful Environmental Study Teams"
- Researchers and citizen based groups
- Data available at 3riversquest.wvu.edu
- West Virginia Water Research Institute
  - Mon River QUEST started in 2009
- Expanded to Upper Ohio River Basin in 2013
  - Funded by the Colcom Foundation

3 Rivers QUEST Sampling

- >40 sites sampled monthly across 25,000mi^2 and 5 states
- Monongahela River
- Ohio River
- Upper Allegheny River
- Lower Allegheny River- Duquesne University



Water Quality Issues in Western PA

- Historical Sources of Pollution
  - Industrial effluent - toxic chemicals
  - Stormwater runoff – road salt
  - Raw sewage - CSOs
  - Abandoned Mine Drainage (AMD)

- Destroyed fish and plant life
- Affected residents' ability to use streams
- Increase in Water quality due to SMCRA (1977) and CWA (1972)

Water Quality Issues in Western PA: Natural Gas Extraction

- Conventional and Unconventional Natural Gas Extraction
- Marcellus Shale- unconventional shale formation in PA
  - Utilize horizontal drilling and hydraulic fracturing technologies
- Rapid Growth in Unconventional Drilling
  - Before 2008- 20 wells in PA
  - In 2008, 200 drilled
  - In 2009, 800 drilled
  - By 2023, over 20,000 permitted in PA
- Biggest concern is wastewater disposal

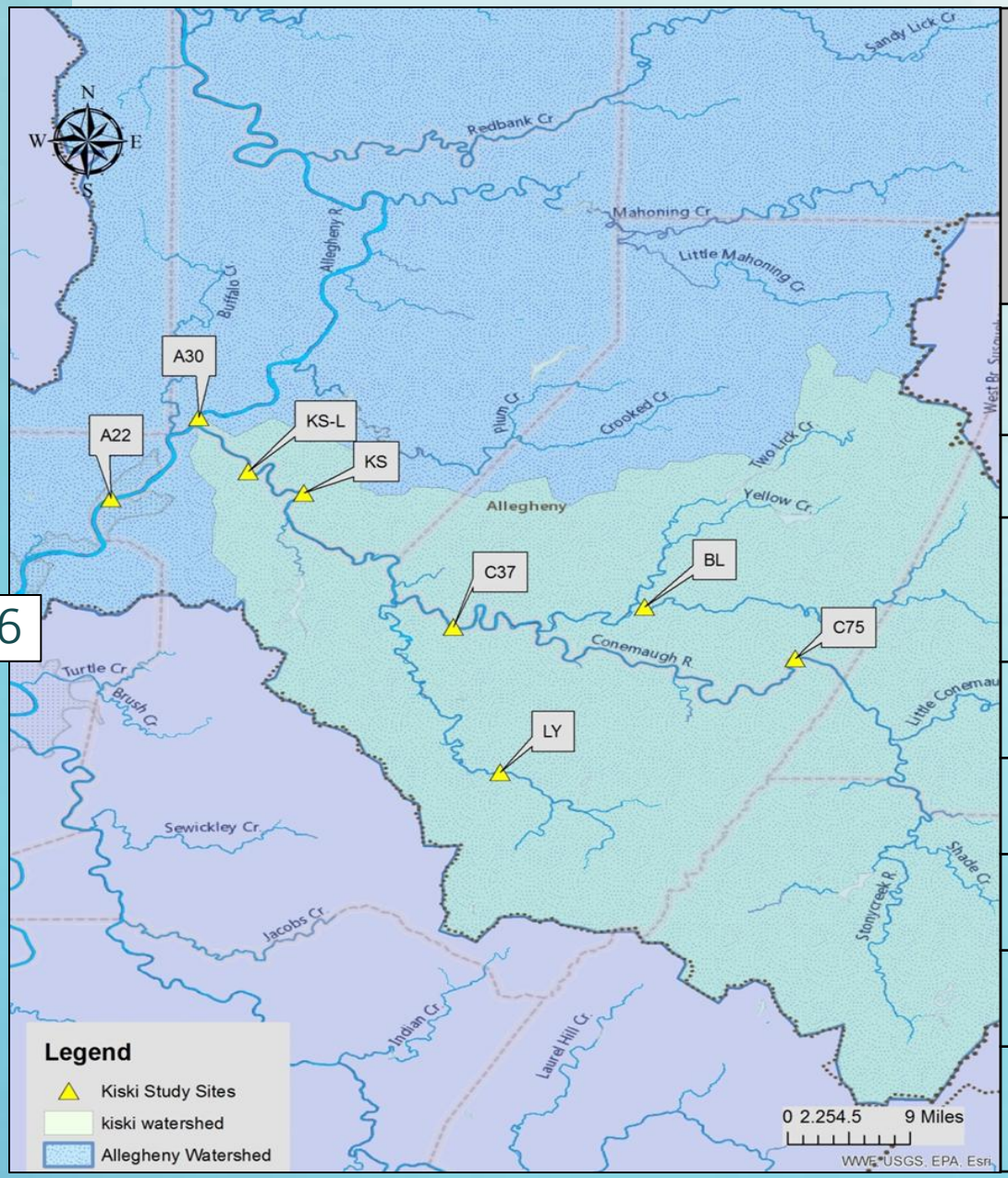
Water Quality Issues in Western PA: Unconventional Wastewater

- Requires large amounts of water
- Wastewater contains high concentrations of chemical additives, from the fracking fluid as well as naturally occurring brines and radioactive materials from the geological formation
- Challenge of Disposal
  - Deep well injections
  - Publically Owned Treatment Works (POTWs)
    - At first, POTWs accepted fracking wastewater
    - In 2011, the PADEP asked energy companies to voluntarily stop sending wastewater to POTWs due to their inability to remove the high levels of TDS, bromide, metals, and chloride
    - In 2016, the USEPA banned the practice
    - Most producers treat & reuse water and eventually dispose in injection wells

Water Quality Issues in the Kiskiminetas Watershed

- Active and Abandoned mines scatter throughout watershed
  - Extensive history of AMD problems
  - Decreasing since 1960s
  - Historically, 80% of the sulfate load of the Allegheny River came from the Kiski
- Road Salt and Salt brines used in all Counties within watershed
- Both conventional and Unconventional wells within Allegheny Watershed
  - Brine treatment facilities within Kiskiminetas system

Sampling Sites

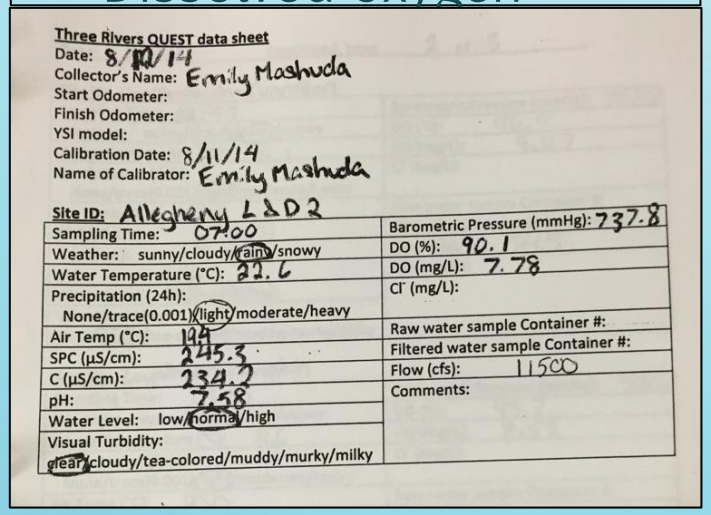


Original Site (Sampled Jan-Dec 2013)	Current Site (sampled since January 2014)	Site Code
Allegheny River at L&D5		A30
	All-Tarentum	A22
Allegheny River at L&D 2		A6
Loyalhanna-Kingston		LY
Conemaugh-Seward		C75
Blacklick-Josephine		BL
Conemaugh-Tunnelton		C37
Kiskiminetas-Vandergrift	Kiskiminetas-Leechburg	KS (-L)

3 Rivers QUEST Data Collected

On Site Measurements

- pH
- Specific Conductance
- Air Temperature
- Water Temperature
- Dissolved oxygen



Three Rivers QUEST data sheet
Date: 8/11/14
Collector's Name: Emily Mashuda
Start Odometer:
Finish Odometer:
YSI model:
Calibration Date: 8/11/14
Name of Calibrator: Emily Mashuda

Site ID: Allegheny L&D 2

Sampling Time: 0700	Barometric Pressure (mmHg): 737.8
Weather: sunny/cloudy/rainy/snowy	DO (%): 90.1
Water Temperature (°C): 22.6	DO (mg/L): 7.78
Precipitation (24h): None/trace(0.001)/light/moderate/heavy	Cl⁻ (mg/L):
Air Temp (°C): 19	Raw water sample Container #:
SPC (µS/cm): 245.3	Filtered water sample Container #:
C (µS/cm): 234.2	Flow (cfs): 11500
pH: 7.58	Comments:
Water Level: low/normal/high	
Visual Turbidity: clear/cloudy/tea-colored/muddy/murky/milky	

Certified Lab Measurements

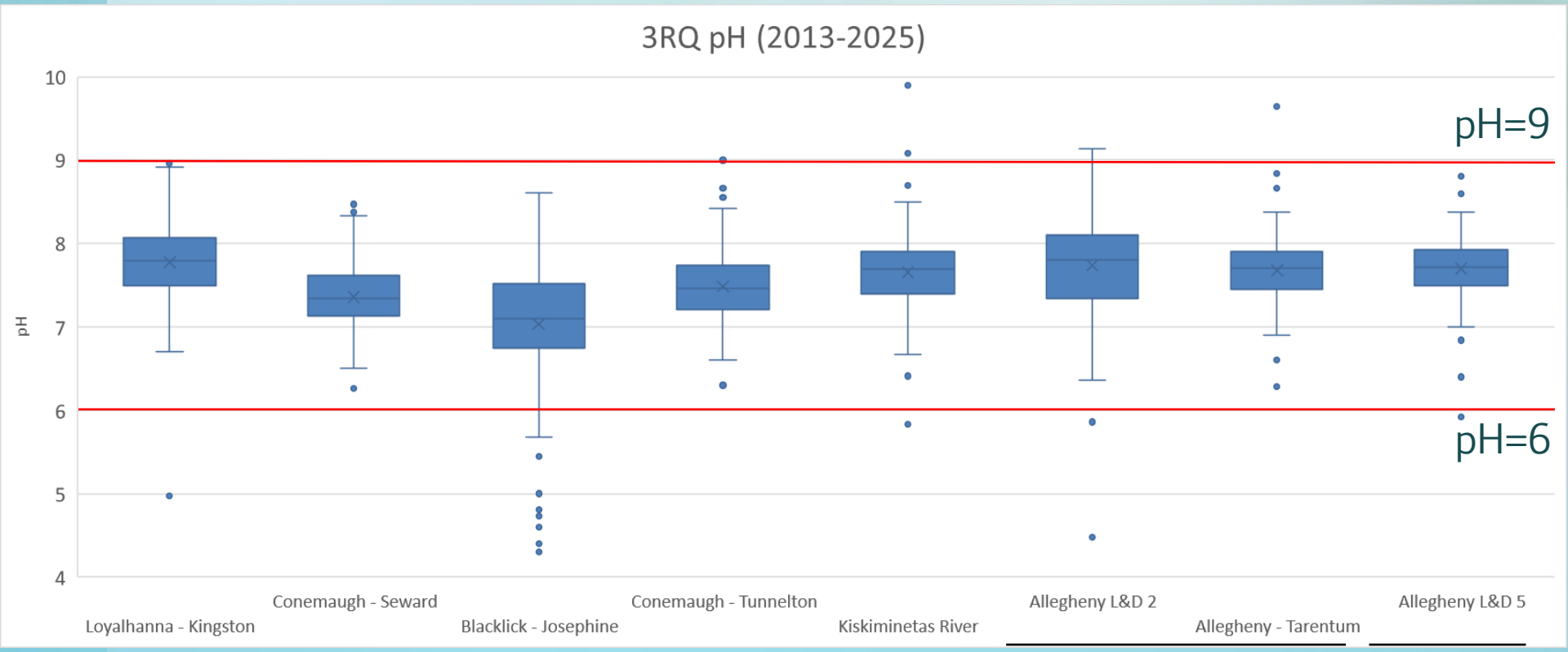
- pH, Acidity, Alkalinity
- Total Dissolved Solids
- Total Suspended Solids
- Dissolved metals:
  - Aluminum
  - Calcium
  - Iron
  - Manganese
  - Magnesium
  - Sodium
  - Strontium
- Anions:
  - Bromide
  - Chloride
  - Sulfate

Methods: Data Analysis

- Parameter Concentrations/Levels
  - 3RQ data (2013-2025) and historic data retrieved from EPA STORET (1950-1998)
  - pH, TDS, sulfate, aluminum, chloride, bromide
- Ratios of Parameters
  - Br/Cl : SO_4/Cl
  - Ca/Mg : Ca/Sr

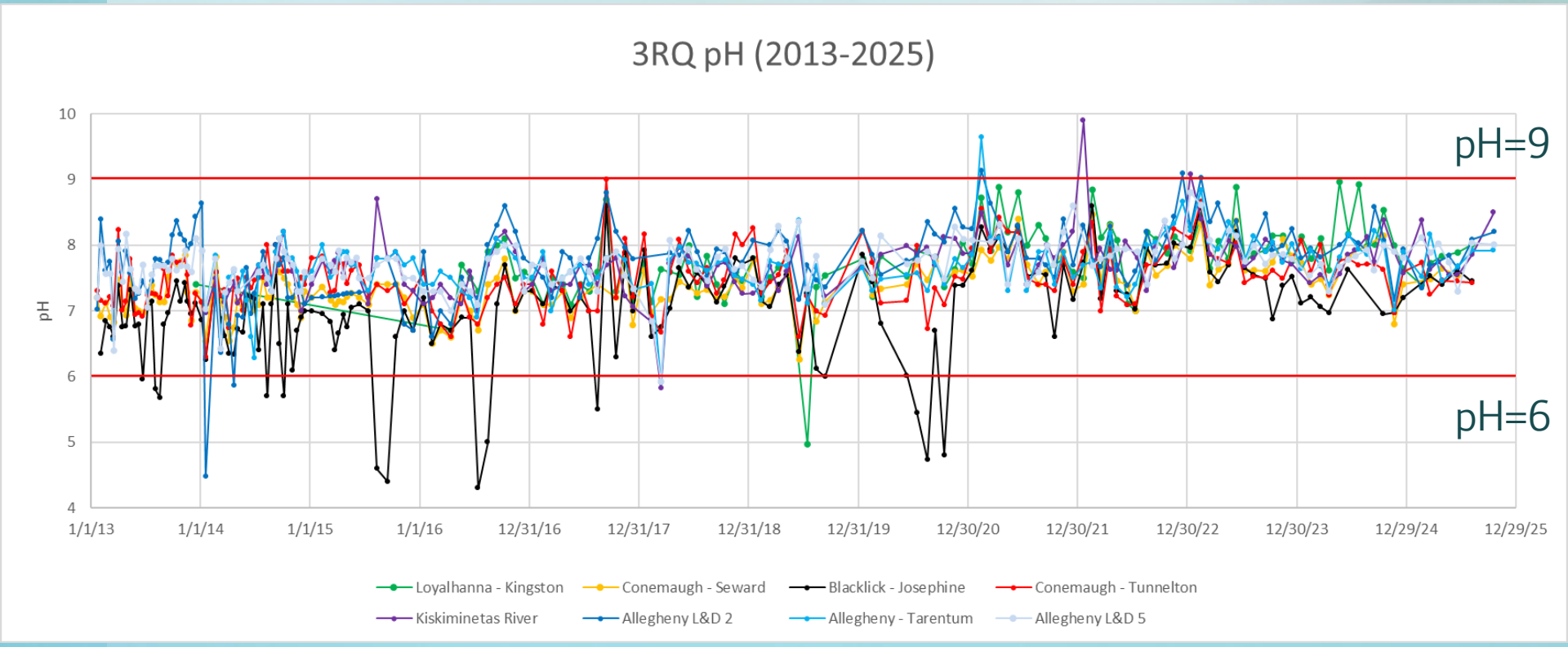
Associated Pollutants	AMD	Road Salt	Unconventional Wastewater/ Treatment plant effluent
Sulfate (SO_4)	×		×
Iron (Fe)	×		
Magnesium (Mg)		×	×
Manganese (Mn)	×		
Aluminum (Al)	×		
Acidity	×		
Total Dissolved Solids (TDS)	×	×	×
Bromide (Br)			×
Chloride (Cl)		×	×
Strontium (Sr)			×
Calcium (Ca)		×	×
Sodium (Na)		×	×

pH



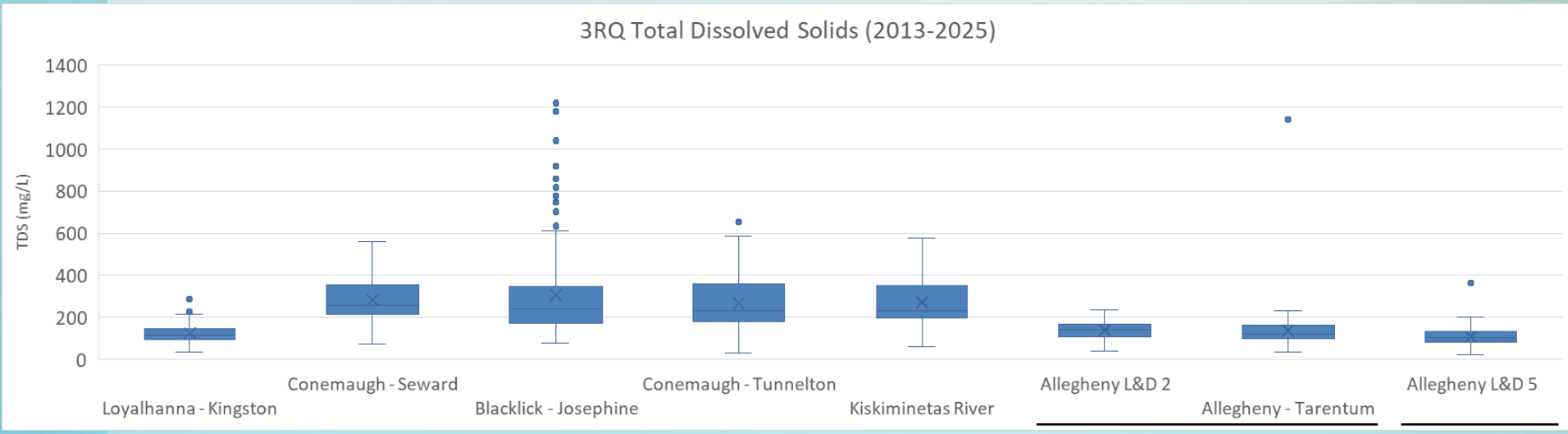
- WWF and TSF uses require pH 6-9
- Blacklick lowest pH
  - 13 data points below pH=6, 6 outliers
- Several other sites also had outliers <6, and two sites had pH>9

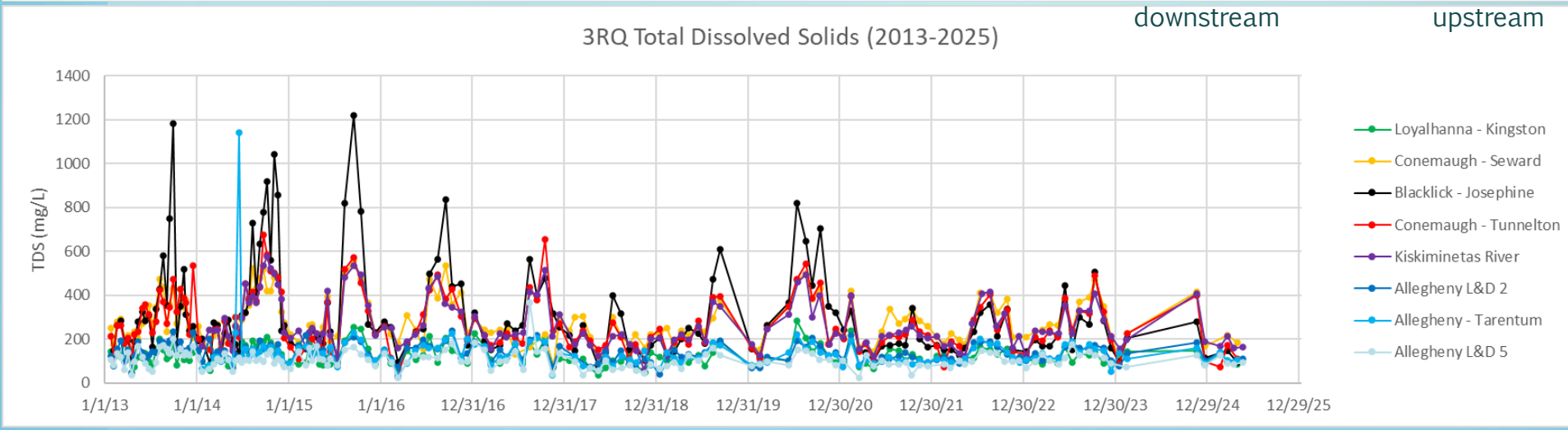
pH



- Slight increase in pH values over time
- Blacklick hasn't had any pH<6 since 2020, so maybe that's a sign of improvement

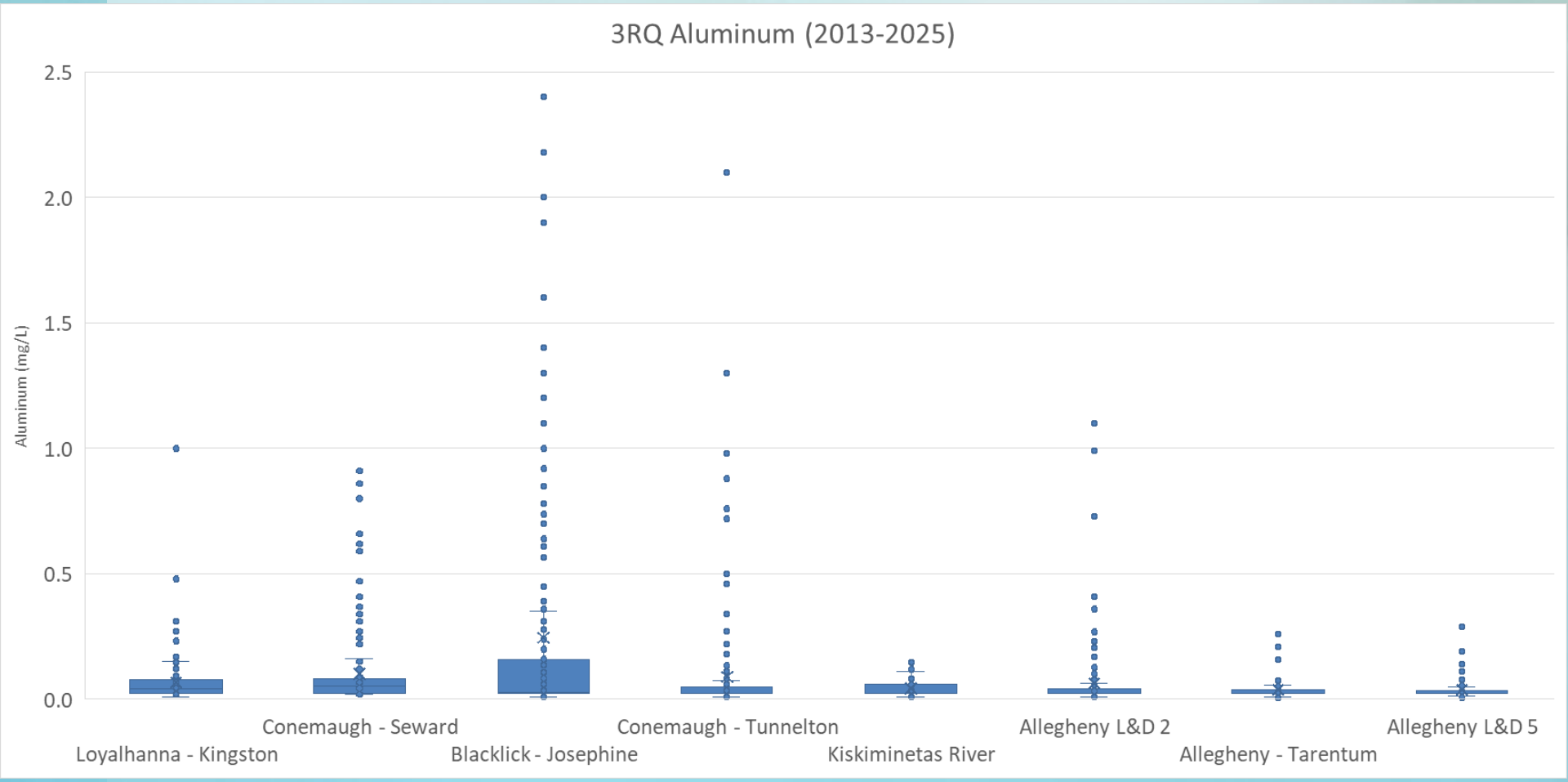
Total Dissolved Solids (TDS)





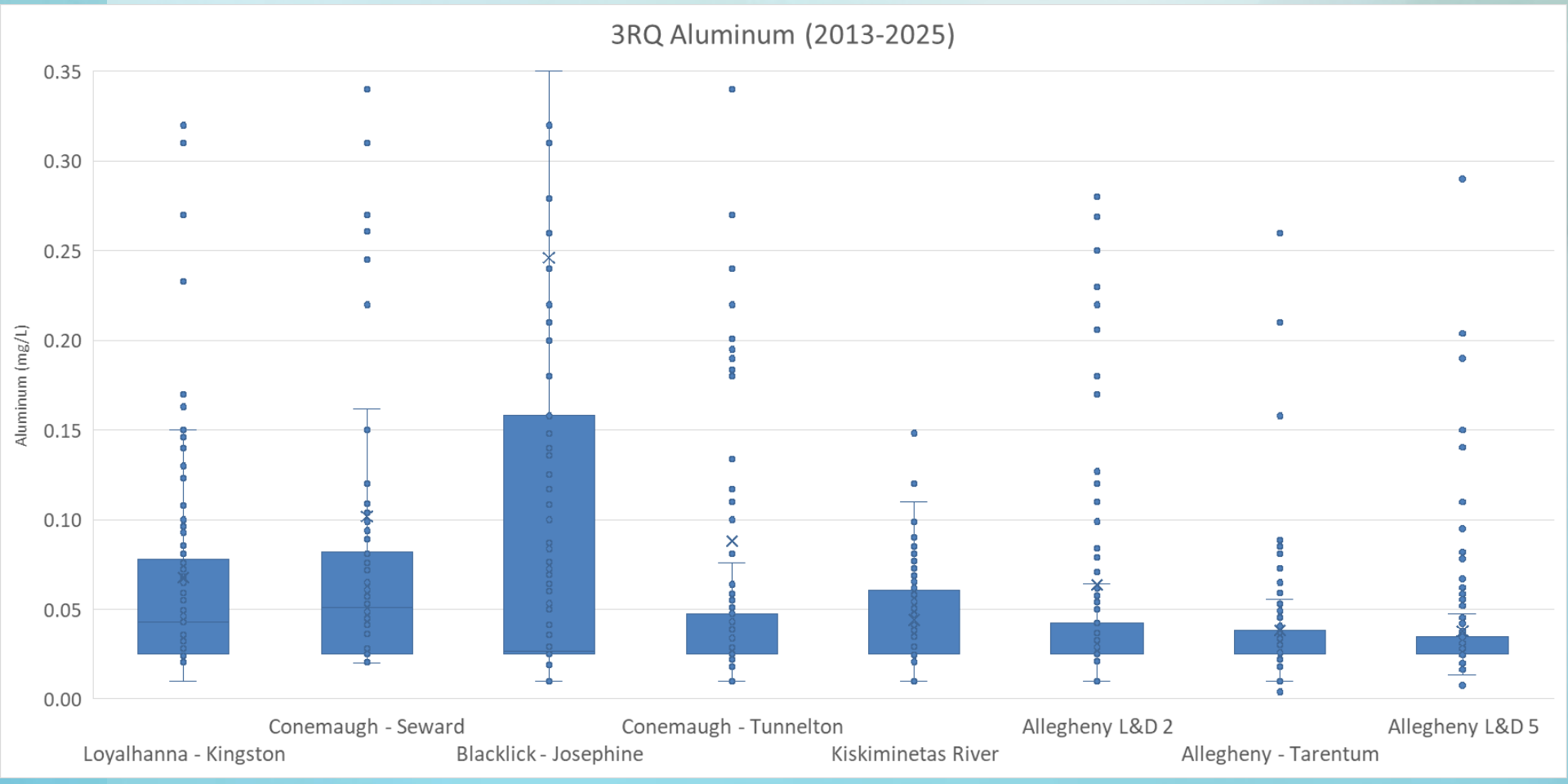
- TDS is fairly high (>200 mg/L) in all Kiski sites except for Loyalhanna-Kingston
  - Maybe decreasing since 2020?
- The Kiski River appears to be a source of TDS in the Allegheny River

Aluminum



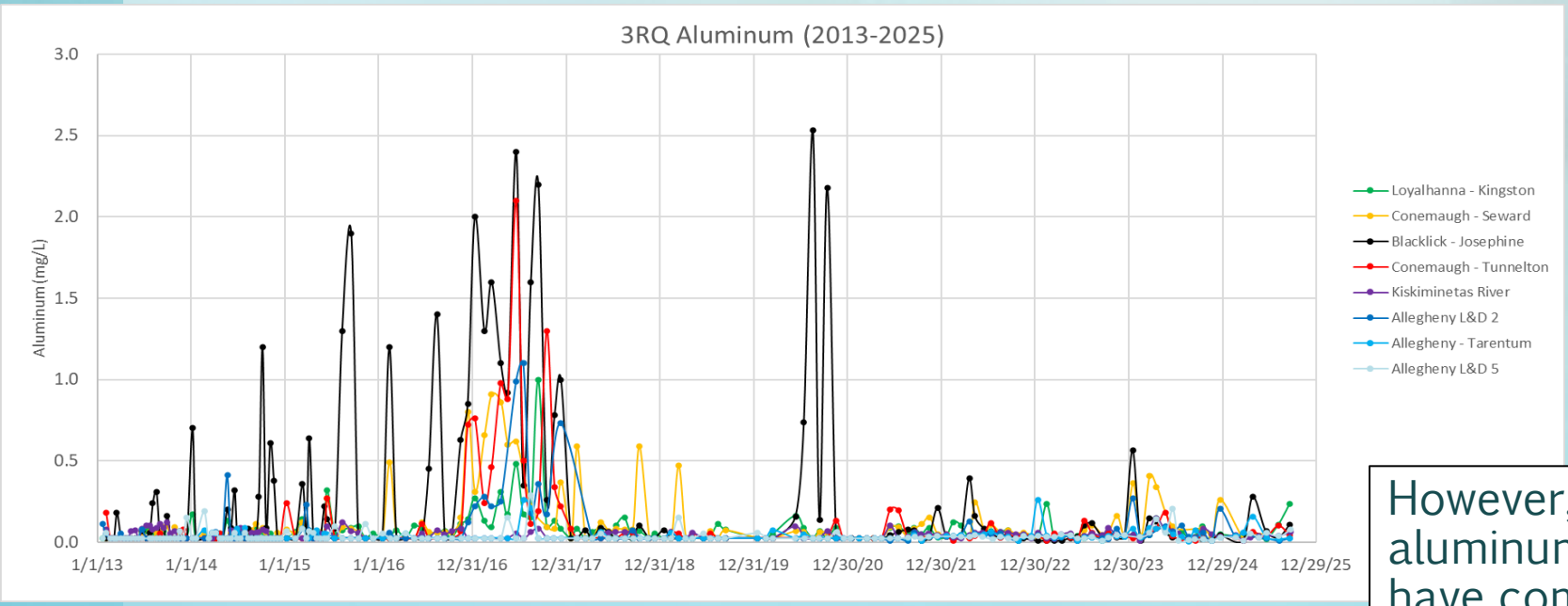
That's all the aluminum data, but let's zoom in a little…..

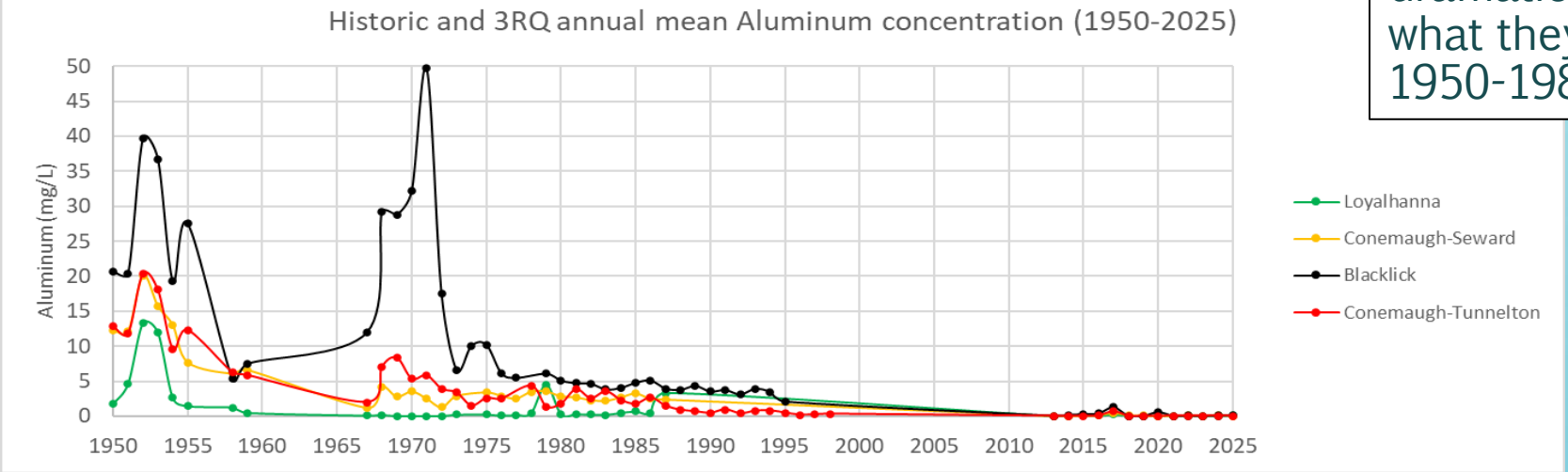
Aluminum



- In the 3RQ data from 2013-2025, Blacklick, Con-Seward and Con-Tunnelton have more aluminum

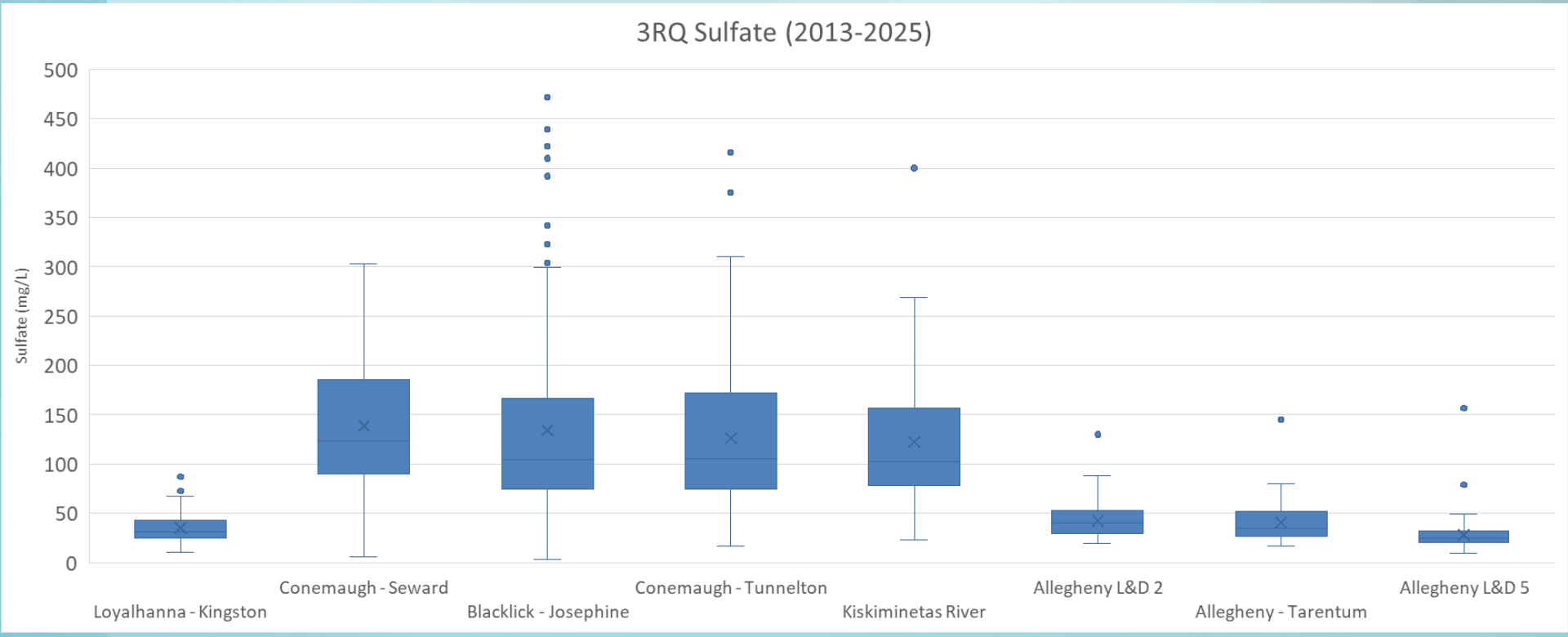
Aluminum





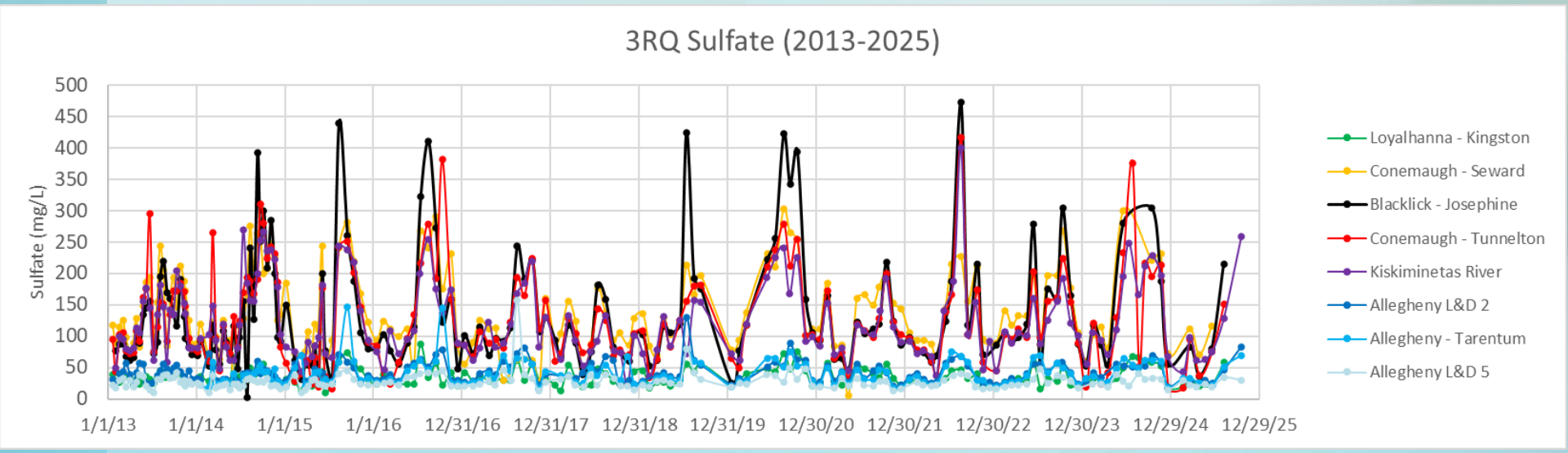
However, average aluminum levels have come down dramatically from what they were in 1950-1980

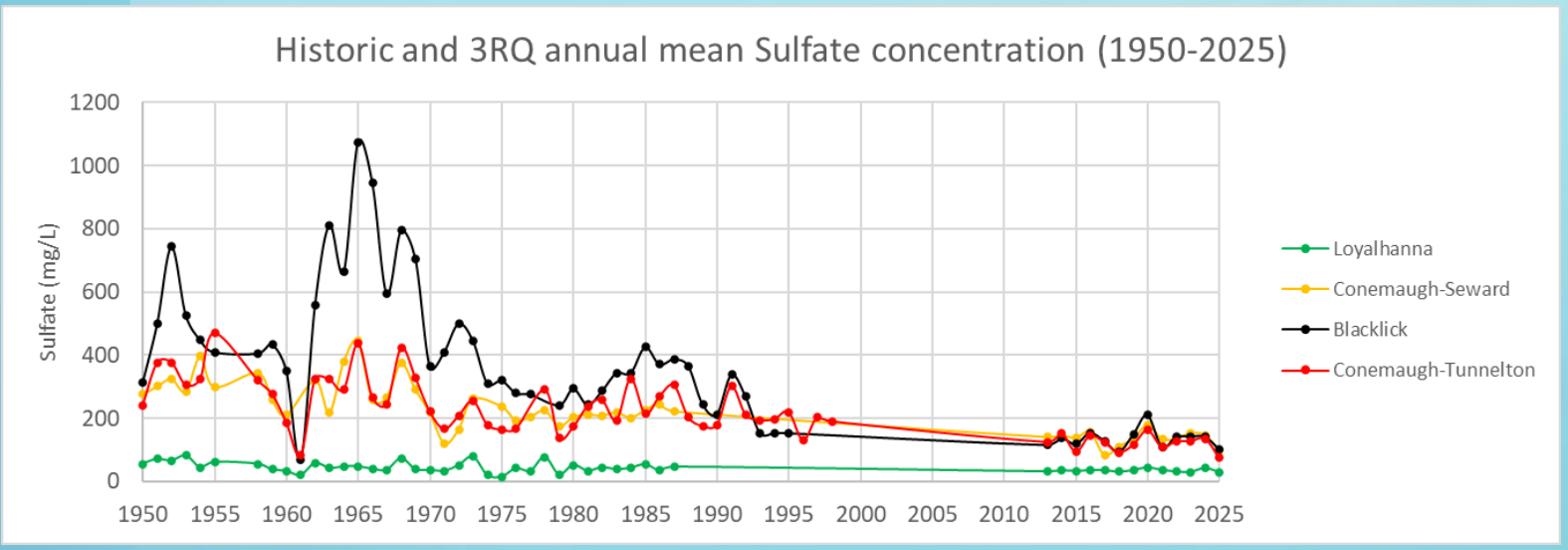
Sulfate



- All Kiski sites but Loyalhanna have higher sulfate levels compared to the Allegheny River

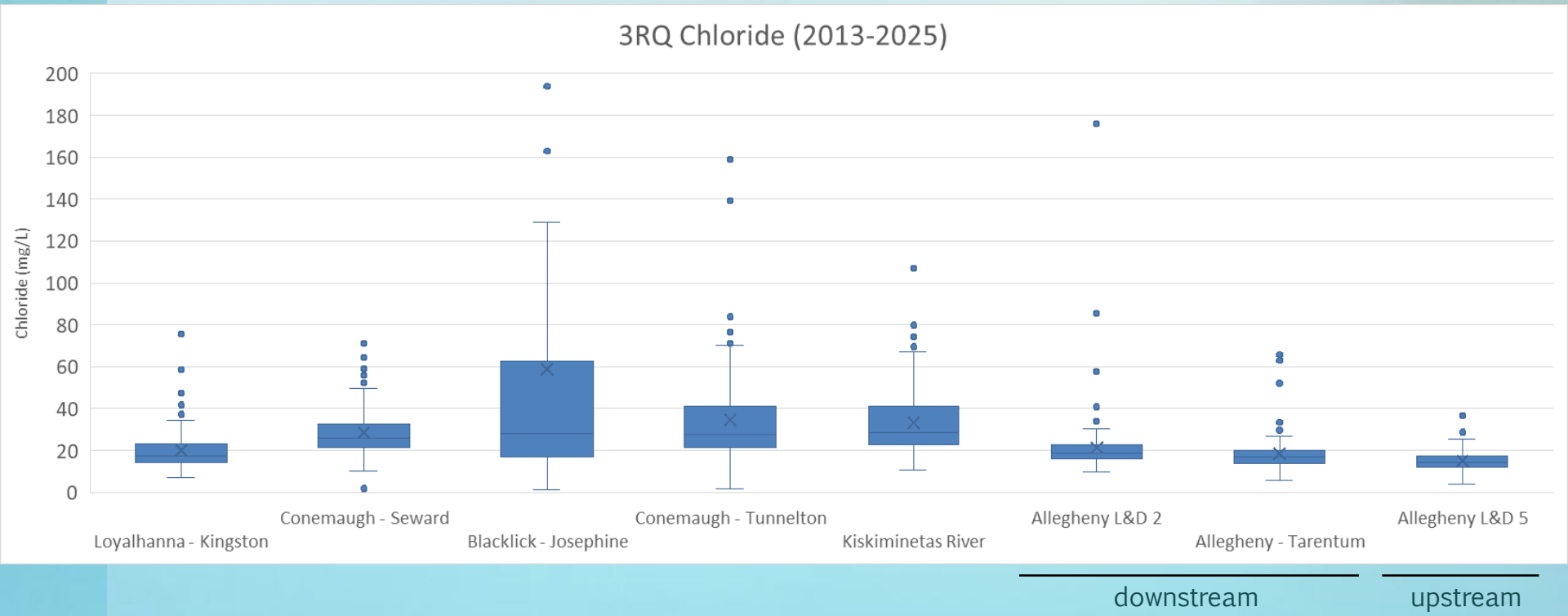
Sulfate





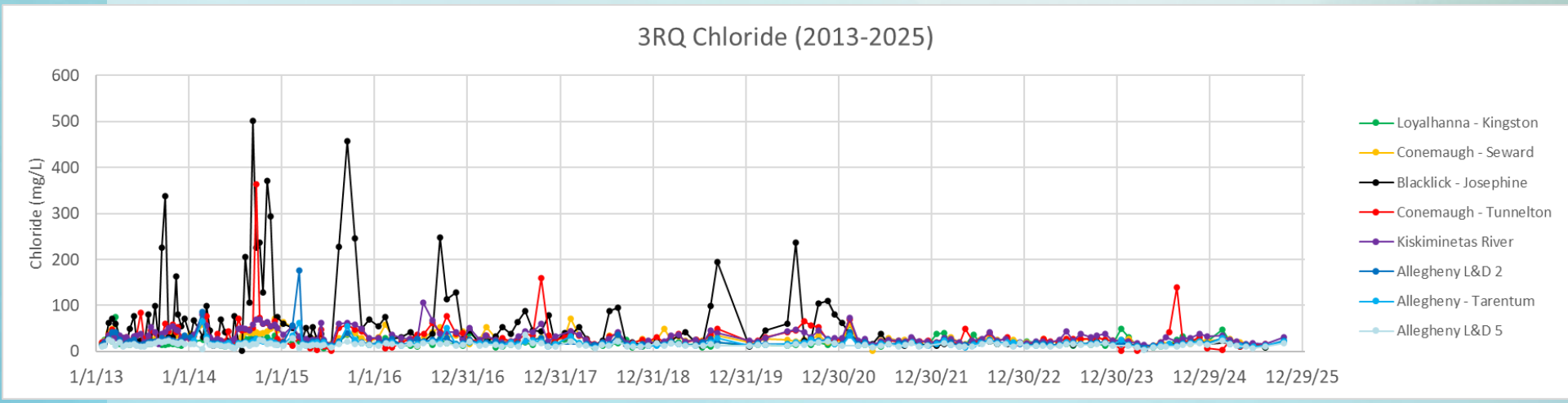
In recent years (2013-2025), sulfate levels are stable, but they have fallen significantly since 1950-1990

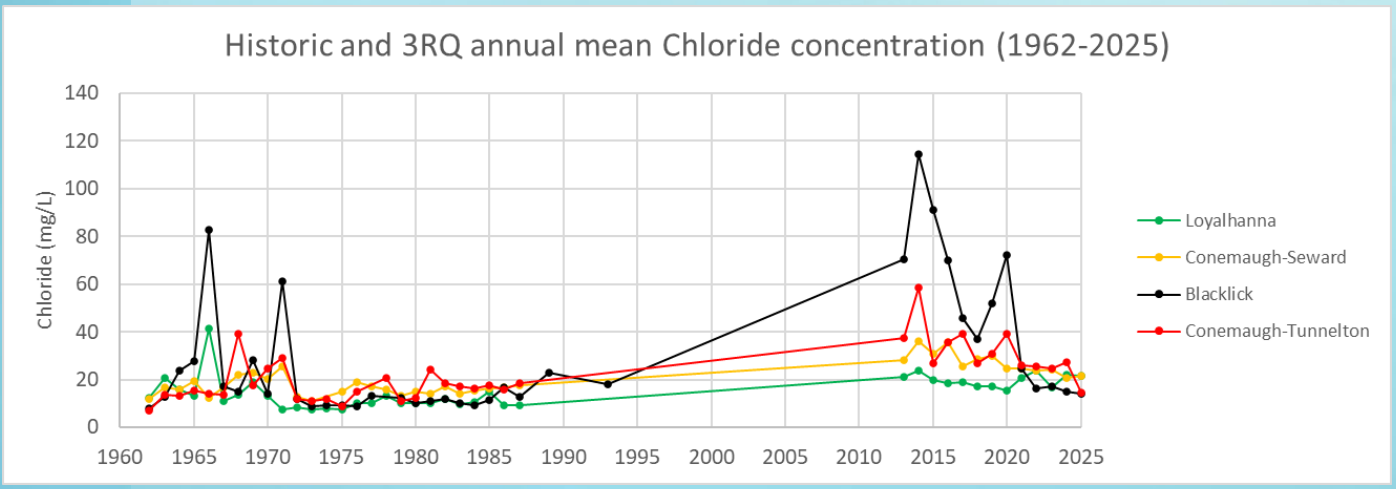
Chloride



- Highest in Blacklick, Con-Tunnelton, Con-Seward, and Kiski
  - Somewhat lower in upstream Loyalhanna
- The Kiski system seems to be a source of chloride in the Allegheny River

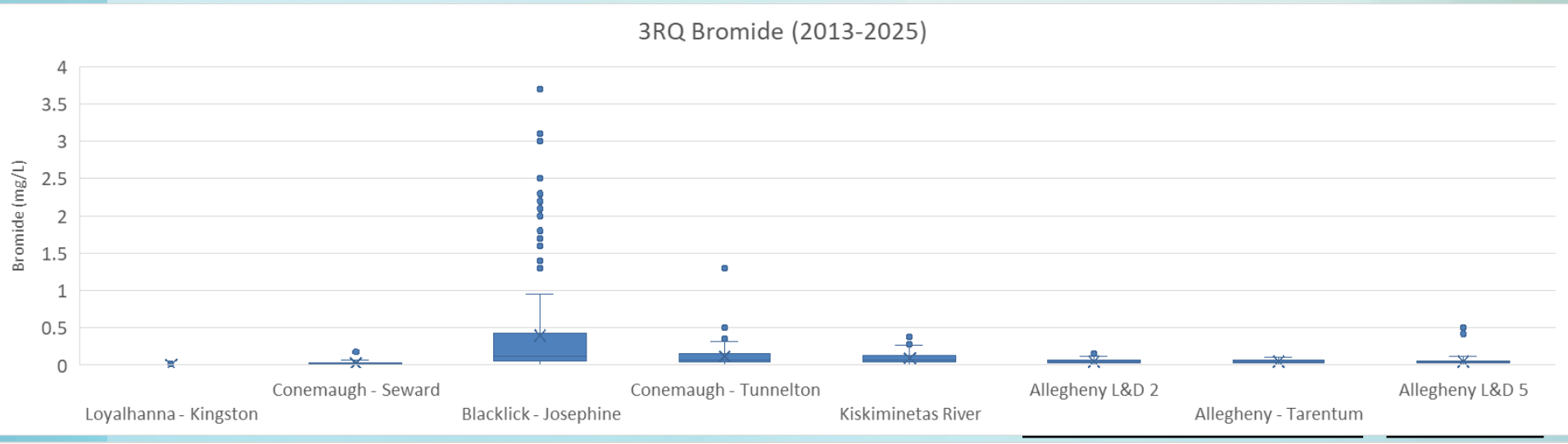
Chloride

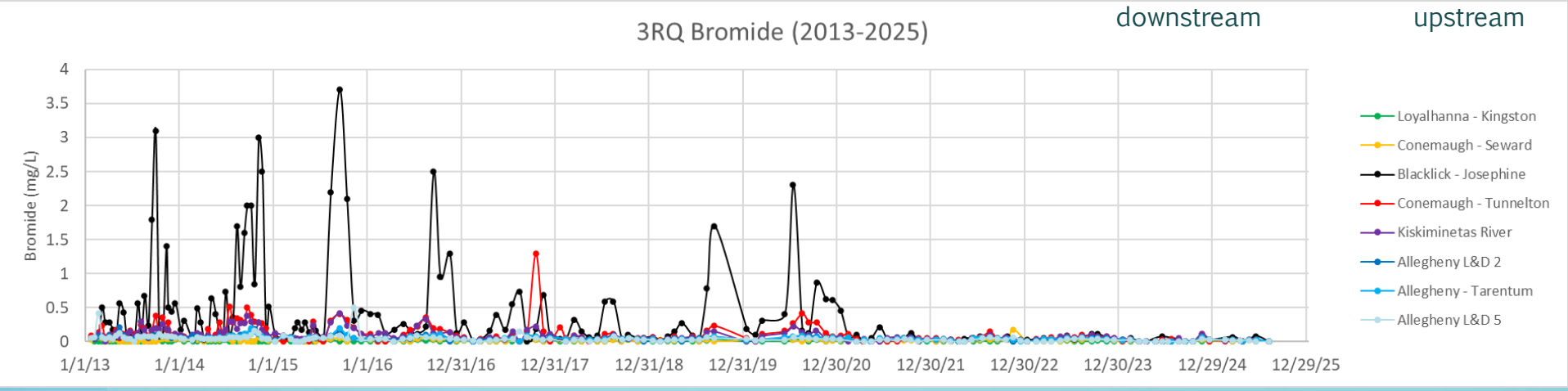




- For PWS, the SDWS=250 mg/L
- Blacklick and Con- Tunnelton have exceeded this several times in 2013-15
- Recent decline, but still much higher than averages from 1960-1990
  - Road salting began in the 1940s and has increased over time

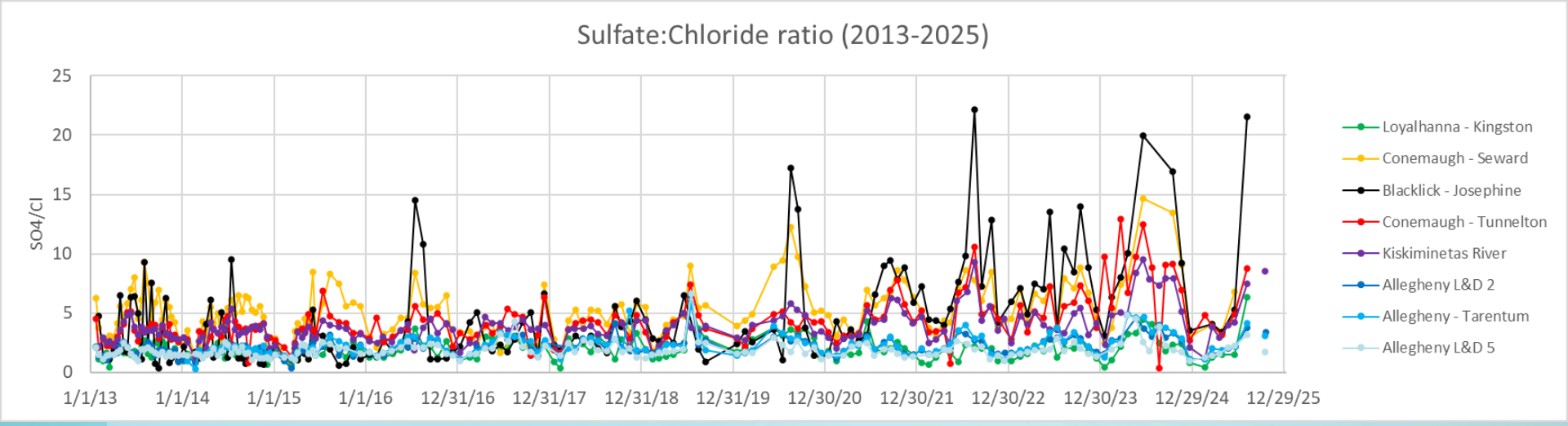
Bromide

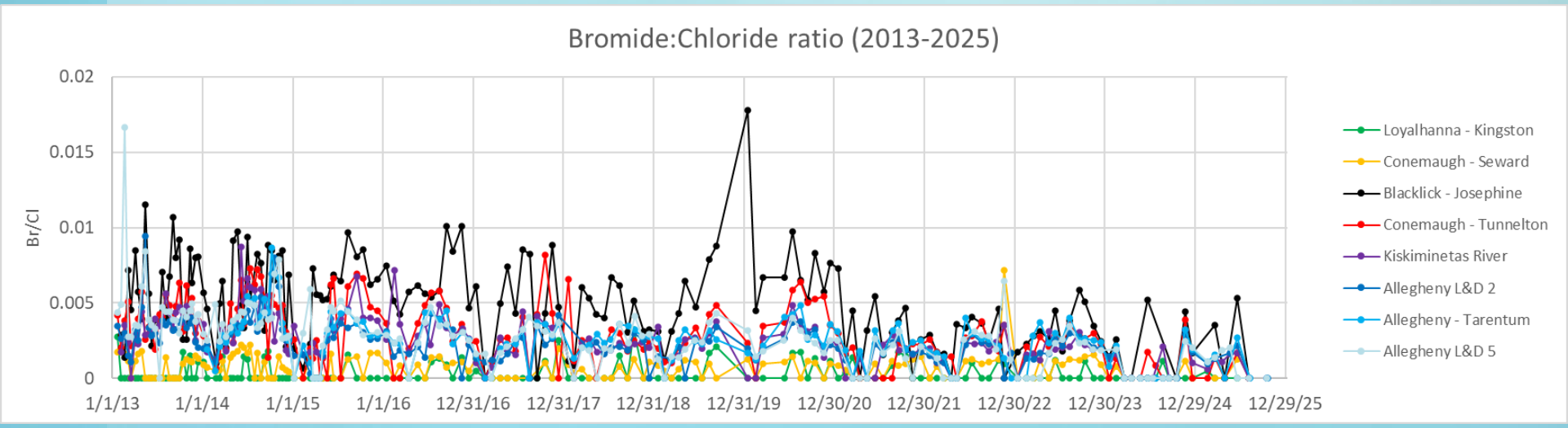




- Naturally low in surface water
- Bromide is not harmful by itself, but can cause carcinogenic trihalomethane byproducts when processed into drinking water
- Blacklick has greatest concentrations, but has decreased since 2021 (no historic data)

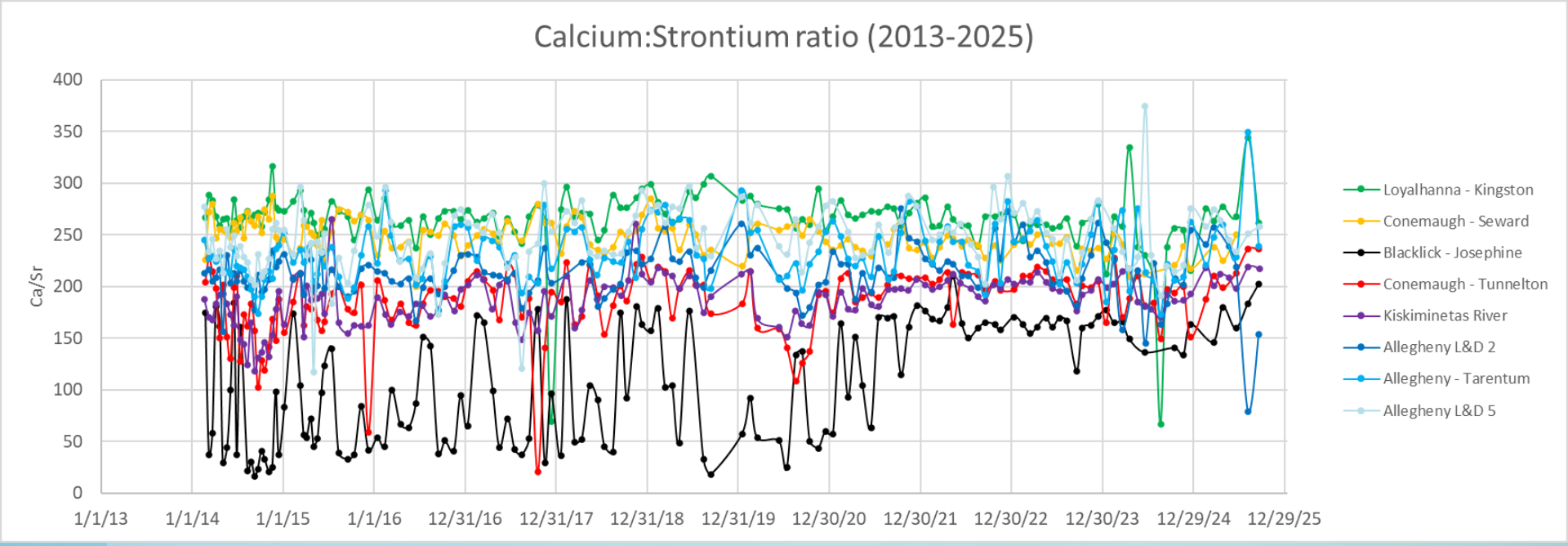
SO_4:Cl and Br:Cl Ratios over time





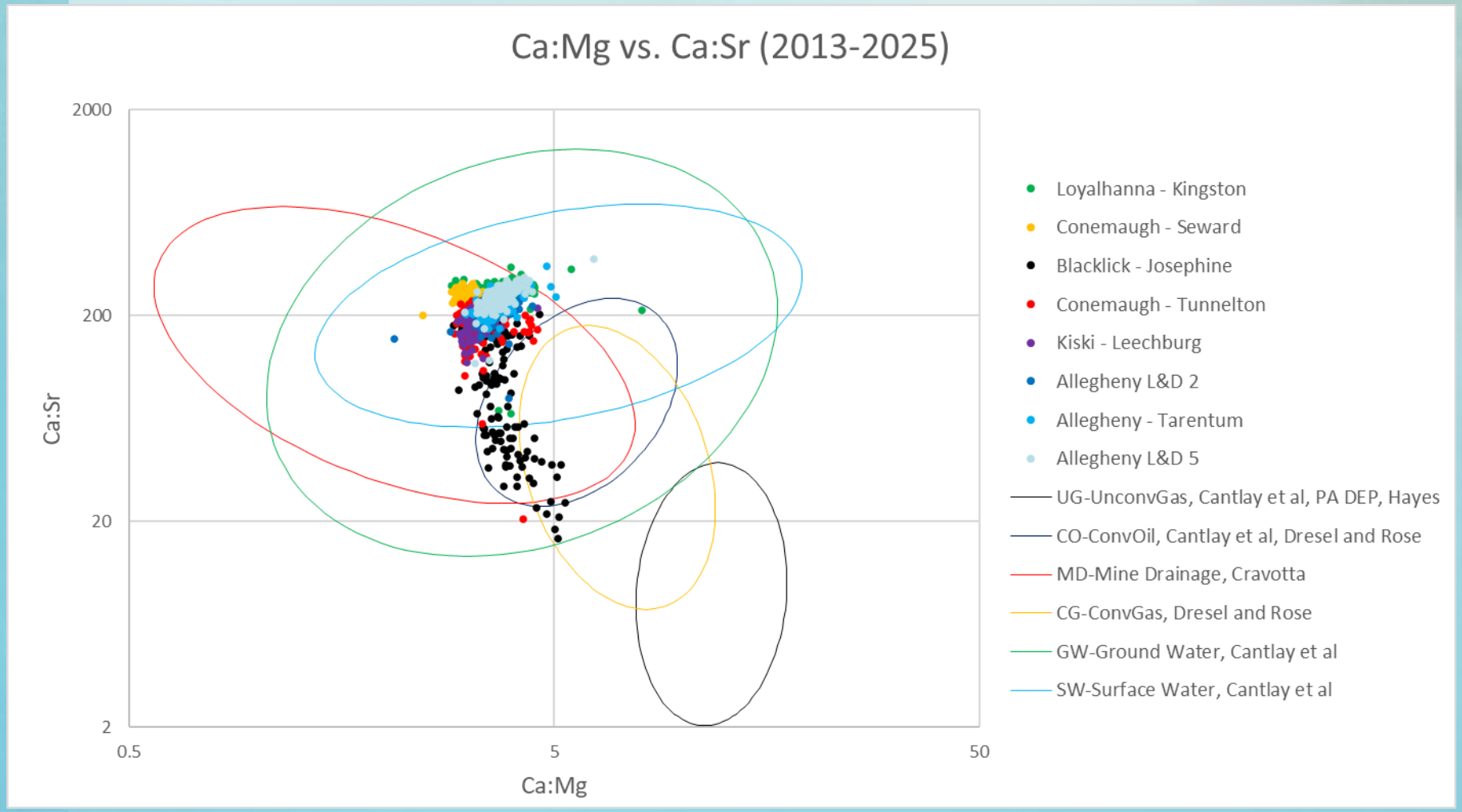
- Sulfate:Chloride has increased in Blacklick, Con-Seward, and Con-Tunnelton
- Bromide:Chloride has decreased in Blacklick and Con-Tunnelton
- Both ratios have stayed fairly stable at the other sites

Ca:Sr over time



- Higher Sr decreases the Ca:Sr ratio
- Levels at Blacklick, Con-Tunnelton, and Kiski are lower than Loyalhanna and Con-Seward sites
  - Con-Seward and Loyalhanna do not receive input from Blacklick
- Blacklick ratios have increased over time, possibly indicating a reduction in strontium when unconventional wastewater was no longer being treated

Mass ratios: Ca:Mg vs. Ca:Sr



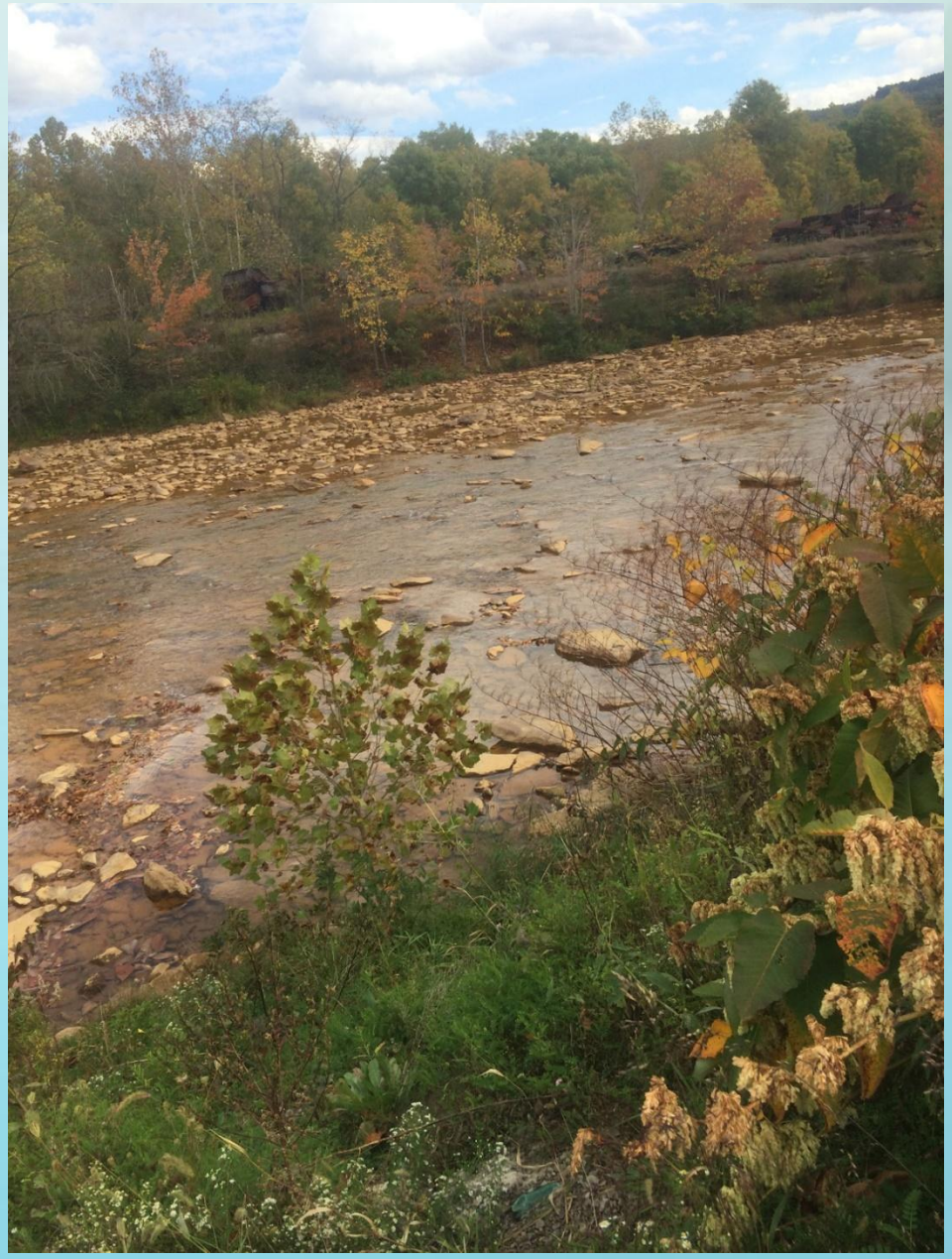
All samples fall within the standards from surface water and ground water. However, Blacklick shows a much wider range of values than the other sites and is shifted towards the oil & gas ovals.

Key Findings

- Blacklick Creek is the most impacted of our 3RQ sites, but has shown improvement (pH, TDS, Al, Cl, Br, Ca:Sr ratio)
  - Some improvement is seen since ~2019 (after wastewater change)
  - Other improvement is seen since 1990s (after CWA and downturn in AMD inputs)
- While some AMD-associated pollutants (such as aluminum and sulfate) have declined over time, chloride has increased
  - Possibly due to increased use of road salt, which is a long-term problem for waterways
- Mass ratios suggest that Blacklick Creek has been influenced by produced water from conventional or unconventional gas extraction

Thank you!

Questions?



Thanks to my collaborators at Duquesne, especially Emily Mashuda Day, Brady Porter, and John Stolz. Also the many students who have helped to collect samples since 2013.

And thanks to our 3RQ partners at WVWRI and to Colcom Foundation for funding this important long-term monitoring.