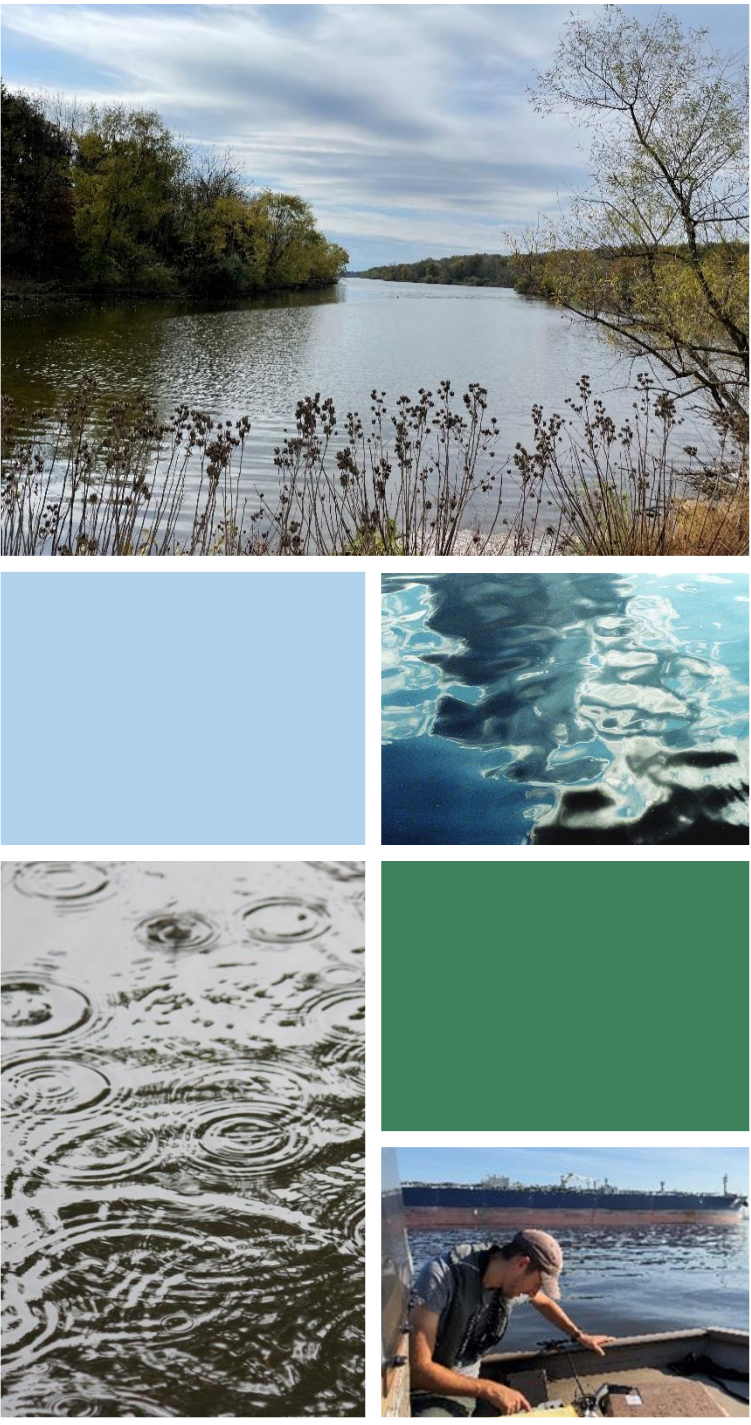




Chlorides in the Delaware River Basin: *Charting a Pathway Forward*

Elaine Panuccio, Senior Water Resource Scientist
Avery Lentini, Community Engagement Specialist

October 16, 2025
2025 Upper Delaware River Rendezvous





Salt pollution is rising in the non-tidal Delaware River



Upper Delaware trends and cumulative impacts



Why does this matter?



Why is this happening?

Special Protection Waters Program

- Special Protection Waters (SPW) is an **antidegradation** policy: “Keep the clean water clean.”
- SPW rules cover ~6,780 of the 13,800 mi² DRB watershed (197-mile stretch)
- Program managed through stricter point-source regulations

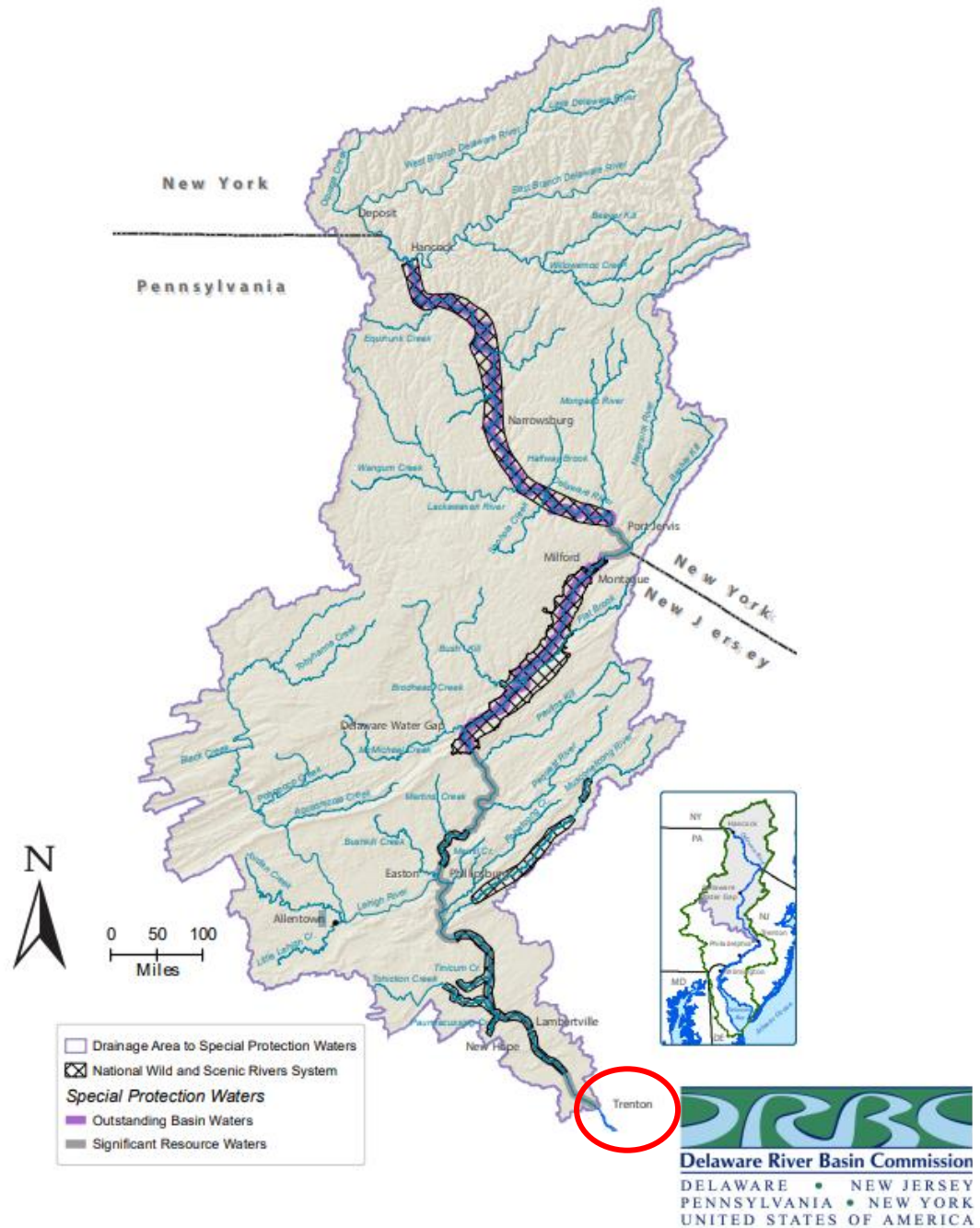


Results from Measurable Change Assessment (2009–2011)

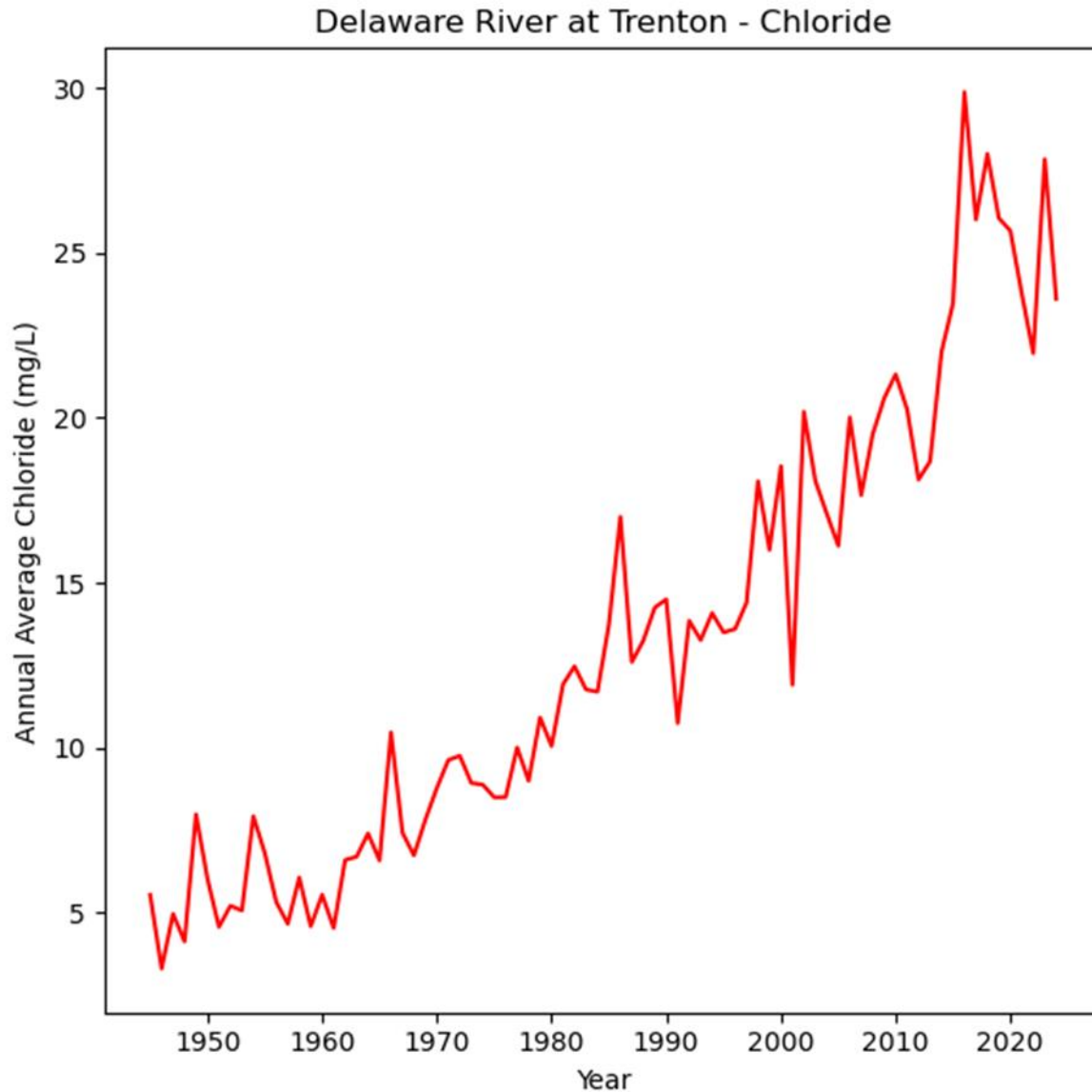
	Site Color Key			Dark Blue	=Interstate Control Point (ICP)					Dark Red	=Pennsylvania Tributary Boundary Control Point (BCP)						Dark Green	=New Jersey Tributary Boundary Control Point (BCP)									
		Del. River at Trenton	Del. River at Washngtn Crossing	Pidcock Creek, PA	Delaware River at Lambrtville	Wicke-cheoke Creek, NJ	Lockatong Creek, NJ	Delaware River at Bulls Island	Pauna-cussing Creek, PA	Tohickon Creek, PA	Tinicum Creek, PA	Nishi-sakawick Creek, NJ	Del. River at Milford	Cooks Creek, PA	Musco-netcong River, NJ	Del. River at Rieglsvil	Pohat-cong Creek, NJ	Lehigh River, PA	Del. River at Easton	Bushkill Creek, PA	Martins Creek, PA	Pequest River, NJ	Del. River at Belvidere	Paulins Kill River, NJ	Del. River at Portland		
	Parameter	Site Number-->	1343 ICP	1418 ICP	1463 BCP	1487 ICP	1525 BCP	1540 BCP	1554 ICP	1556 BCP	1570 BCP	1616 BCP	1641 BCP	1677 ICP	1737 BCP	1746 BCP	1748 ICP	1774 BCP	1837 BCP	1838 ICP	1841 BCP	1907 BCP	1978 BCP	1978 ICP	2070 BCP	2074 ICP	
Field	Dissolved Oxygen (DO) mg/l											~															
	Dissolved Oxygen Saturation %											~															
	pH, units																										
	Water Temperature, degrees C																										
Nutrients	Ammonia Nitrogen as N, Total mg/l																										
	Nitrate + Nitrite as N, Total mg/l																**										
	Nitrogen as N, Total (TN) mg/l																**										
	Nitrogen, Kjeldahl, Total (TKN) mg/l																										
	Orthophosphate as P, Total mg/l																										
	Phosphorus as P, Total (TP) mg/l																										
Bacteria	Enterococcus colonies/100 ml	~			~																						
	Escherichia coli colonies/100 ml	**	**	**	**	**	**			**	**	**															
	Fecal coliform colonies/100 ml																										
Conventionals	Alkalinity as CaCO3, Total mg/l																										
	Hardness as CaCO3, Total mg/l											~															
	Chloride, Total mg/l			**		**	**	**	**	**		**	**	**	**	**	**	**	**	~	**	**	**	**		**	
	Specific Conductance µmho/cm			**		**	**	~	**	**	**	**	**	**	**	**	~	**	**	~	~	~	**	~			
	Total Dissolved Solids (TDS) mg/l																										
	Total Suspended Solids (TSS) mg/l																										
	Turbidity NTU																										
	KEY		= No indication of measurable change to EWQ							**	= Indication of measurable water quality change toward more degraded status							~	= Weak indication of measurable water quality cha								
 Delaware River Basin Commission																											

Non-tidal Drainage Area & SPW (Non-tidal)

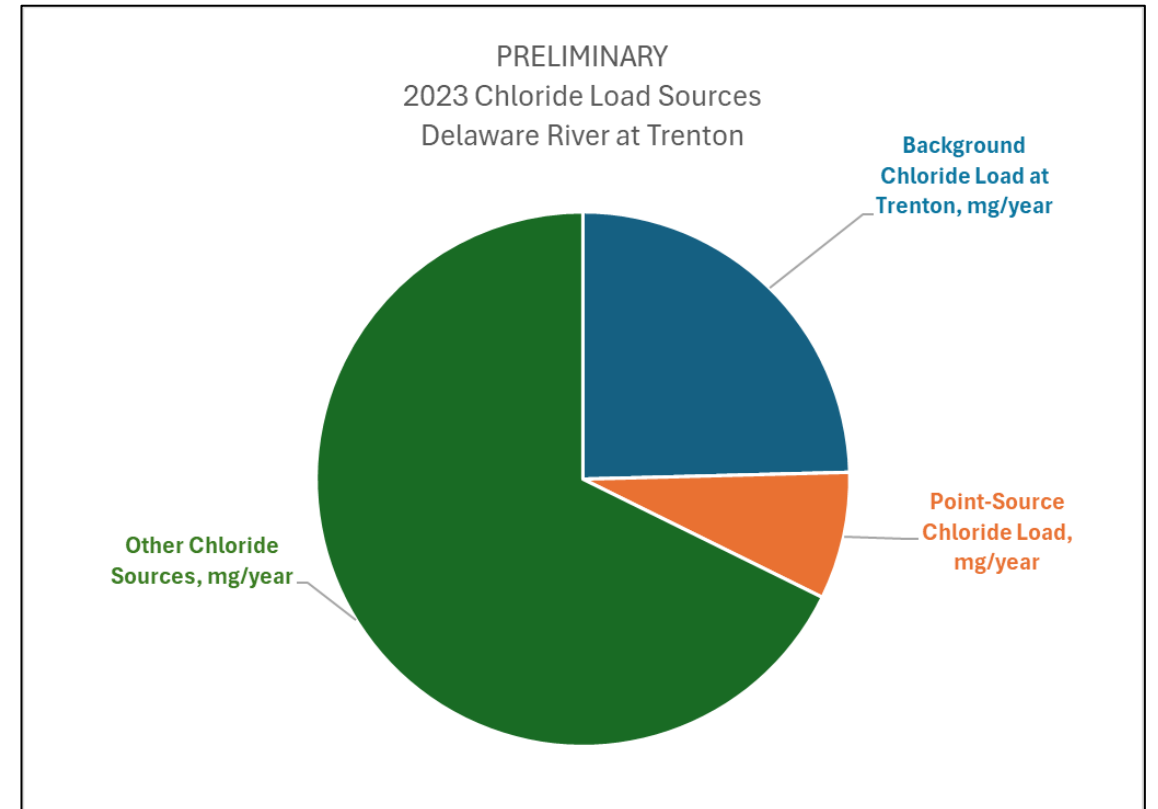
Drainage Area to DRBC's Special Protection Waters



Chloride Trends and Source Attribution at Trenton



Data obtained from the Water Quality Portal





Salt pollution is rising in the non-tidal Delaware River



Upper Delaware trends and cumulative impacts



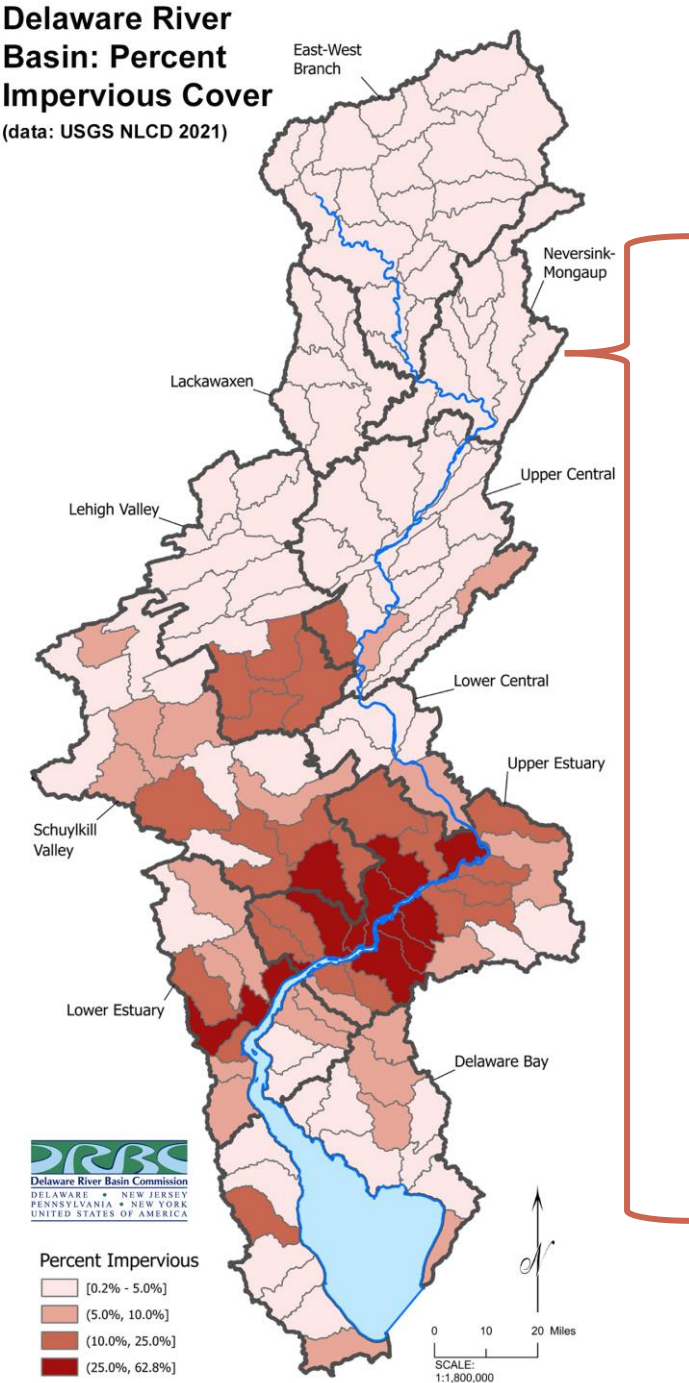
Why does this matter?



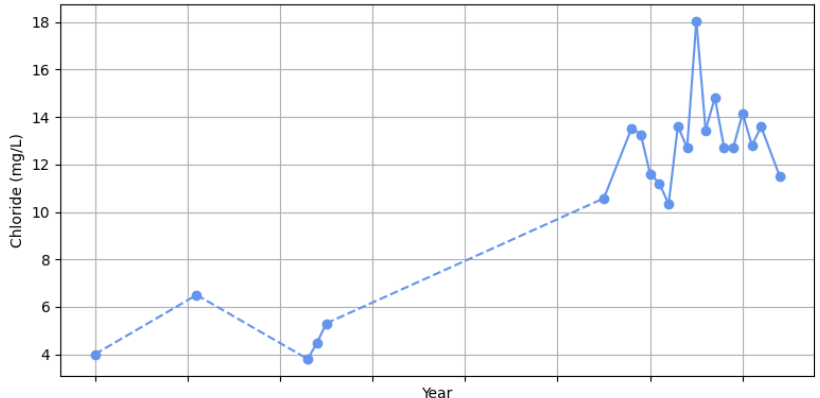
Why is this happening?

Upper Delaware River Chloride Trends

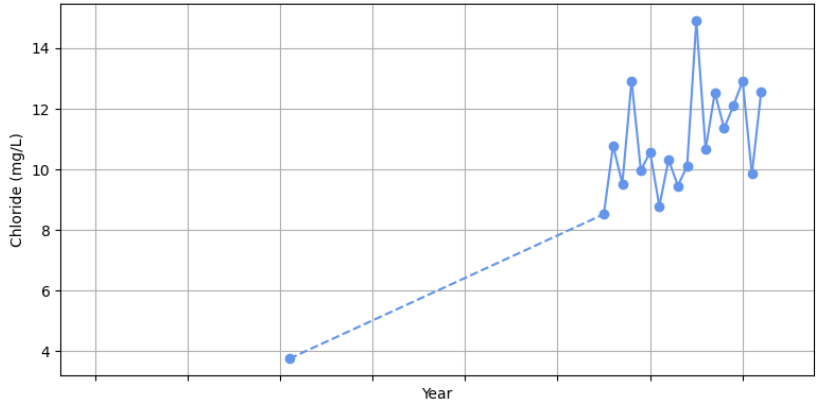
Delaware River Basin: Percent Impervious Cover
(data: USGS NLCD 2021)



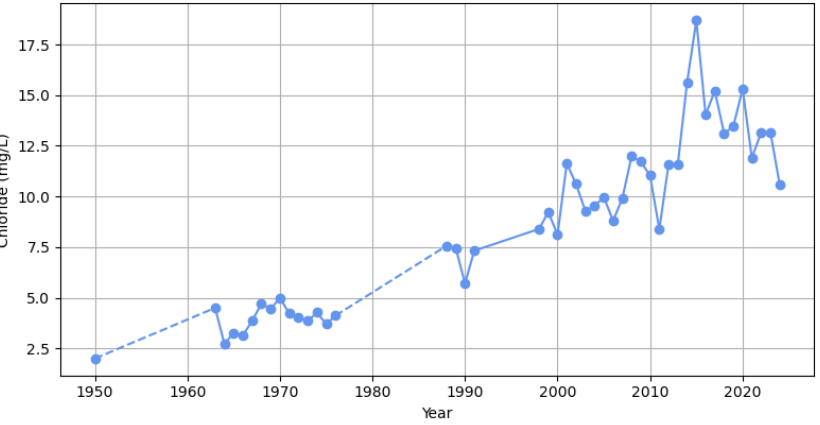
Upper Delaware River Long-term Chloride Trends
West Branch Delaware River at Rt. 191 Bridge (N=156)



Delaware River at Callicoon to Cochection
(N=217)

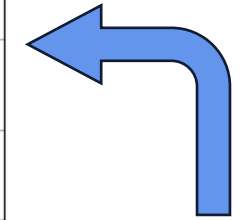
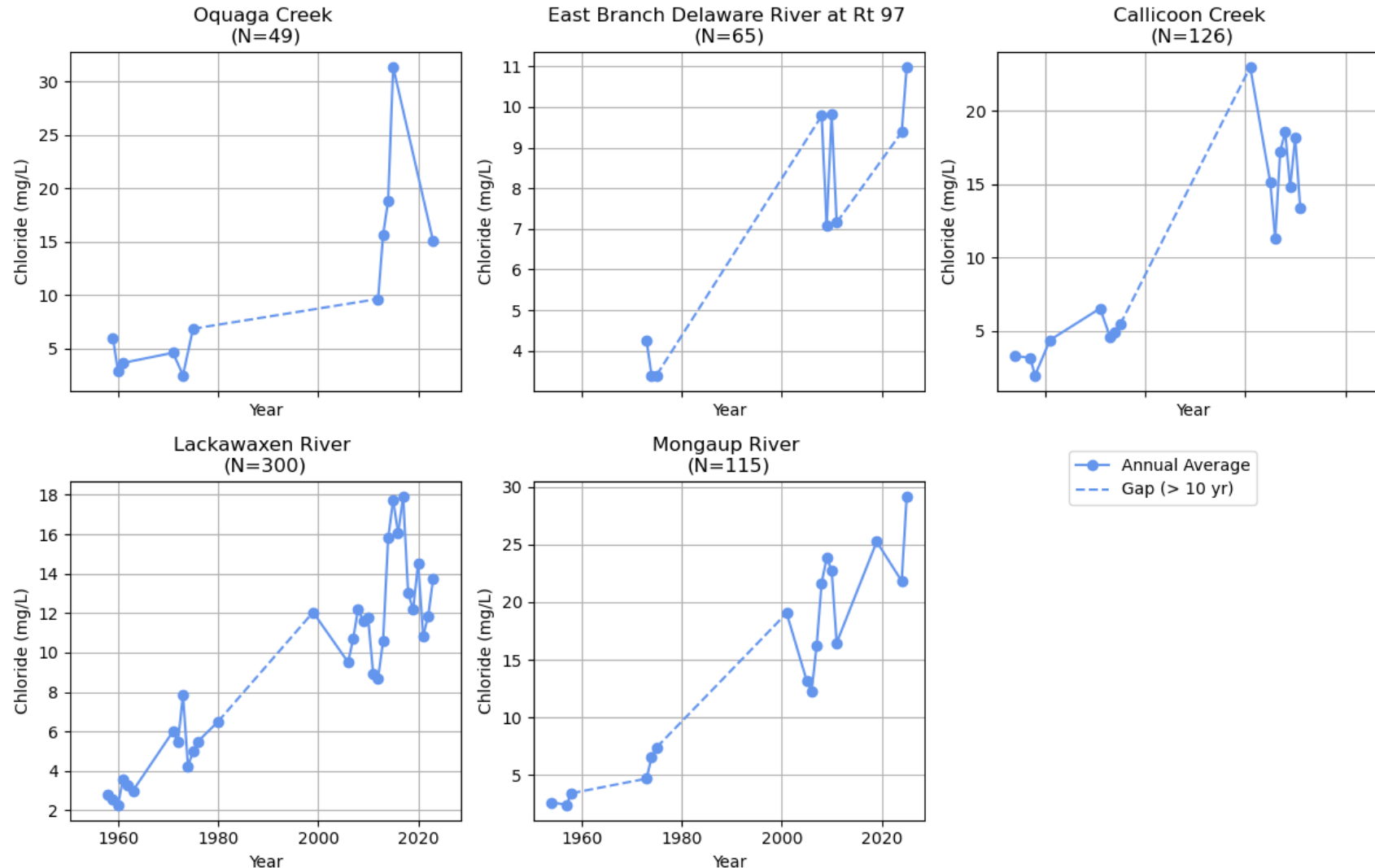


Delaware River at Millrift to Port Jervis
(N=506)



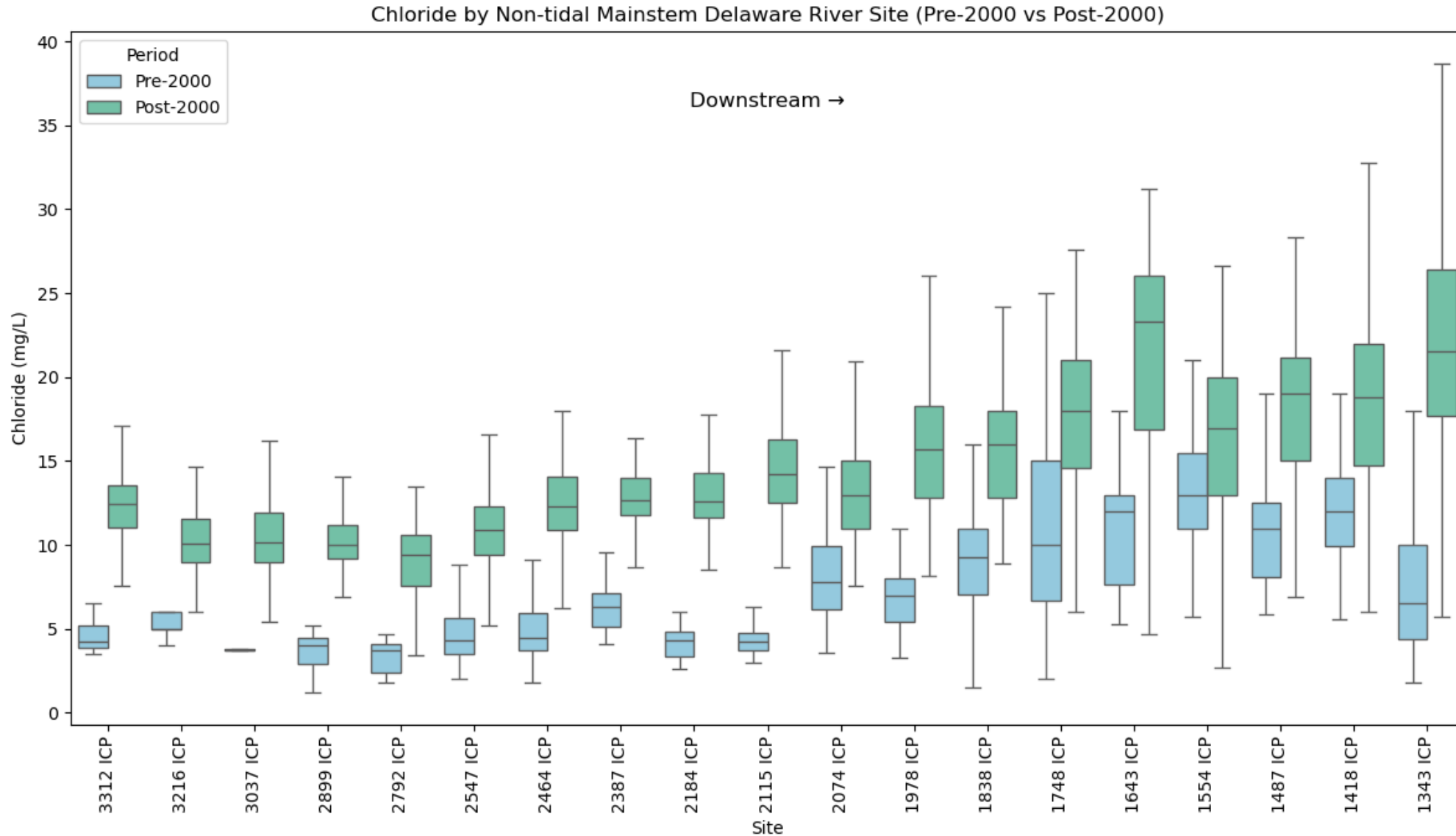
Upper Delaware Tributary Chloride Trends

Upper Delaware Tributary Long-term Chloride Trends

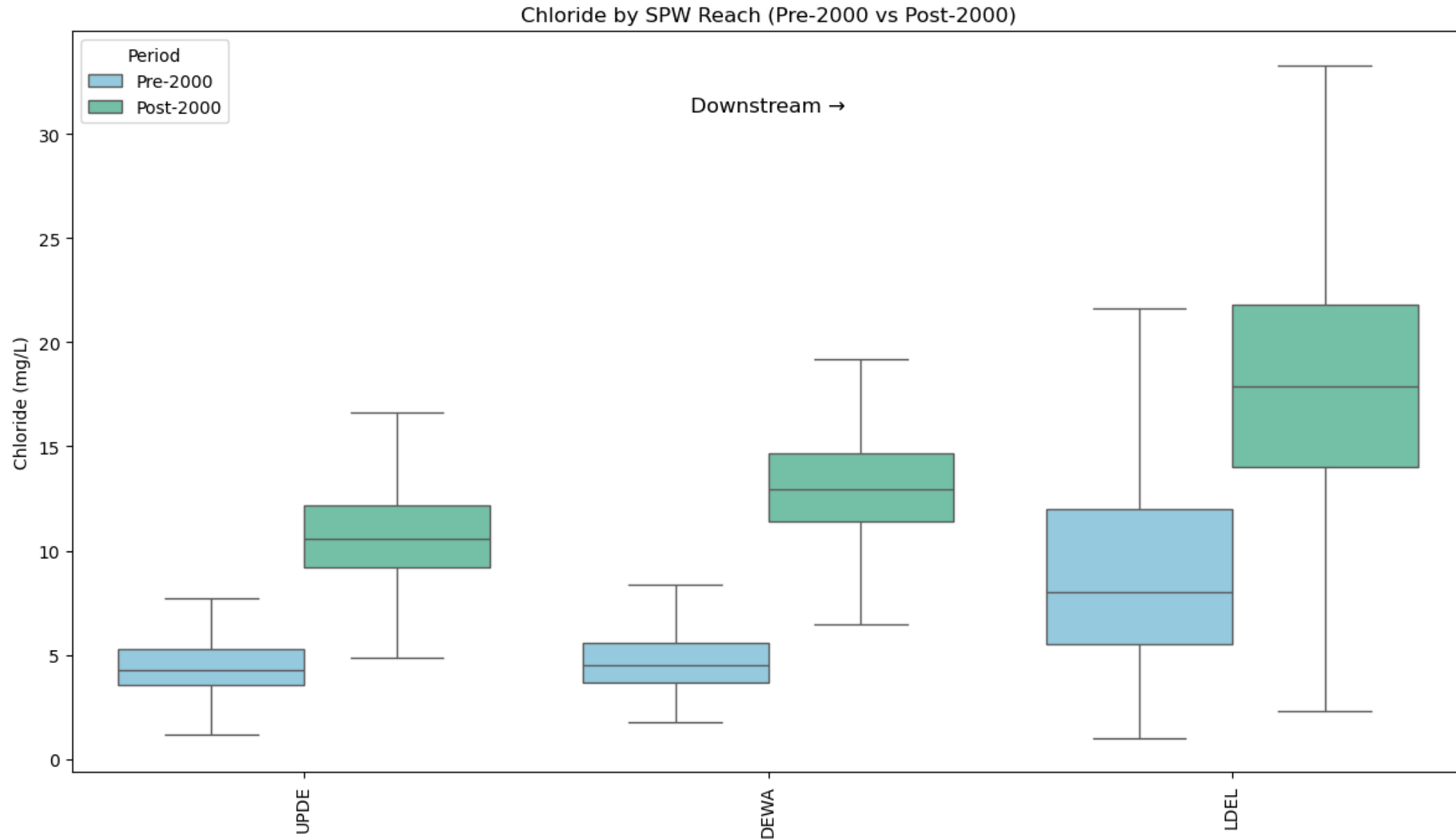


Our current
tributary
watershed!

Chloride Concentrations at Mainstem Sites: Pre-2000 vs Post-2000



Chloride Concentrations by SPW Reach: Cumulative Impacts Over Time





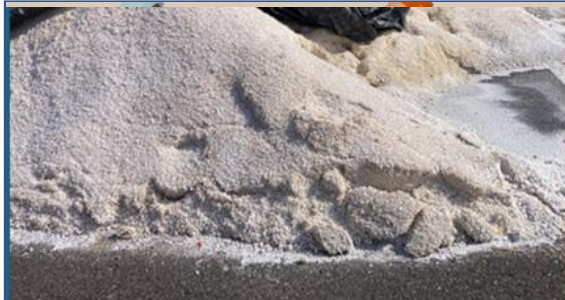
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Upper Delaware trends and cumulative impacts



Why does this matter?



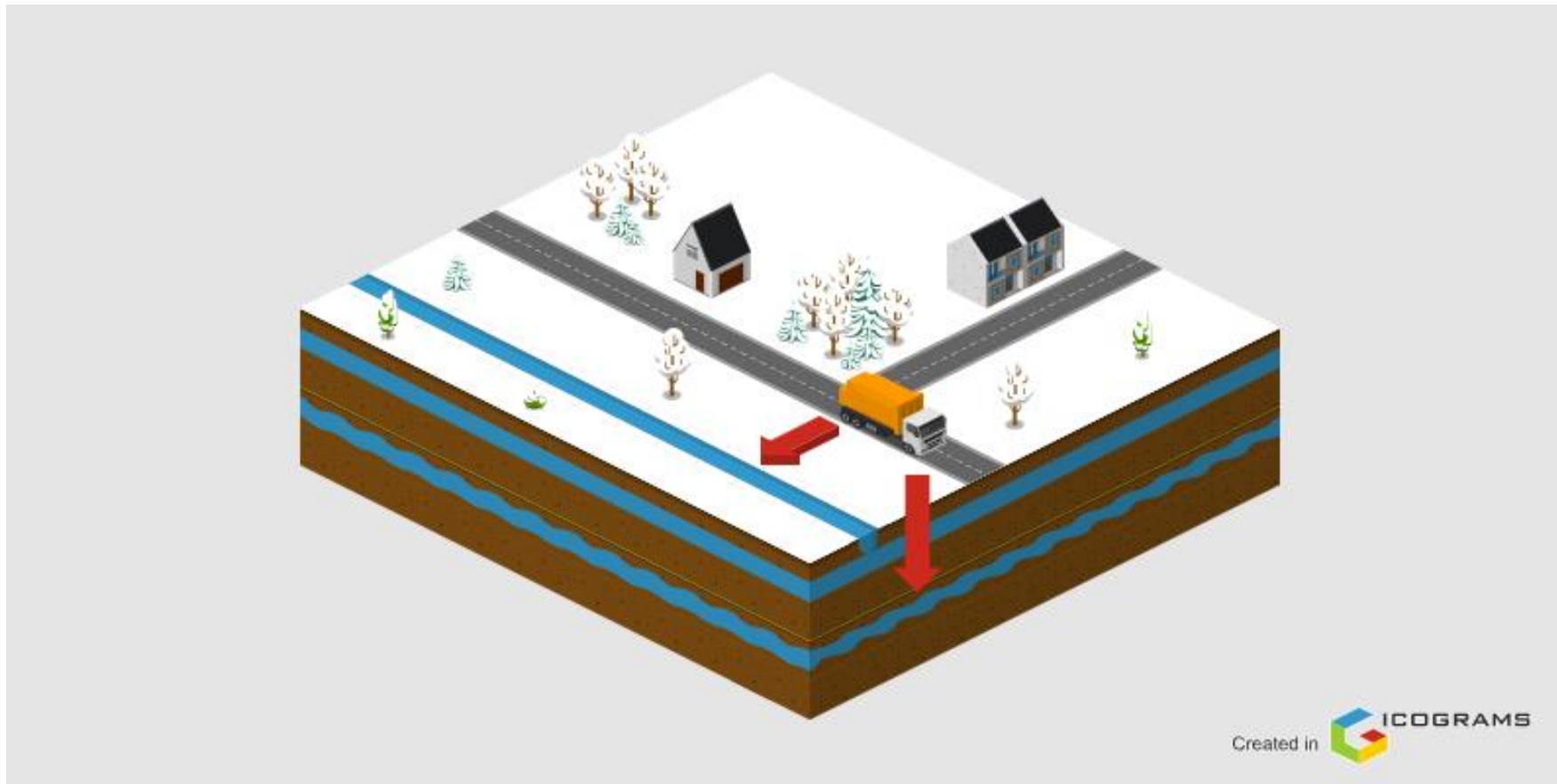
Why is this happening?

Freshwater Salinization Syndrome: Ecological and Infrastructure Impacts

- What is “*freshwater salinization syndrome*”?
 - A chronic increase in salt concentrations across freshwater systems driven by human activities
- **Aquatic life:** High chloride concentrations are toxic to aquatic life (USEPA Criteria: 230 mg/L)
 - At lower chloride levels:
 - Stresses sensitive taxa (mayflies, stoneflies)
 - Reduced biodiversity
- **Infrastructure:** Chloride is highly corrosive that can lead to costly repairs

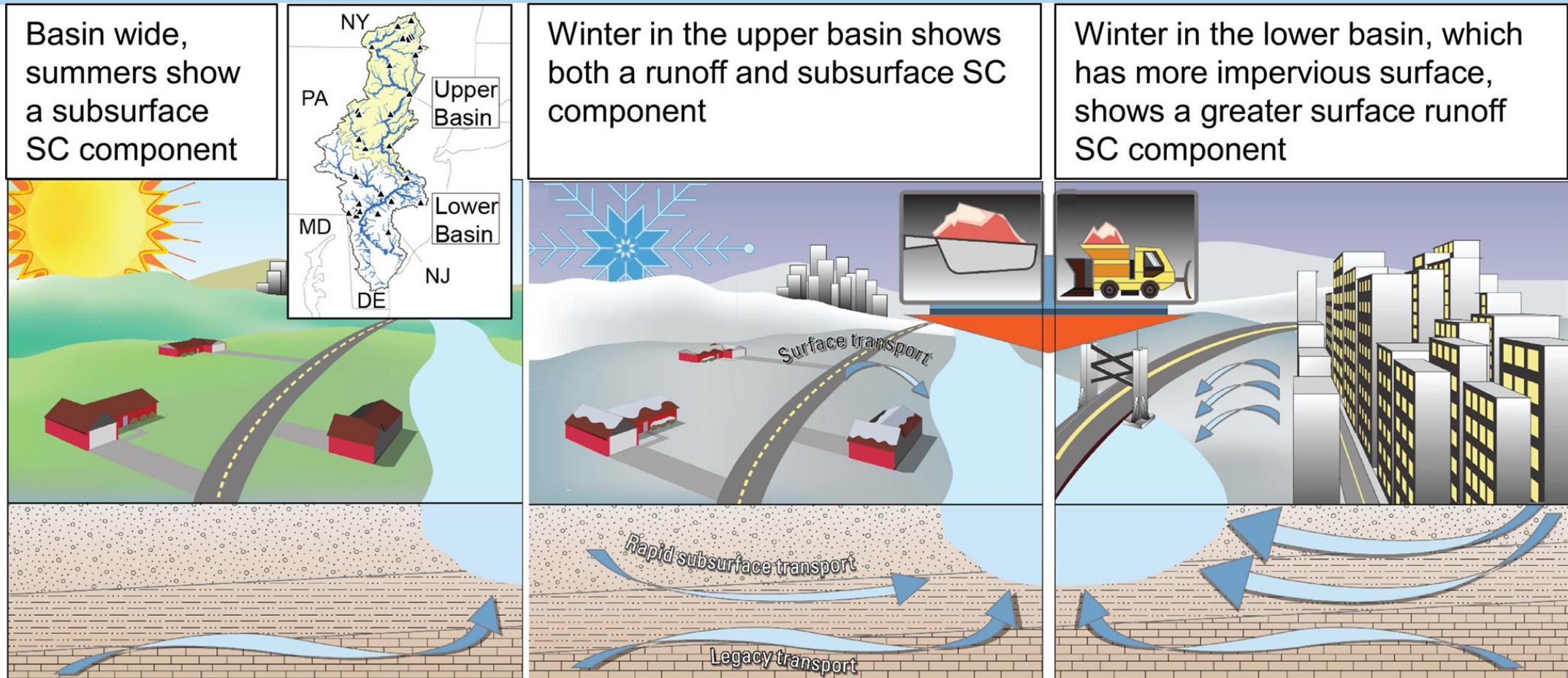


Salt in Groundwater



Transport of applied salts

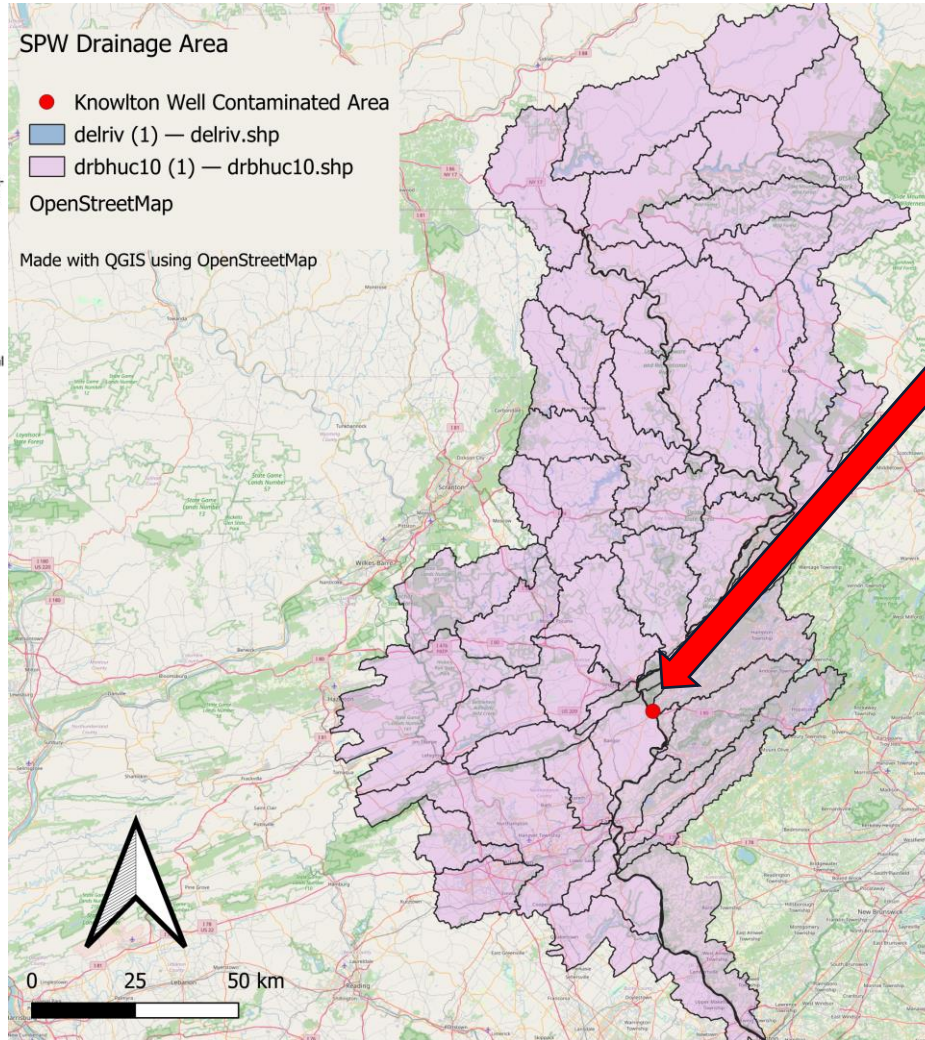
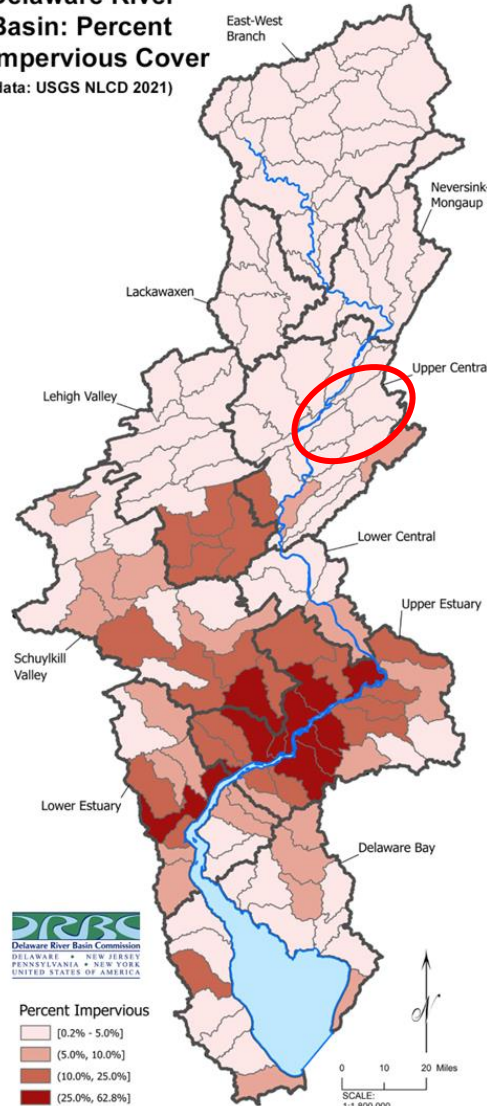
USGS Study: Deicing salt drives specific conductance patterns in Delaware River



Rumsey, C.A., Hammond, J.C., Murphy, J., Shoda, M., and Soroka, A. Spatial patterns and seasonal timing of increasing riverine specific conductance from 1998 to 2018 suggest legacy contamination in the Delaware River Basin. *Science of the Total Environment*, 858(1), 159691 (2023). <https://doi.org/10.1016/j.scitotenv.2022.159691>

Salt Contaminated Wells in SPW

Delaware River Basin: Percent Impervious Cover
(data: USGS NLCD 2021)



WARREN COUNTY

A town found the source of its contaminated wells: road salt. What's being done about it?

Updated: Feb. 27, 2019, 1:00 p.m. | Published: Feb. 27, 2019, 7:00 a.m.

ENVIRONMENT

Knowlton and Warren County to fund water filtration for Columbia residents



Bruce A. Scruton

New Jersey Herald

Published 9:43 a.m. ET Jan. 27, 2023



Delaware River Basin Commission

DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA



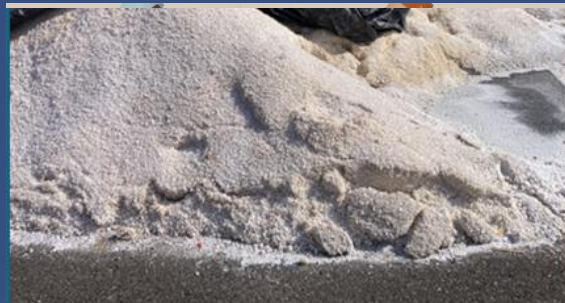
Salt pollution is rising in the non-tidal Delaware River



Upper Delaware trends and cumulative impacts



Why does this matter?



Why is this happening?

Freshwater is getting saltier nationwide

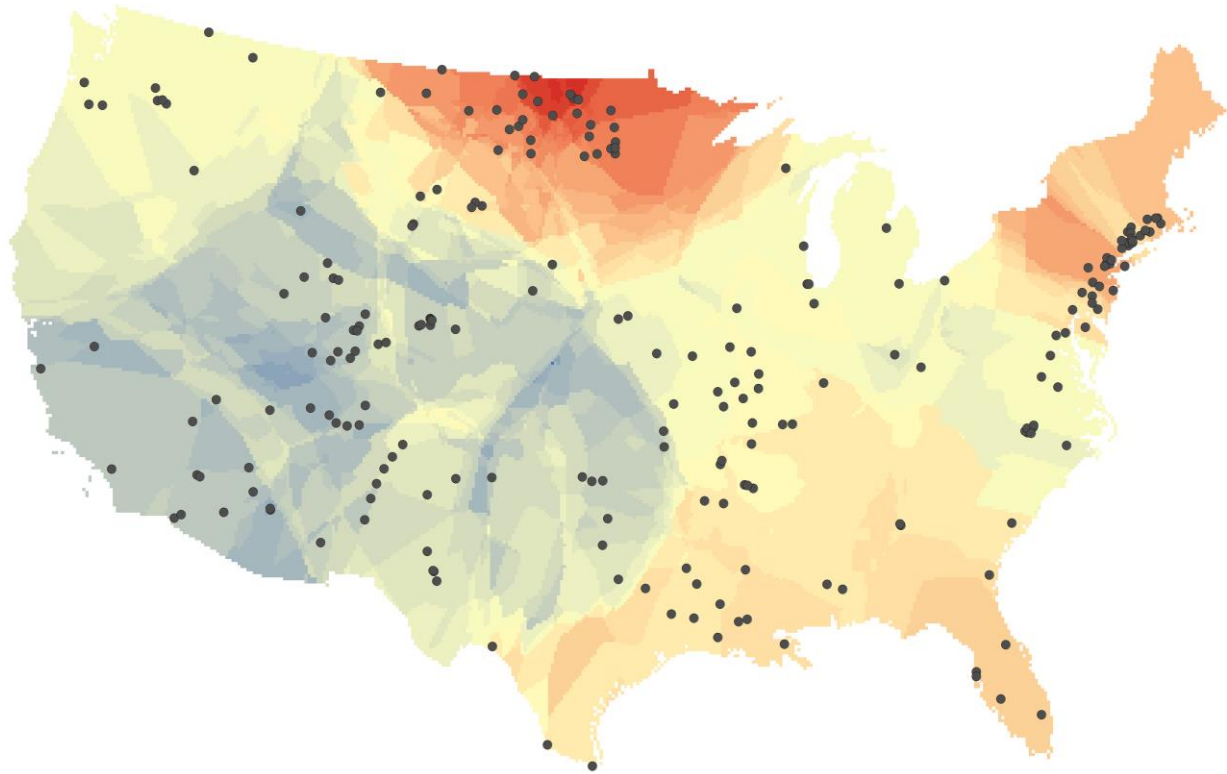


Image credit: Ryan Utz, Chatham University. Source: University of Maryland.

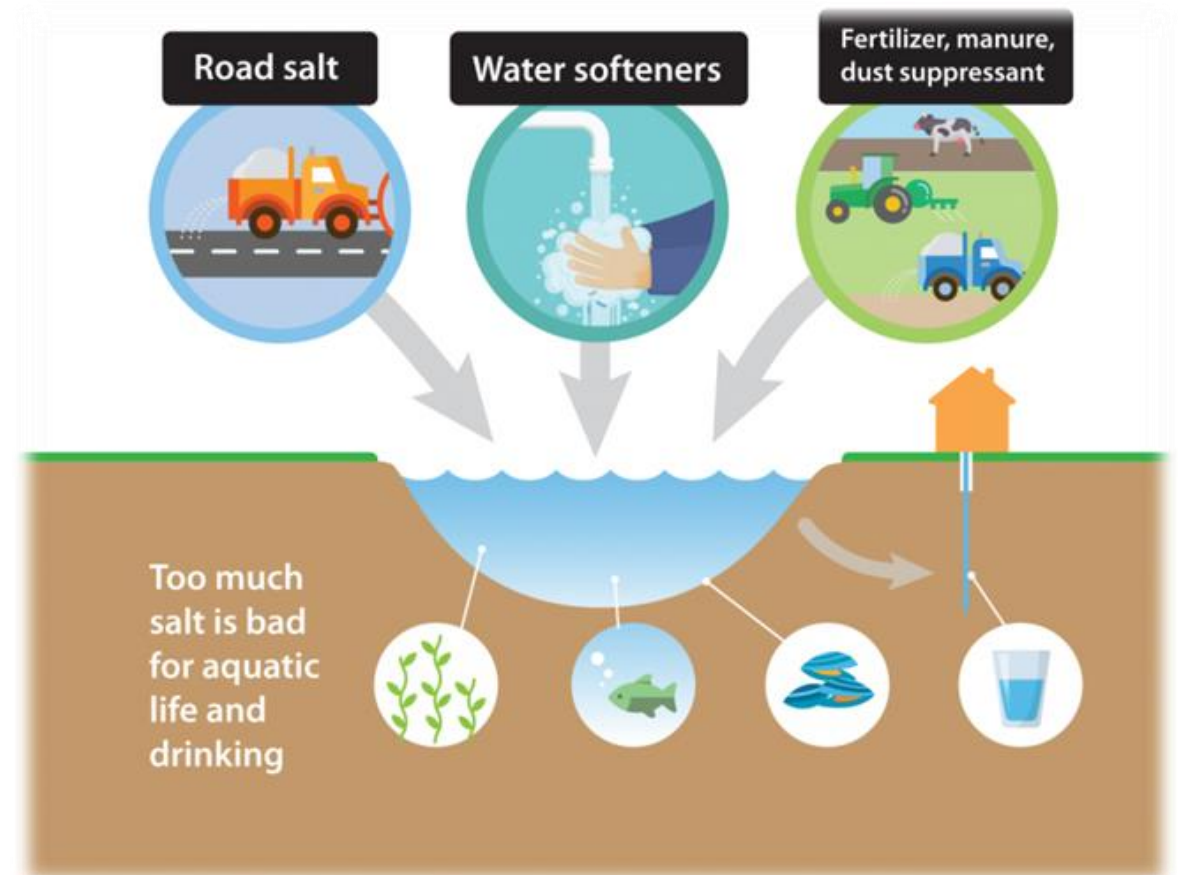


Image source: Clean Water Action, retrieved from <https://cleanwater.org/2021/09/29/how-salt-gets-environment>

The Basin is located within the “Salt Belt”

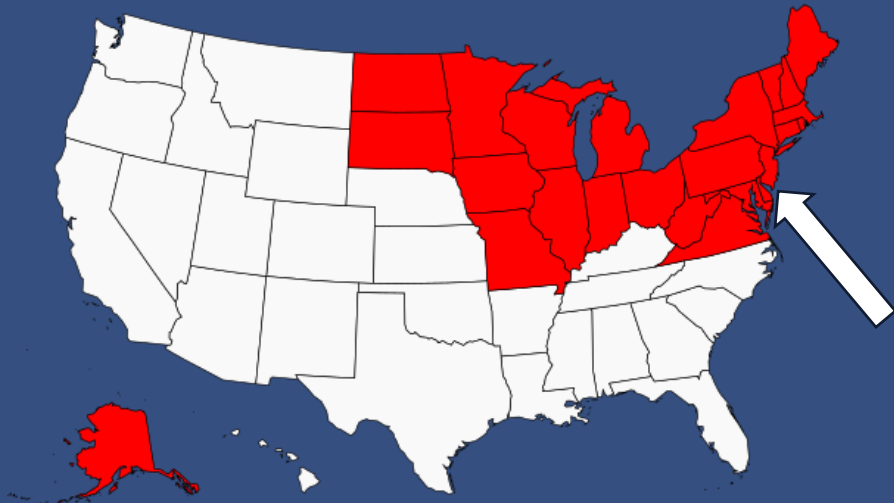
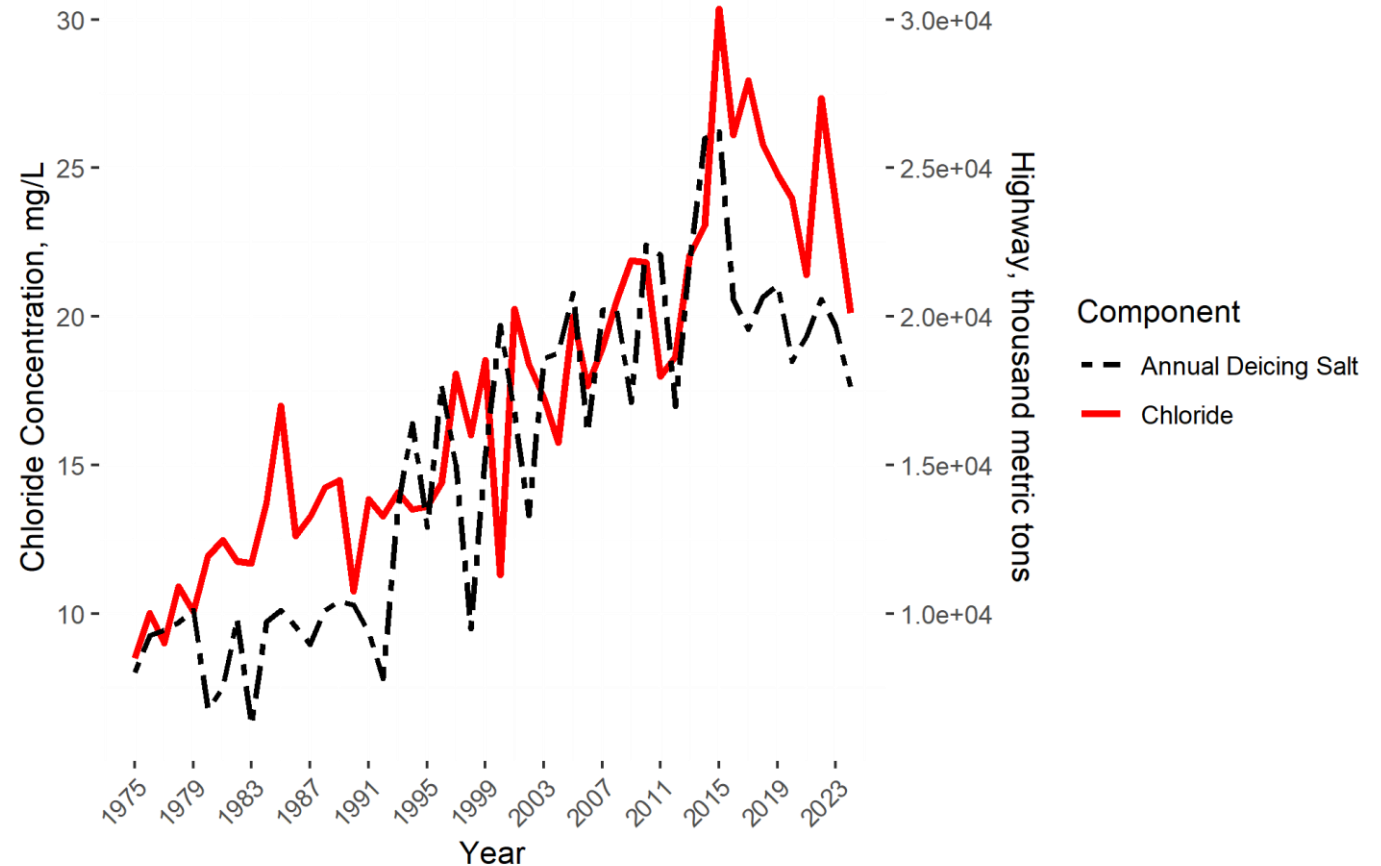


Image: by Randommapmaker, Wikimedia Commons, CC BY-SA 4.0



Annual U.S. Highway Deicing Salt Use and Average Annual Chloride Delaware River at Trenton



U.S. Highway Deicing Salt Data Source: USGS Mineral Commodity Summaries (1975 – 2024)

Oversalting and mismanagement



At Rutgers (ENR)



Over-salting



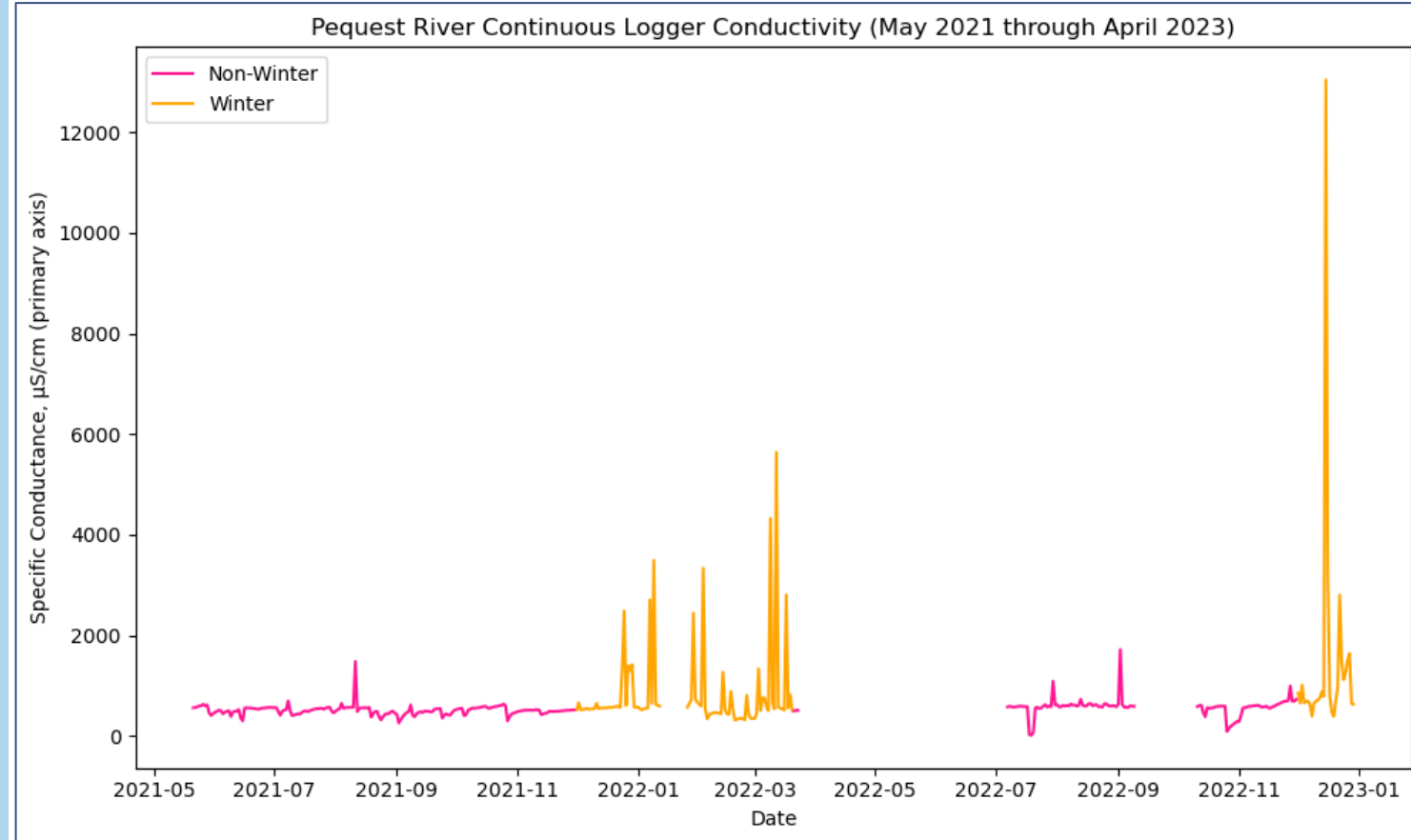
Poorly covered pile



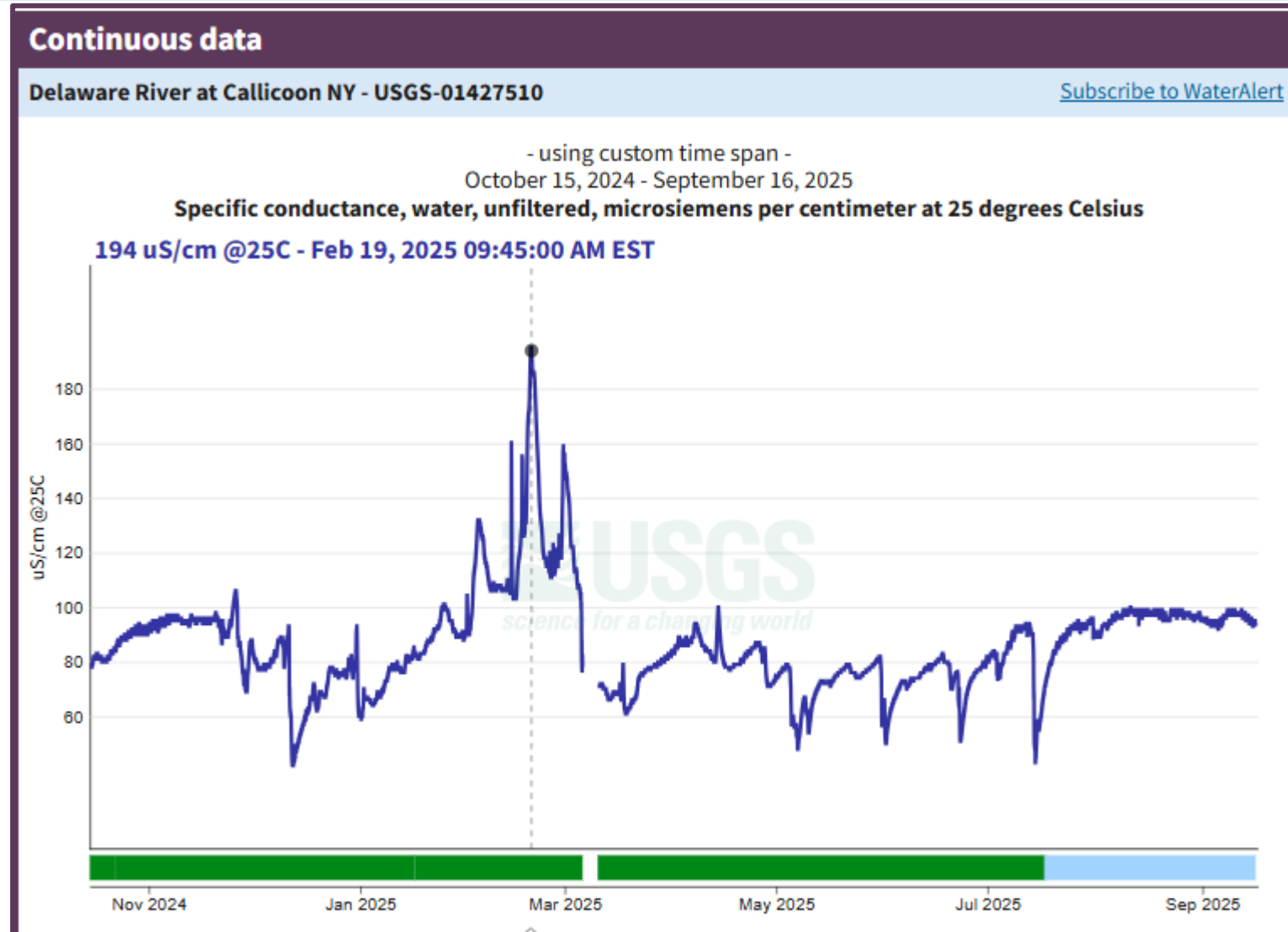
Open salt-pile



Elevated conductivity during winter

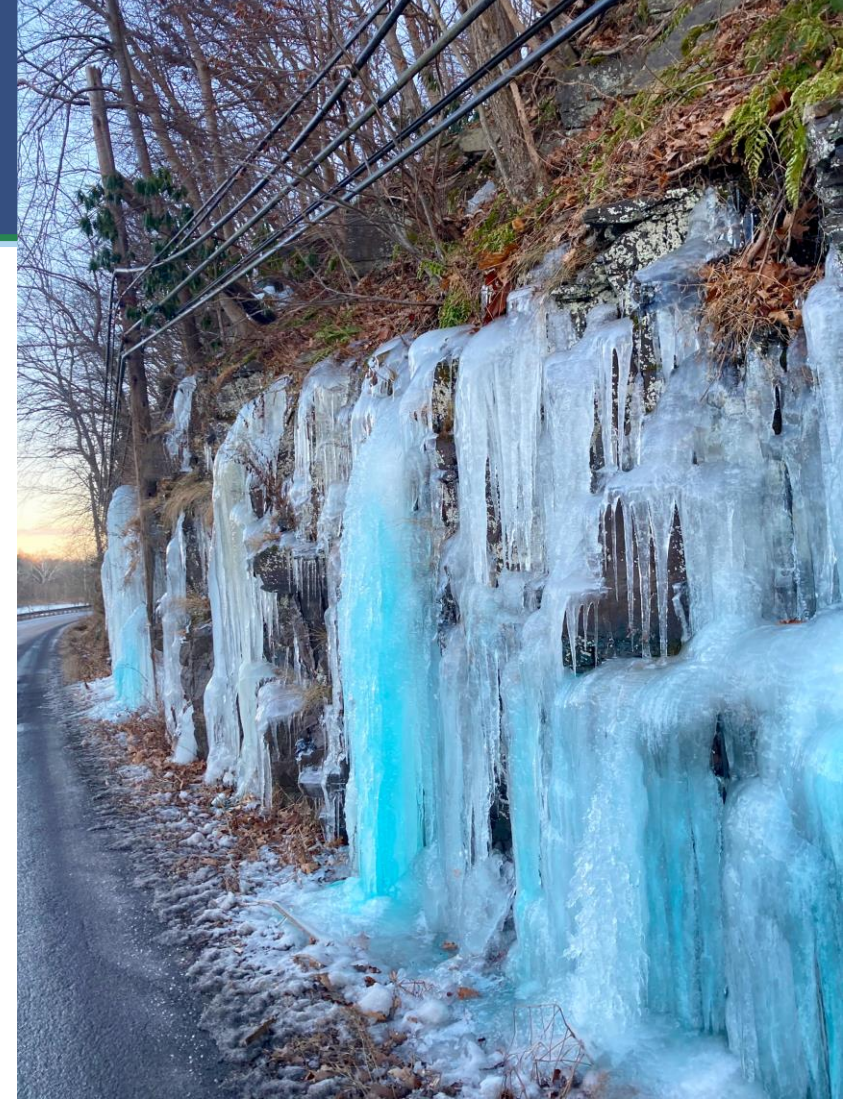


USGS Continuous Gages Capture Winter Salting Influence



Summary

- Freshwater is getting saltier over time in the non-tidal Delaware River despite Special Protection Waters policy
 - “Keep the clean water clean”
- Although below USEPA chronic aquatic life criterion (230 mg/L), **trends** are concerning
- Short and long-term impacts:
 - Conductivity spikes occur after winter deicing salt activities
 - Stored subsurface component contributes to elevated baseflow concentrations
- Management options are necessary to slow down trends



Paths Forward

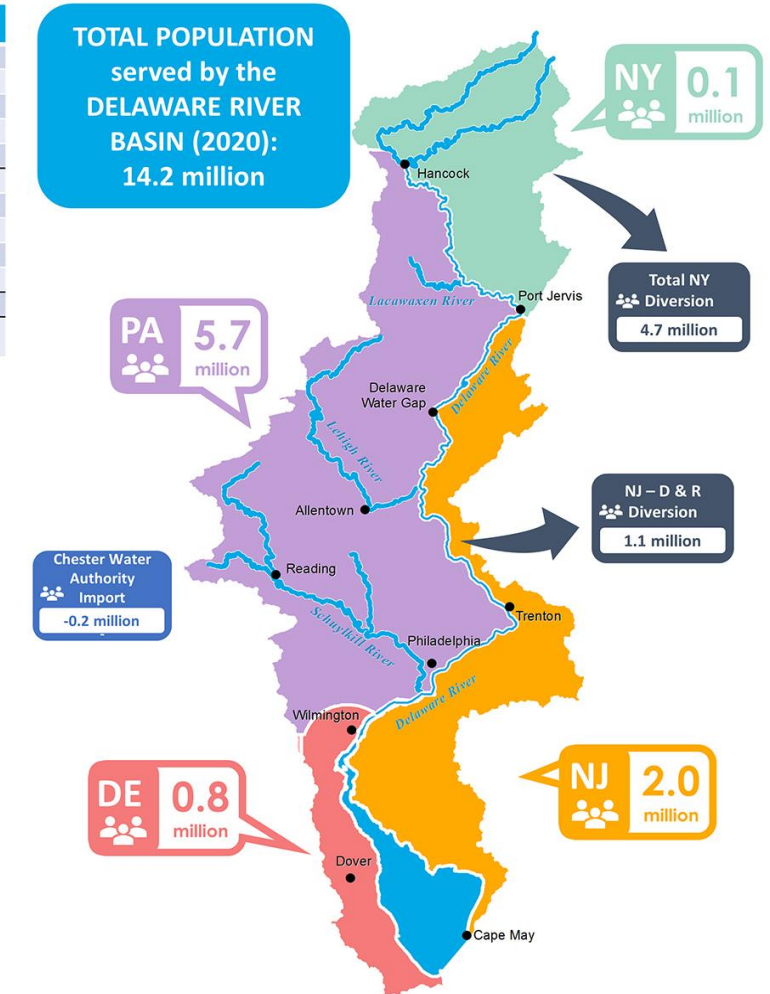


DRBC helps manage a high quality, sustainable supply of water for the Delaware River's many uses.

- DRBC is federal-interstate agency formed in 1961 with a mission to manage a river system without regard to political boundaries.
- Members:
 - Four basin state governors: PA, DE, NJ, and NY
 - The federal government: US Army Corps of Engineers
- Unified approach to protecting the Delaware River and its resources, a vital water supply for an estimated **14.2 million people**.

	POPULATION (2020)
State	
Delaware	0.774
New Jersey	1.989
New York	0.117
Pennsylvania	5.749
Total DRB Population	8.629
Import/Export	
NJ – D & R Diversion	1.087
Total NY Diversion	4.664
CWA Import	-0.187
Total Import/Export	5.564
TOTAL ESTIMATED POPULATION SERVED	14.193

Total NY diversion includes NYC diversion and upstate NY communities. All values are in million people.



DRBC staff manages a wide range of programs,
typically falling under two main categories.

FLOW

1

An adequate
and sustainable
supply of water

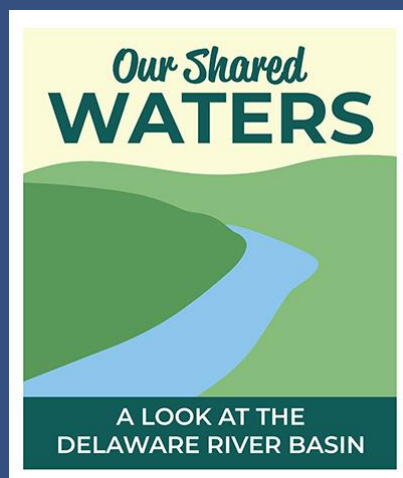
WATER QUALITY

2

Clean and
healthy water
resources



Leveraging *Our Shared Waters*, DRBC's partner network



CELEBRATING 100+ PARTNERS

Our Shared Waters connects policymakers and partners across all sectors, with membership from utilities, nonprofits, government, and businesses.

Is your organization interested in joining the initiative?

Contact Elizabeth.Brown@drbc.gov for more information.



DRBC's Pilot Study:

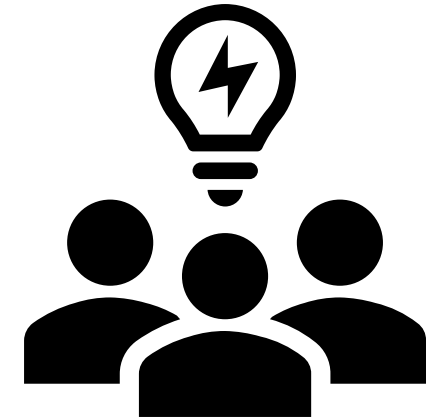
Working with Municipalities to Implement Salt Reduction Measures

- Voluntary collaboration with municipalities to gather data and test out best management practices.
- Sharing of recent salt application records will serve as baseline data for future reductions
- Important considerations:
 - Liability concerns
 - Maximizing supplies budget
 - Limitations of voluntary approaches when working with municipalities (budget, staff capacity, etc.)
- Support for implementing BMPs without necessarily needing new equipment



What does it mean to be in the pilot study?

- Work cooperatively with Commission staff
- Baseline understanding of current practices
 - Sharing of salt application data
- Test out alternative salt reduction measures
- **Training and education***
- Lessons learned



DRBC's role: gathering data to better understand the viability and environmental impact of alternative options

Challenge:

As far as we know, there are no municipal ordinances in the basin that restrict salt application. Salting practices handled on the local, typically municipal, level.

Challenge:

Mindset of more salt = more safety.

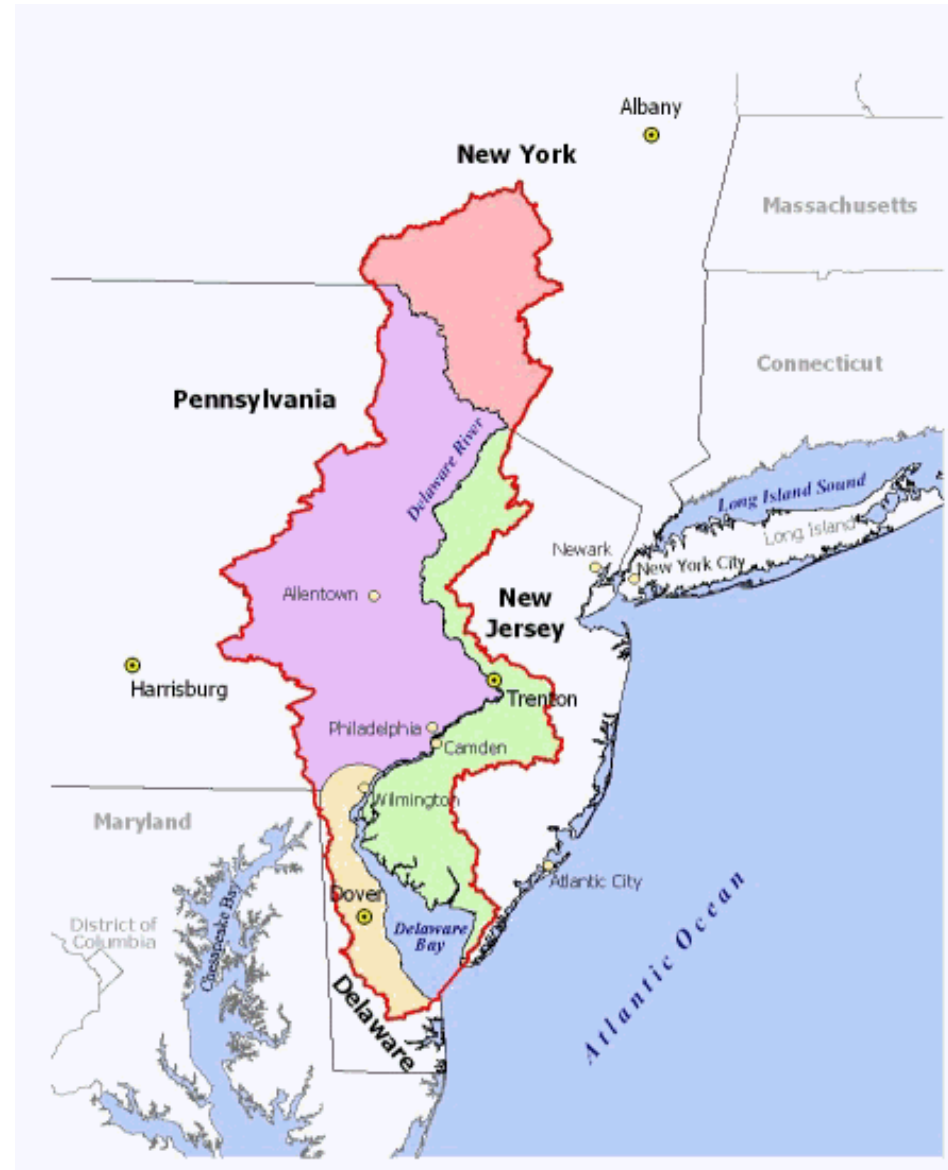
In reality, oversalting can have negative impacts on infrastructure and impacts can be costly down the line for municipalities.

Goal: Work collaboratively with municipalities to maintain public safety and implement best management practices to reduce road salt application loads

Addressing the issue
of road salt over-
application is
complicated and
involves working with
municipal employees
in a voluntary setting.

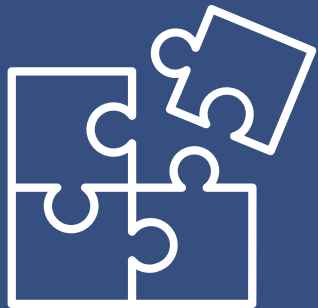


The Delaware River Basin is HUGE!



...Coordinated
partnerships can help
gather important data.

Who can play role in chloride reduction?



- Nonprofits and grassroots organizations
 - Watershed groups
- Technical and scientific partners
- Government agencies
- DRBC's Salinity Impacts Freshwater Toxicity (SIFT) workgroup
- Public awareness efforts are the first step



Questions?

Elaine.Panuccio@drbc.gov
Avery.Lentini@drbc.gov



DRBC.gov

<https://tinyurl.com/DRBC-Chlorides>

