Part 2: Spatio-temporal patterns of specific conductivity in streams and rivers of the Delaware River Basin

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Salinization of freshwater

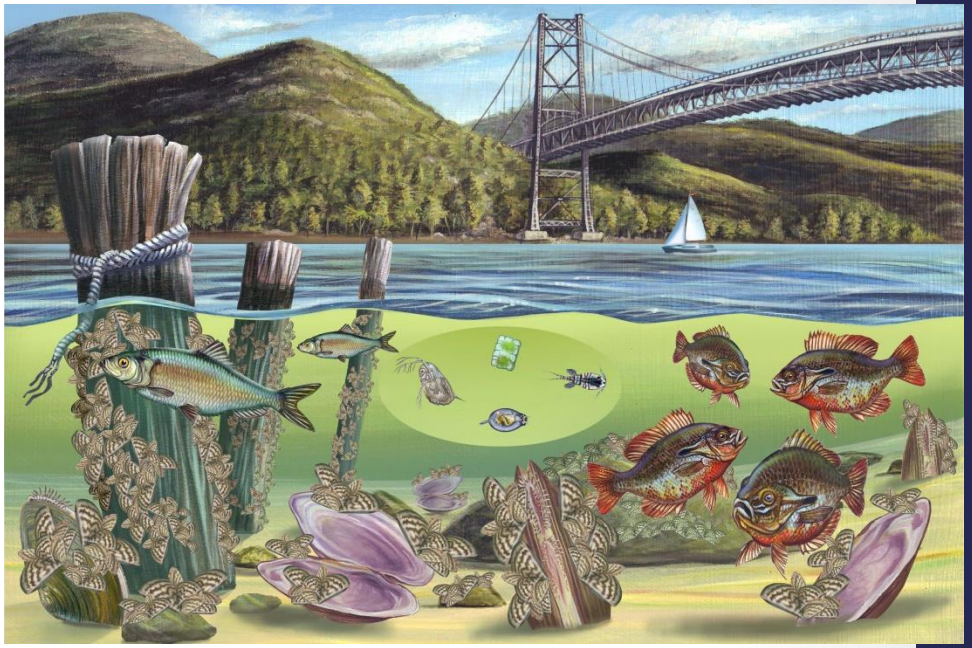
- Sources of ions to freshwaters:
  - Natural: soils and geology
  - Anthropogenic:
    - GW extraction->Salt water intrusion
    - Irrigation and fertilizer application
    - Mining
    - Demineralization of concrete
    - Road salt application
    - Sewage and industrial waste discharge

Brandywine Town Center, winter 2018
Road salt pile

REF: Kaushal, S.S., Likens, G.E., et al. 2018. Freshwater salinization syndrome on a continental scale. *PNAS*, *115*

Salinization of freshwater

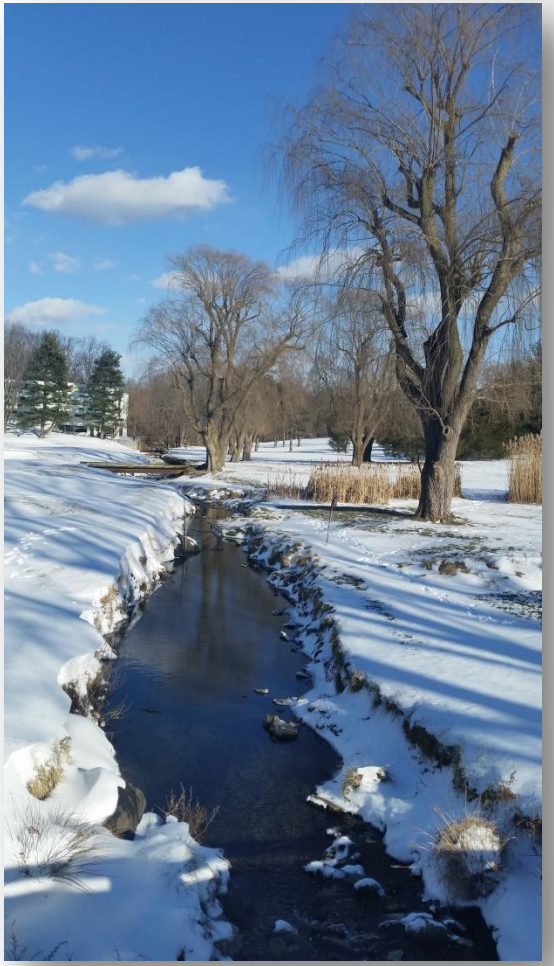
- Environmental implications of are still poorly understood.
- Symptoms can include changes in biodiversity due to osmotic stress and desiccation.
- Emerging threat to freshwater biodiversity



Source: https://www.haikudeck.com/streams--rivers-science-and-technology-presentation-V85aFFyFRe#slide5

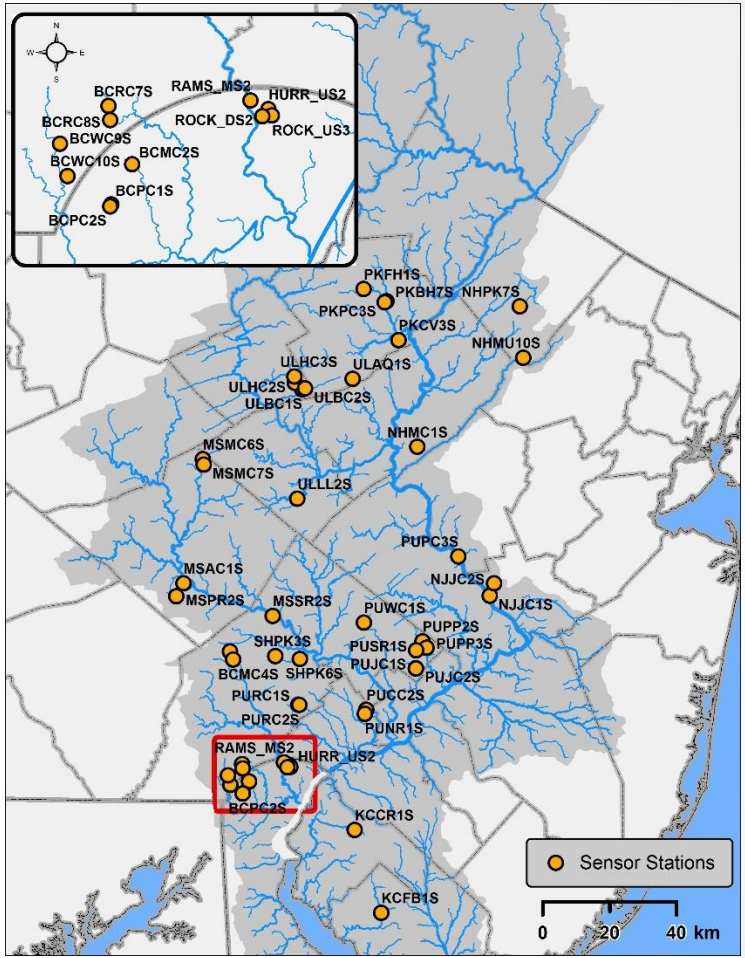
- Kaushal, S.S., Likens, G.E., et al. 2018. Freshwater salinization syndrome on a continental scale. *PNAS*, *115*
- Reid, A.J., Carlson, A.K., et al. 2019. Emerging threats and persistent conservation challenges for freshwater biodiversity. *Biol Revs, 94*

Are tributaries of the Delaware River Basin (DRB) experiencing increased salinization?

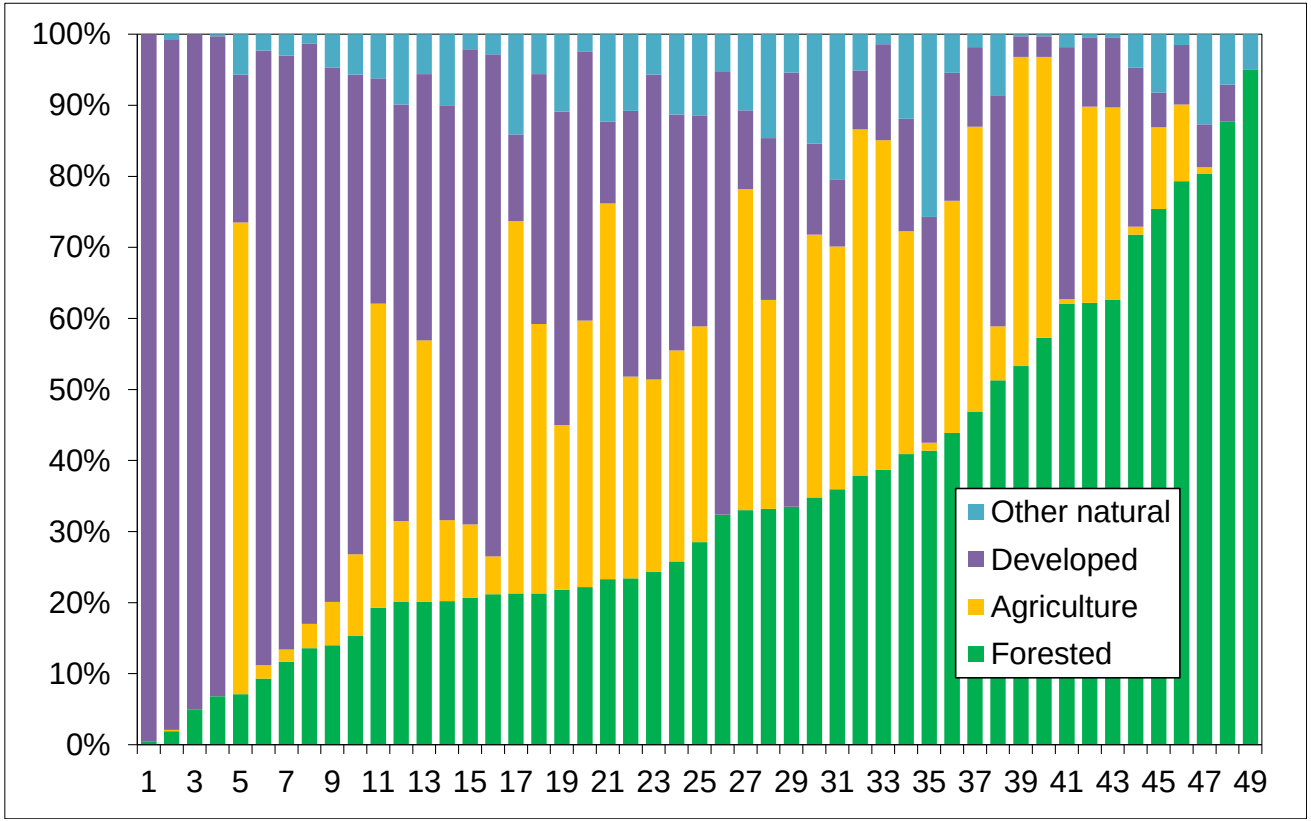


Data selection and screening

- DRWI Sensor Network
- Sensor sites with complete summer (June-August) and winter (December-February) specific conductivity (SC)
- Data in 2017 and/or 2018
- 50 sites selected

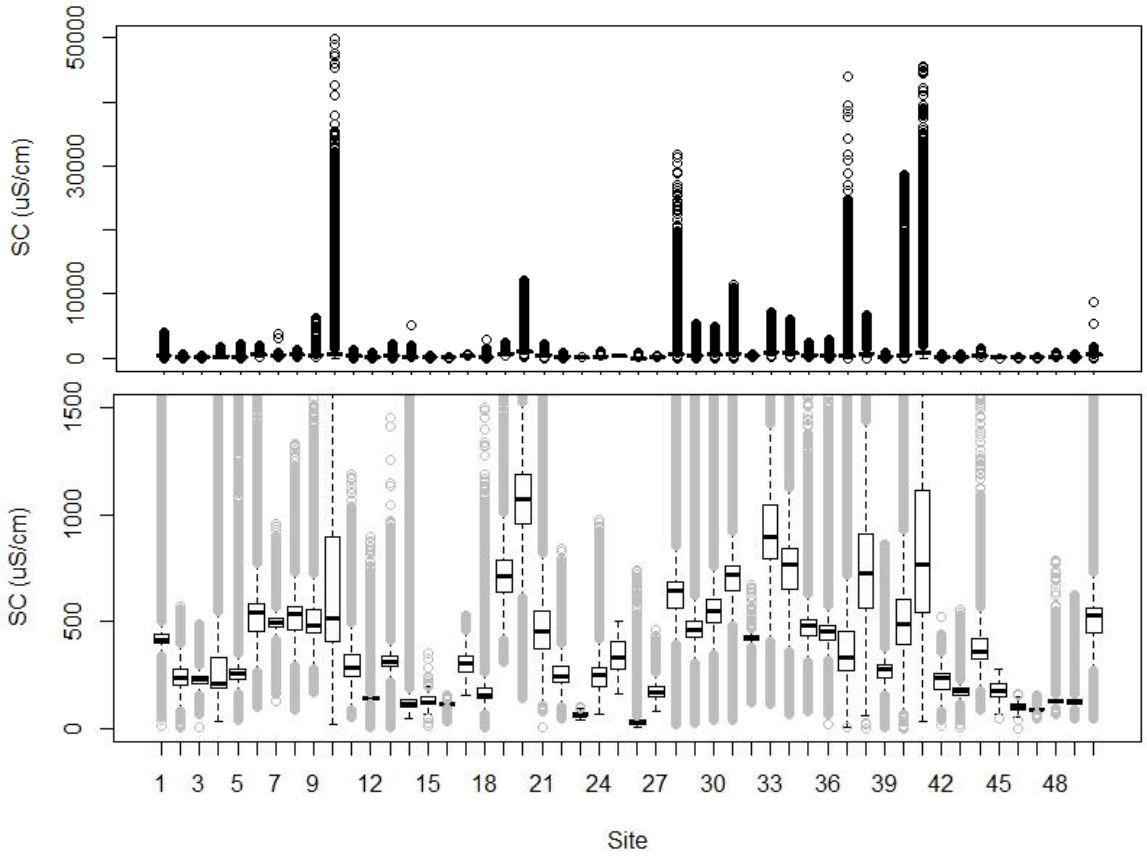


Study sites land-use



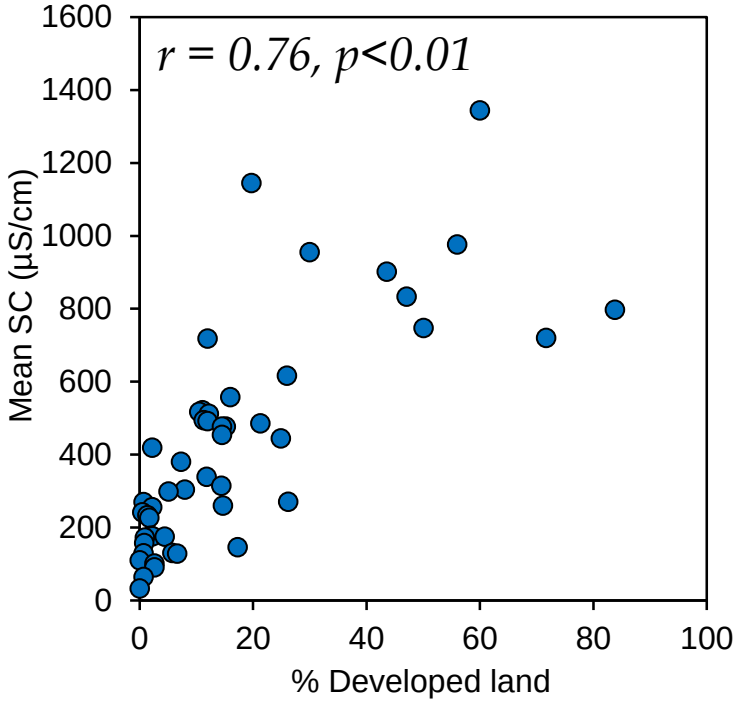
Land use data from the National Land Cover Database 2011 (NLCD2011)

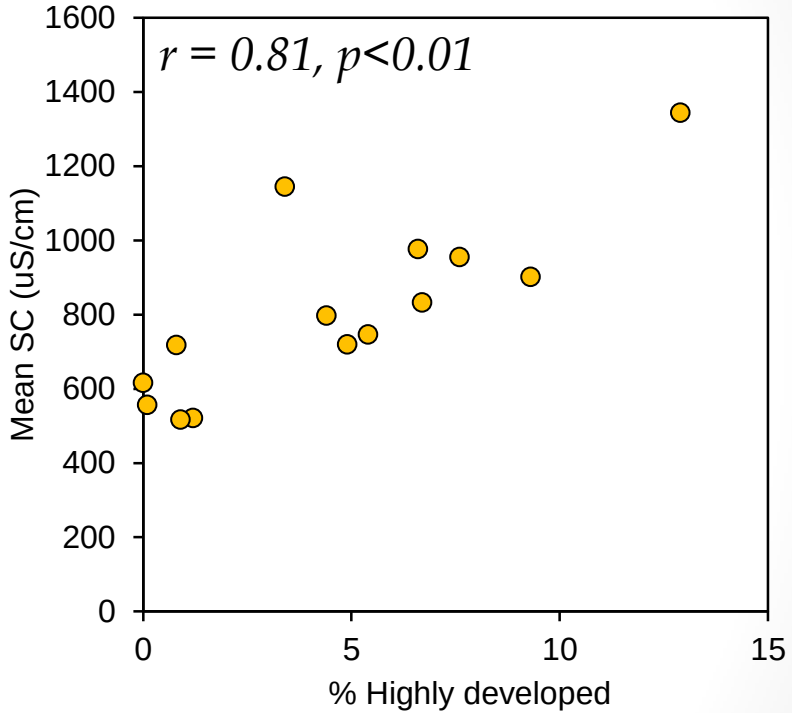
Specific conductivity (µS/cm)



- All available data in 2017-2018

Specific conductivity and land use

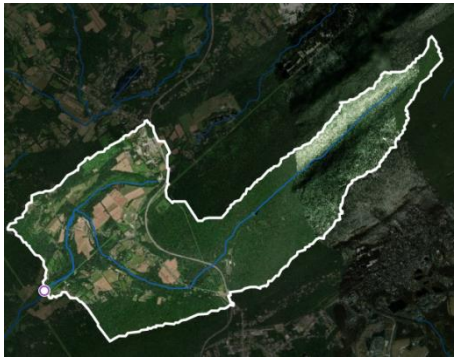


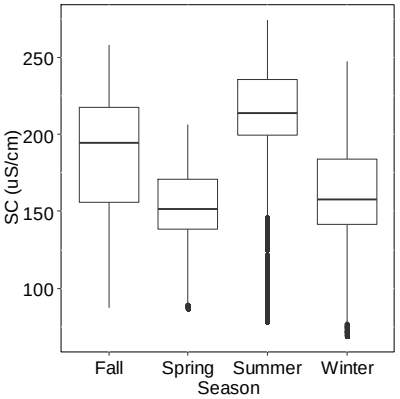


- % developed land in the WS was the best land-use predictor of mean SC across the study period
- For sites with highest mean SC, it was best explained by % highly developed land-use

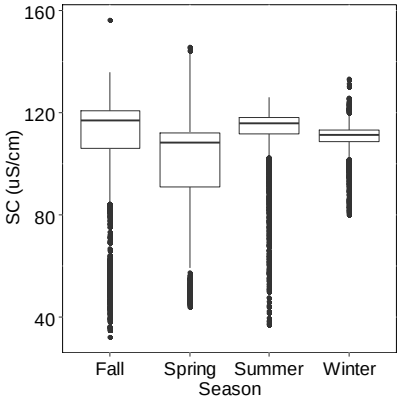
Seasonal trends: forested streams

Aquashicola Creek, 17 km^2

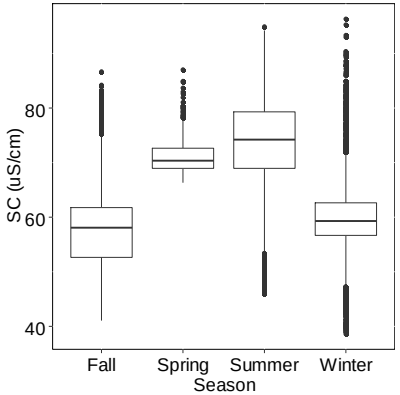




Punches Run, 1 km^2



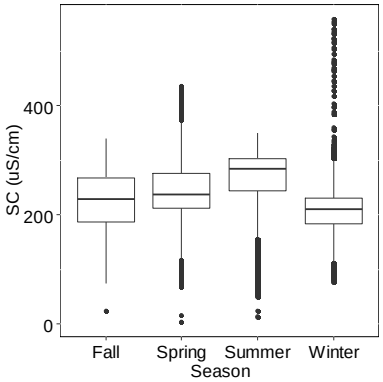
Brodhead Creek, 183 km^2



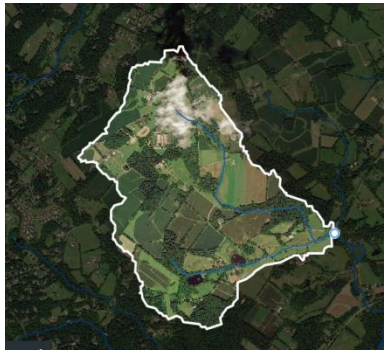
- 80-95%
- Highest in summer – no groundwater dilution
- Frequent low extremes

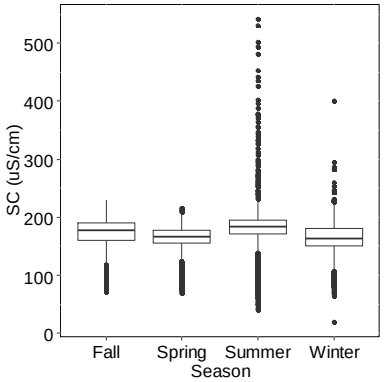
Seasonal trends: agricultural streams

Marsh Creek, 10 km^2

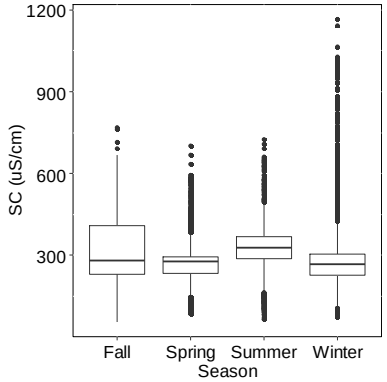


UT west,
Pickering Creek, 4 km^2





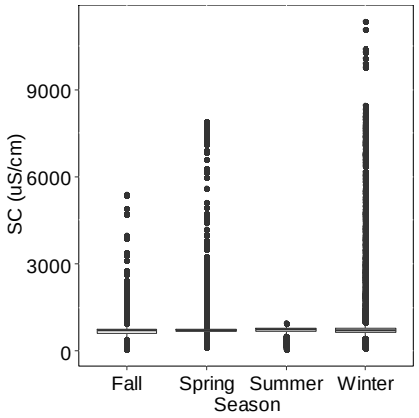
Chestnut Run, 4 km^2



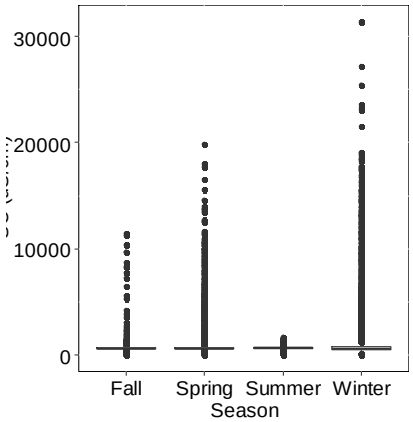
- 52-66%
- Highest in summer – no groundwater dilution
- More cases of high extremes
- Generally higher SC compared to forested sites

Seasonal trends: urban streams

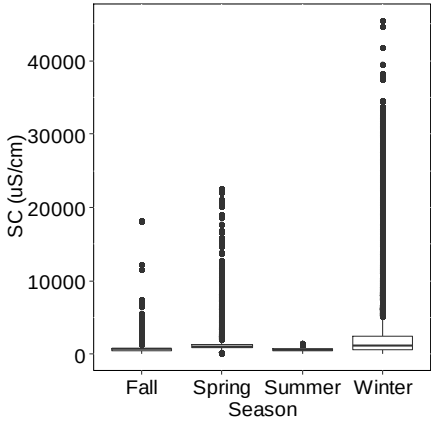
UT Cobbs Creek, 2 km²



Naylors Run, 7 km²



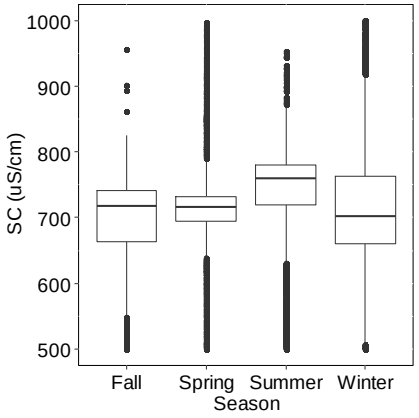
Rocky Run Upper, 2 km²



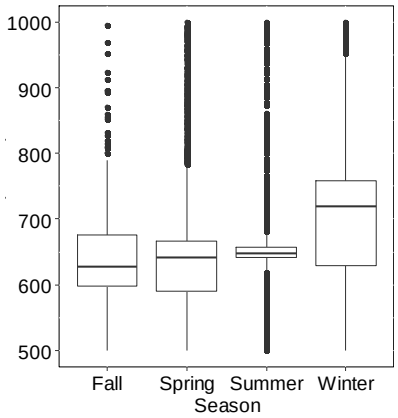
- 82-99%
- Much higher SC relative to forested and ag.
- Extreme SC in the winter but also in the spring

Seasonal trends: urban streams

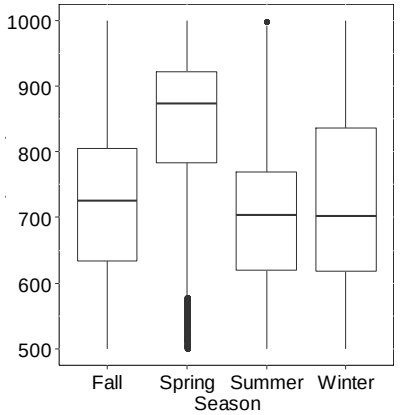
UT Cobbs Creek, 2 km^2



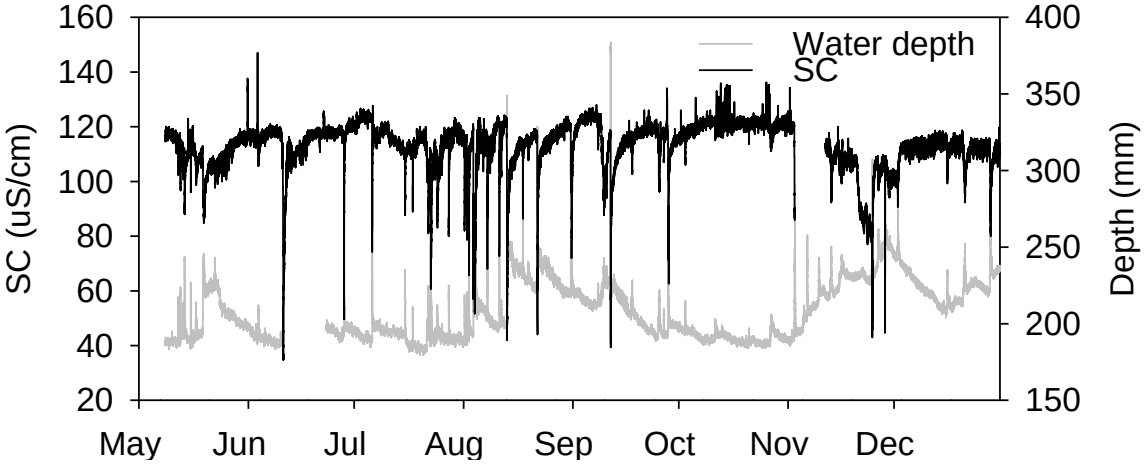
Naylors Run, 7 km^2

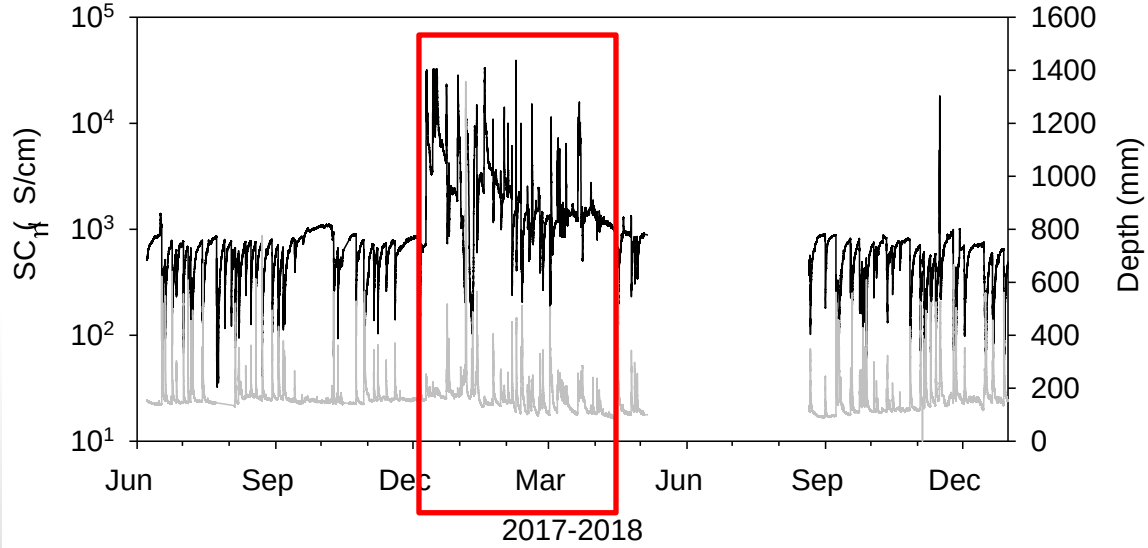


Rocky Run Upper, 2 km^2



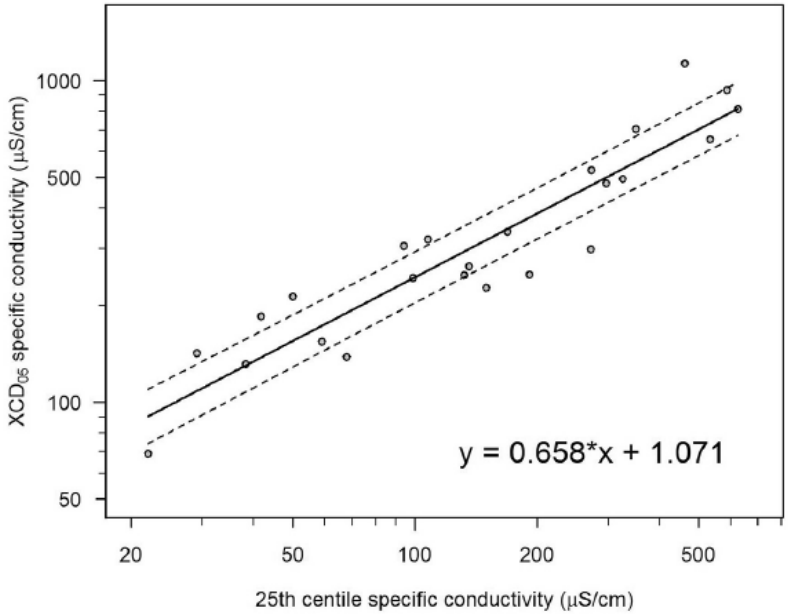
- 82-99%
- Much higher SC relative to forested and ag.
- Extreme SC in the winter but also in the spring
- 25-75% percentile of the measurements there is no clear trend





- Punches Run (Forested)
- Rocky Run (Urban)

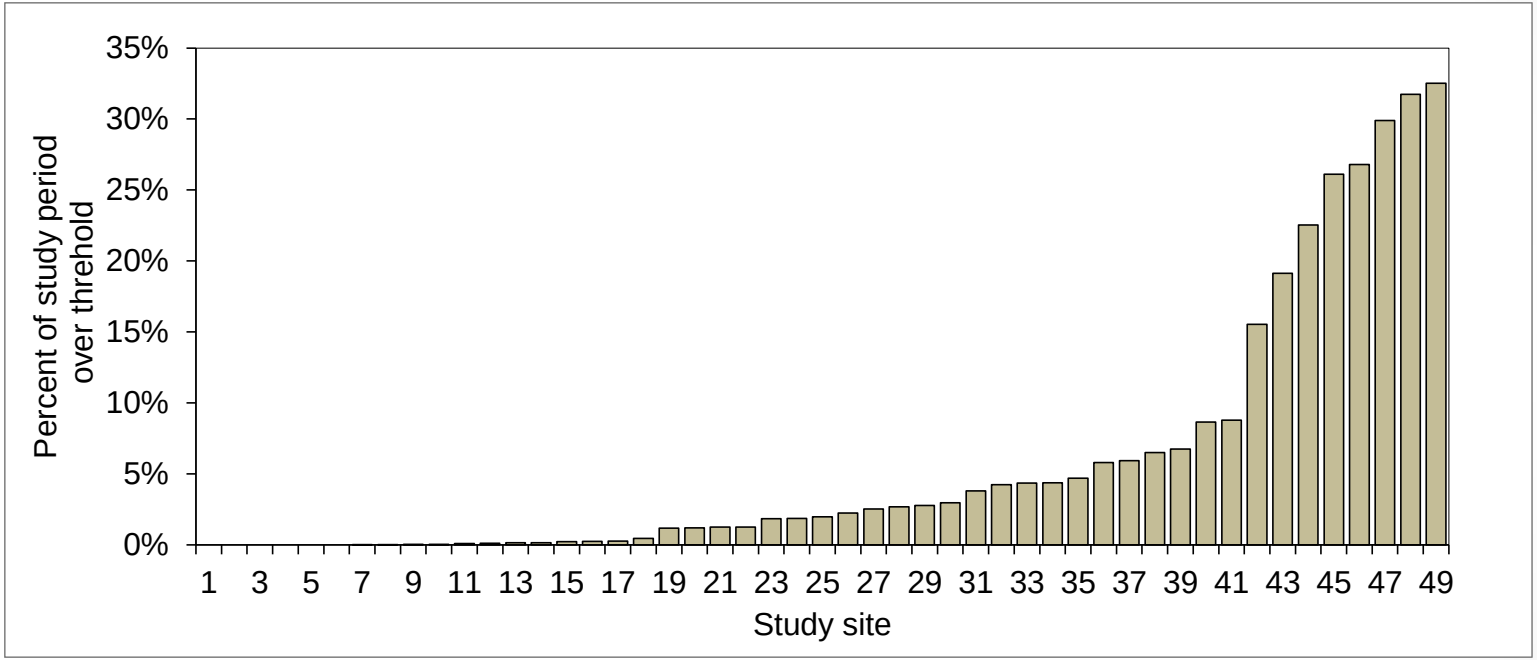
Potential effects on stream health



- Linear model that predicts SC at which 5% of benthic invertebrate g enera will be extirpated (XCD_{05})
  - 95% will be protected
- Based on background SC only
- Median SC ~ background SC
  - Conservative estimate of predicted XCD_{05}

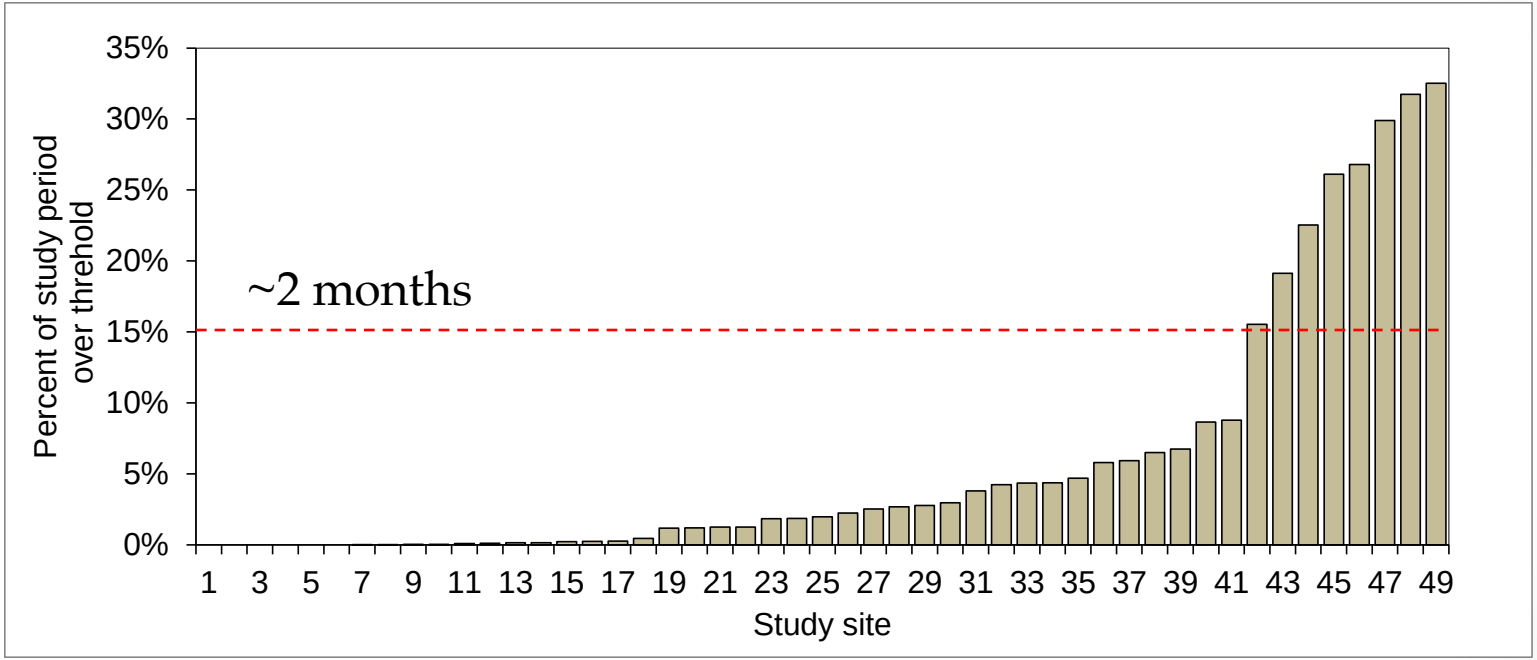
Cormier, S.M., Zheng, L. and Flaherty, C.M., 2018. A field-based model of the relationship between extirpation of salt-intolerant benthic invertebrates and background conductivity. *Science of The Total Environment*, *633*, pp.1629-1636.

Potential effects on stream health



- How frequently less than 95% of the invertebrates was protected.

Potential effects on stream health



- How frequently less than 95% of the invertebrates was protected.

In summary:

- Yes, tributaries of the DRB are experiencing increased salinity.
  - Related to land use, urbanization
    - Winter extremes likely related to road salt application
    - Increased SC year-around in agricultural and urban streams

Future work

- Determine dominant anions and cations
  - Analysis of grab samples
- More in depth land-use examination
  - Include geological and soil data
  - Impervious surface contribution
- Sites with rating curves:
  - Salt load to downstream ecosystems

Acknowledgments

- Collaborators:
  - Marc Peipoch
  - John Jackson
  - David Bressler
  - David Arscott
  - Charlie Dow

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Acknowledgments

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Bartrams Garden
Berks County Conservation District
Berks Nature
Brodhead Watershed Assocation
Darby Creek Valley Association
Delaware Riverkeeper
East Stroudsburg University
Eastern Delaware County Stormwater Collaborative
Great Marsh Institute
Green Valleys Watershed Association
Lake Committee, Somerset Lake Community
Lopatcong Creek Initiative; NJ Highlands Coalition
Montgomery School
Musconetcong Watershed Association
Penn State Master Watershed Stewards, Berks County
Pennypack Ecological Restoration Trust
Primrose Creek Watershed Association
Schuylkill River Greenways
Silver Lake Nature Center
South Jersey Land & Water Trust
The Independence School
The Land Conservancy for Southern Chester County
The Nature Conservancy, Delaware
The Nature Conservancy, New Jersey
The Watershed Institute
Tookany/Tacony-Frankford Watershed Partnership
Trout Unlimited
Trout Unlimited, New Jersey
Upper Perkiomen High School
Valley Forge Trout Unlimited
Wallkill River Watershed Management Group
White Clay Wild and Scenic
Wildlands Conservancy
Willistown Conservation Trust
Wissahickon Valley Watershed Association
Woodstown High School

Questions?