

# Part 3: Spatio-temporal patterns of water temperature in streams and rivers of the Delaware River Basin

19 November 2019

Delaware Watershed Research Conference  
The Academy of Natural Sciences of Drexel University

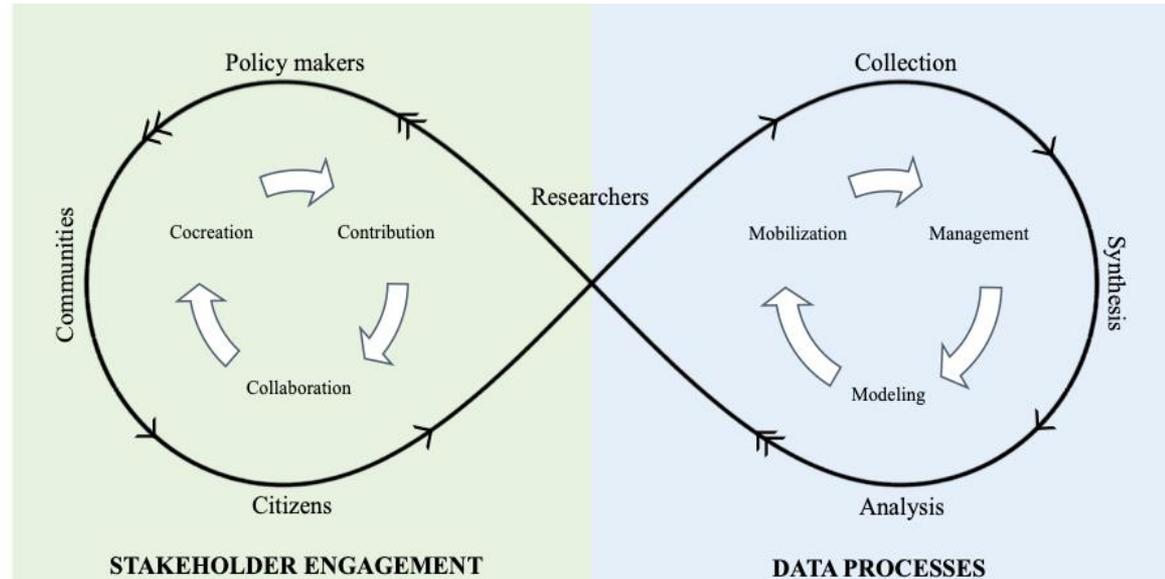
Presenter:

Marc Peipoch, PhD  
Assistant Research Scientist

# More than 35 organizations



# No PhDs needed: how citizen science is transforming research



# What can we learn from their data?



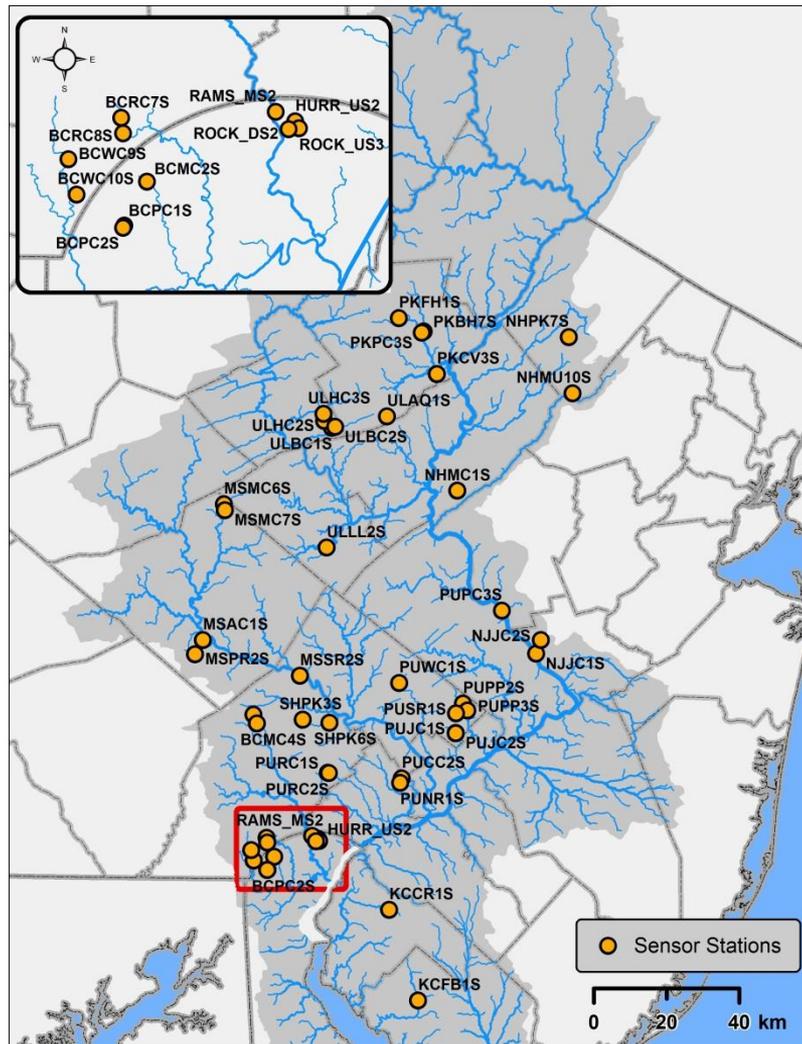
# What can we offer in return?



# EnviroDIY sensor stations

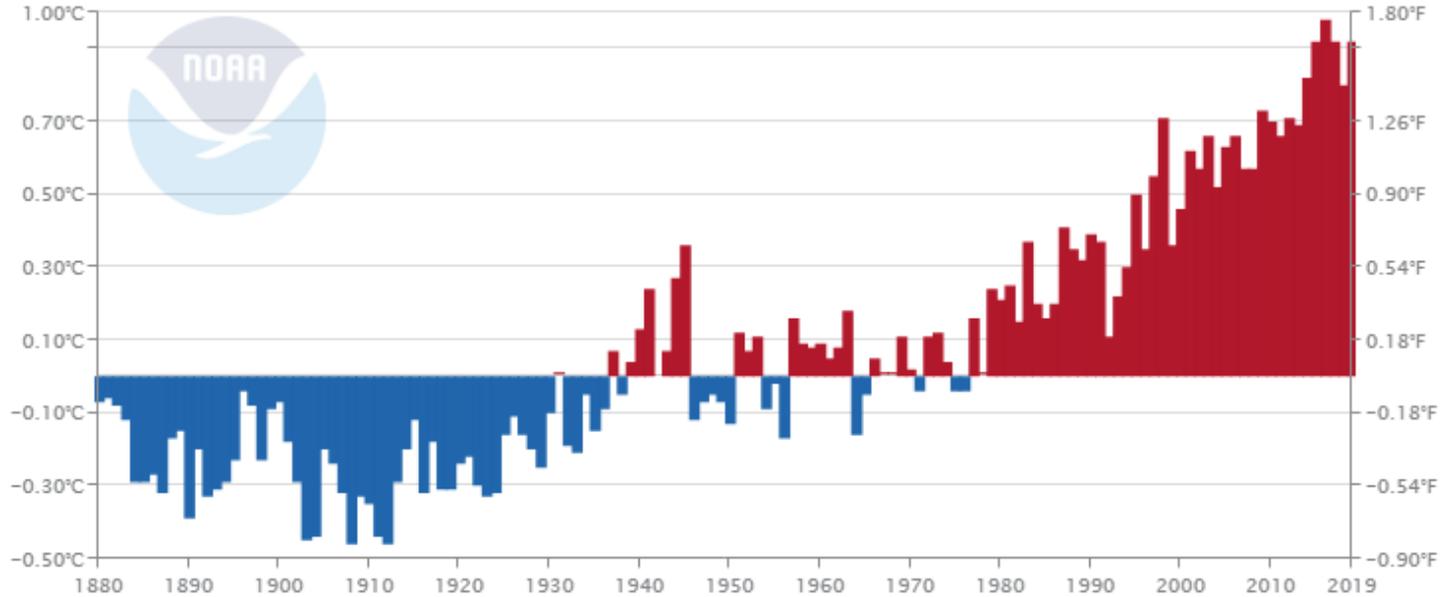
- Conductivity
- Water Temperature
- Depth
- Dissolved Oxygen

Logging data every 5 minutes  
Maintained by Watershed groups



# Global Warming and Stream Temperatures

Global Land and Ocean  
August Temperature Anomalies



Stream temperatures are rising at 65% of the continental U.S. gauges with sufficient data since 1990

## RIVER & STREAM TEMPERATURES

CHANGE IN AVERAGE TEMPERATURE SINCE 1990



Change in mean March-August temperature 1980-2018  
Gauges chosen based on most consistent observational record.  
Source: USGS

# Consequences of Increasing Temperatures

- Longer growing season
- Increased productivity
- Species dispersion (invasive)
- Changes in community composition

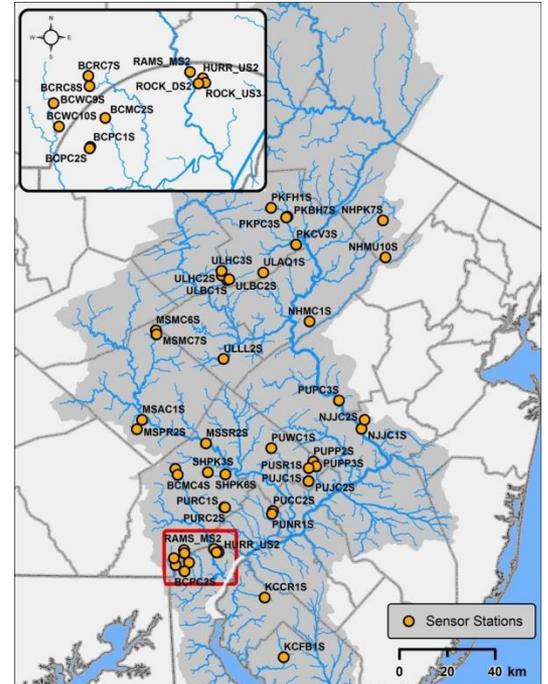


# For Today's purposes:

a preliminary assessment of summer temperatures in the Delaware River Watershed

## Data selection and screening

- DRWI Sensor Network
- Sensor sites with summer (June-September) data for water temperature
- Data from 2017 and/or 2018
- 50 sites selected

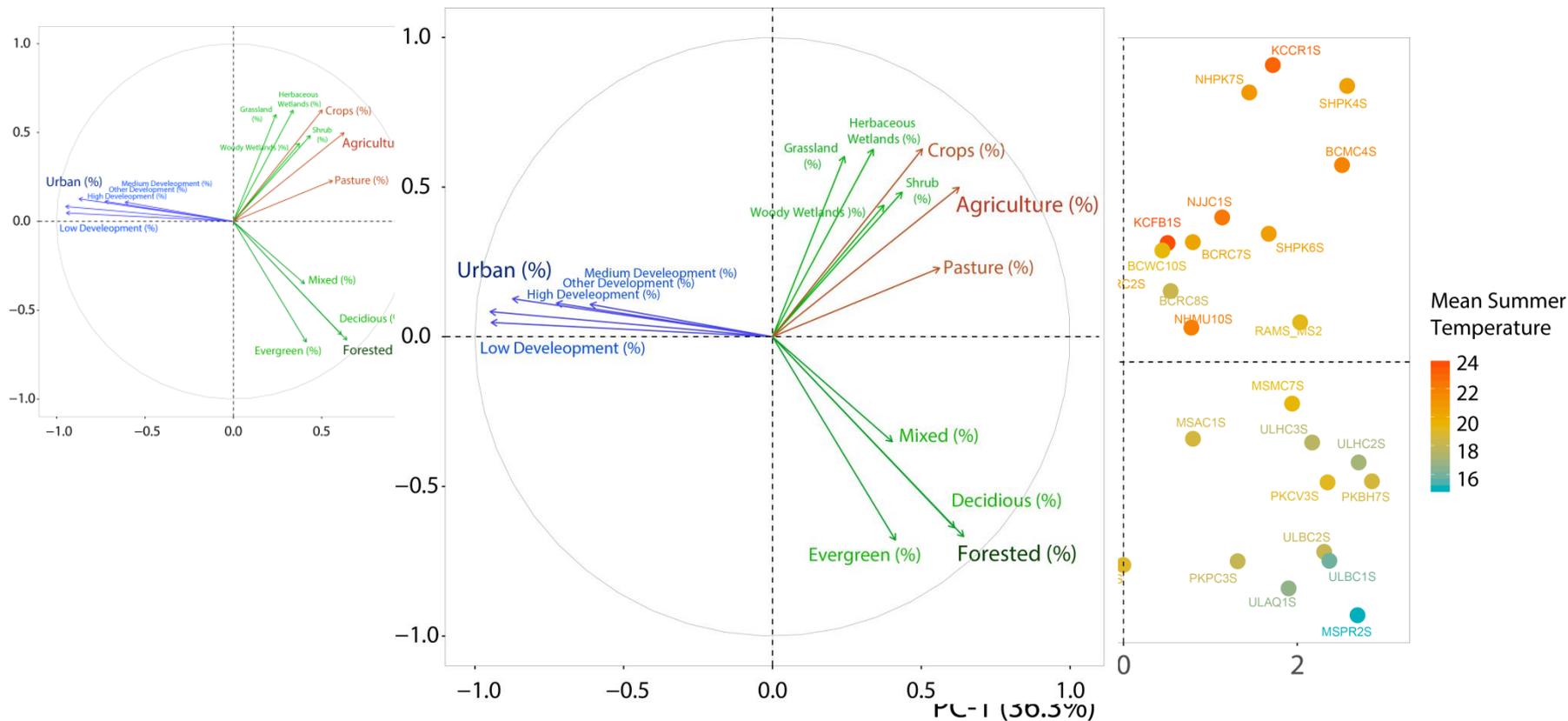


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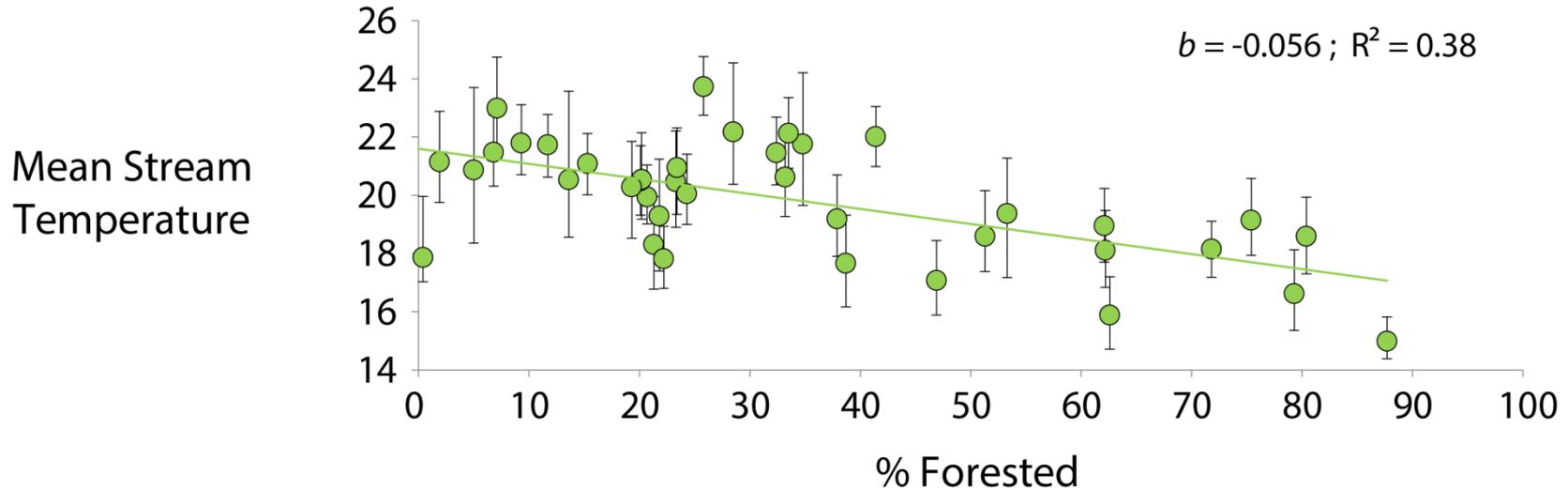
- Relationships between land use and stream summer temperature in the Delaware Watershed

# Land use and stream temperature



50 sites of different size with varying land uses

# Forest area and stream temperature



10% forested area yields a 0.5°C decrease

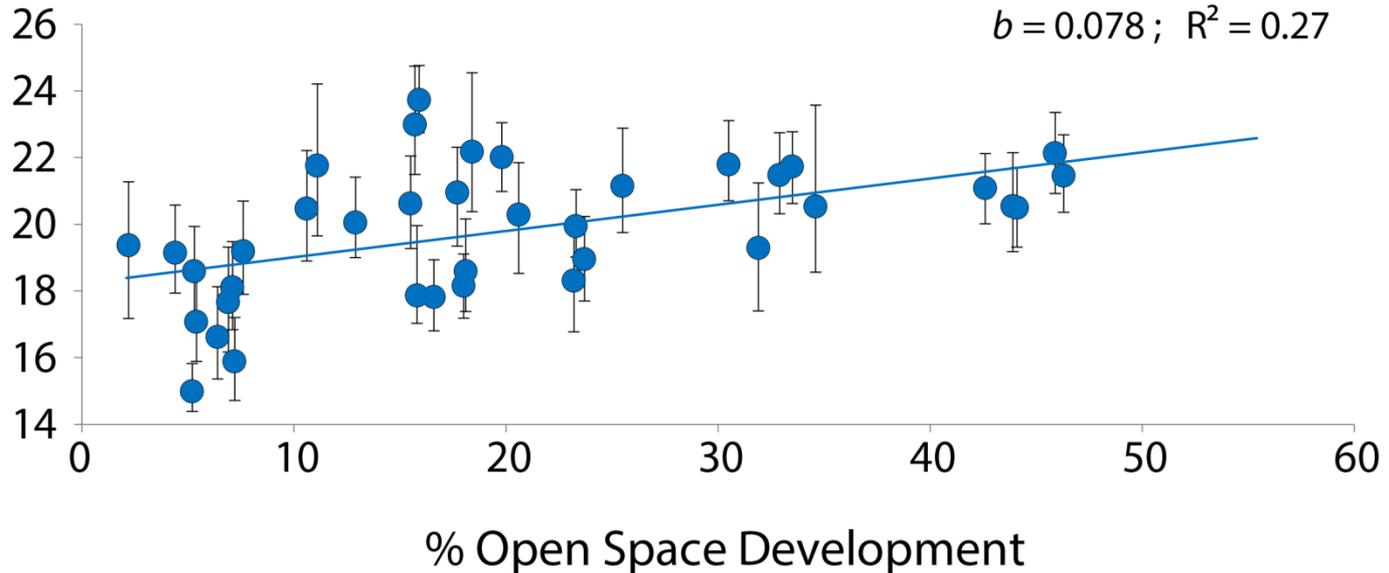
# Urban Development and stream temperature

Open  
development



% Urban or low, med, high  
development intensity ( $R^2 < 0.05$ )

Mean Stream  
Temperature



# For Today's purposes:

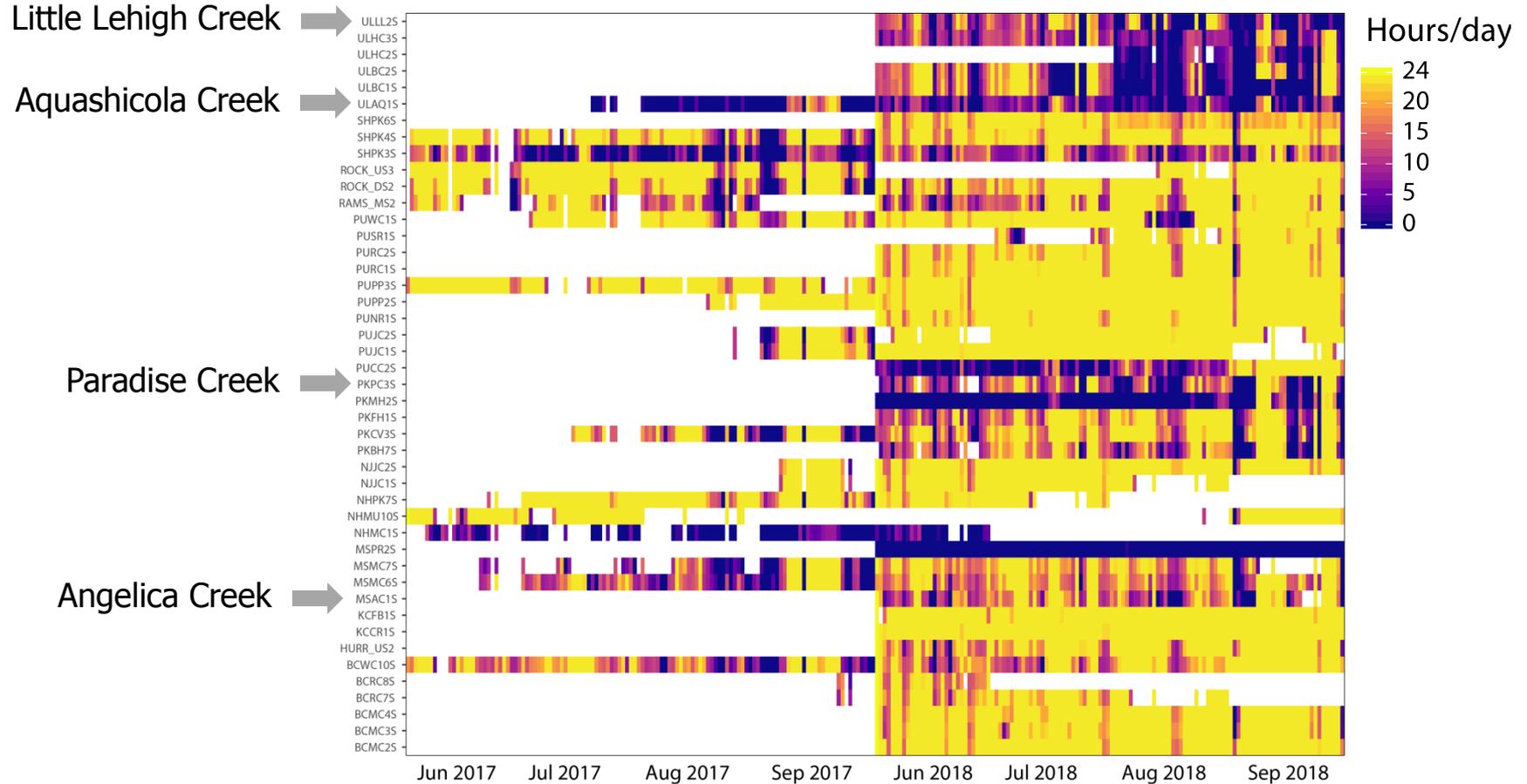
a preliminary assessment of summer temperatures in the Delaware River Watershed

- Relationships between land use and stream summer temperature in the Delaware Watershed
- Evidence of thermal stress for warm- and cold-water fish

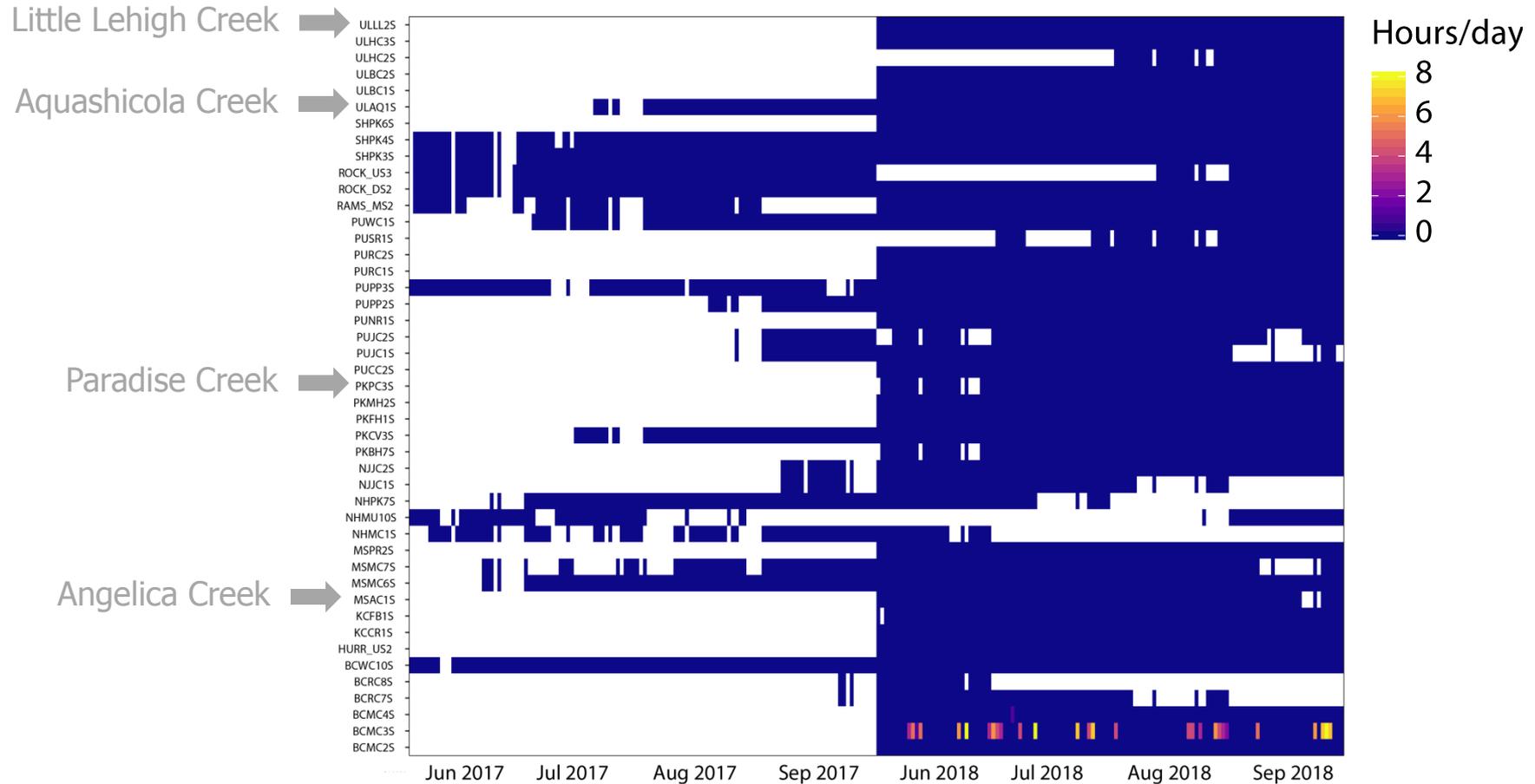
# Temperature Criteria in the Watershed

- **WWF - Warm Water Fishes:** 26.6°C – 30.5°C
- **CWF - Cold Water Fishes:** 15.5°C – 18.8°C

# Number of hours a day exceeding CWF?



# Number of hours a day exceeding WWF?



# For Today's purposes:

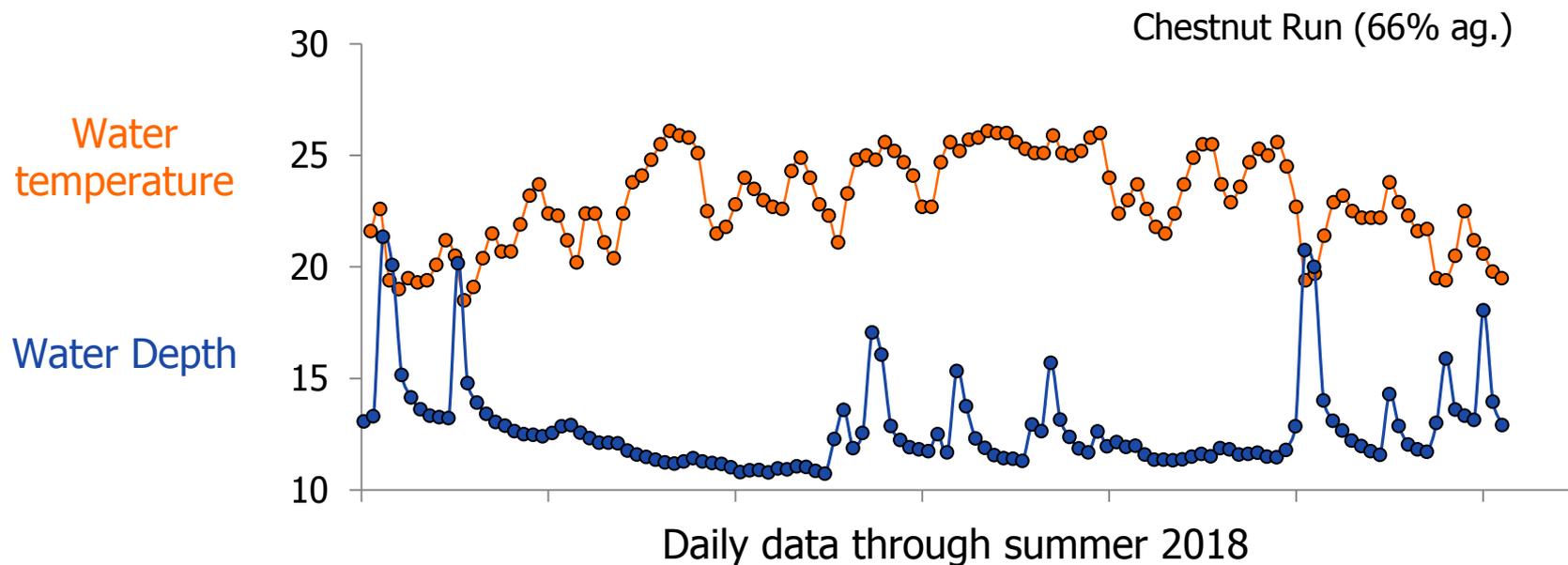
a preliminary assessment of summer temperatures in the Delaware River Watershed

- Relationships between land use and stream summer temperature in the Delaware Watershed
- Evidence of thermal stress for warm- and cold-water fish
- Temperature surges associated with high-flow events in contrasting watersheds

# Temperature surges and stream flow

- A temperature surge was defined as an increase/decrease of  $>1.3^{\circ}\text{C}$  over 15 minutes
- Assumed to persist until temperatures had reached  $\leq 1.3^{\circ}\text{C}$  of the pre-surge temperature

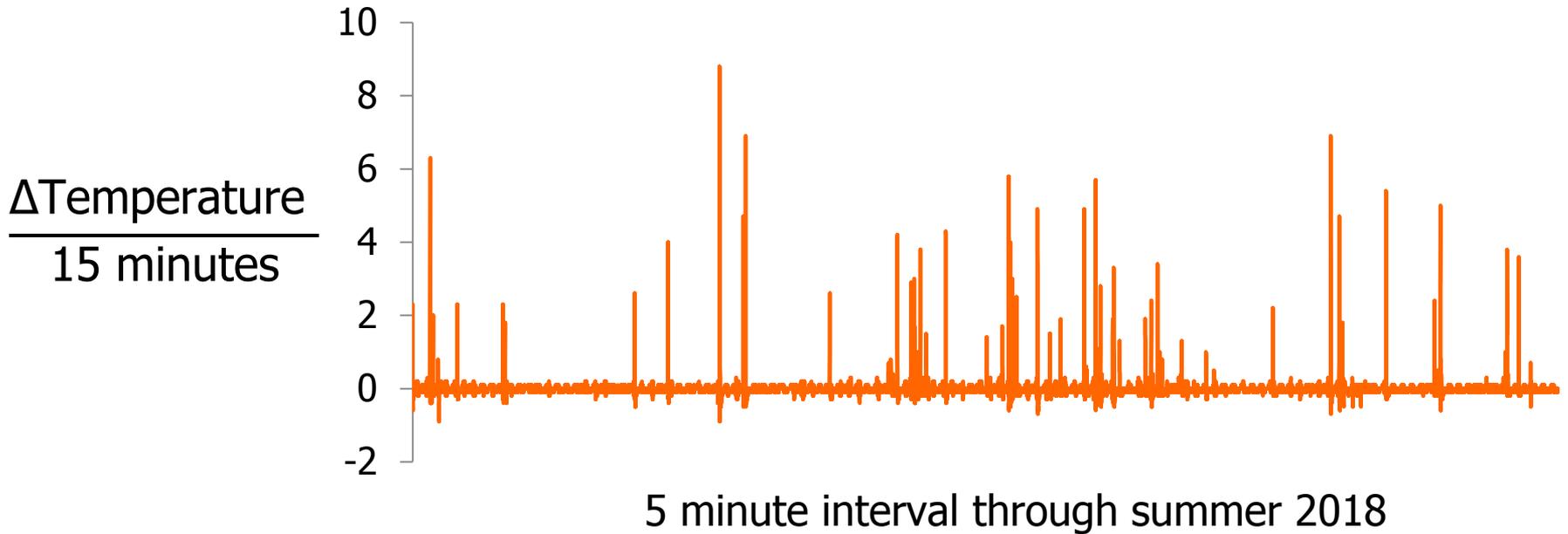
# No evidence of temperature surge in most forested and agricultural streams



Temperature vs. Depth  $r = -0.38$  in Forested Streams

Temperature vs. Depth  $r = -0.47$  in Agricultural Streams

A total of 33 temperature surges registered in Cobbs Creek (88% urban watershed)



# In summary

- Significant 'cooling effects' of forested watersheds on stream temperatures at the large scale
- Exceedance of state criteria for Cold Water Fish by many hours/days in multiple streams
- Contrasting patterns of stormflow on stream temperatures depending on land use

We are just getting started...



- Land Use and Seasonality
- Effects of Stream Restoration
- Mechanisms of temperature surges
- etc..

# Acknowledgments

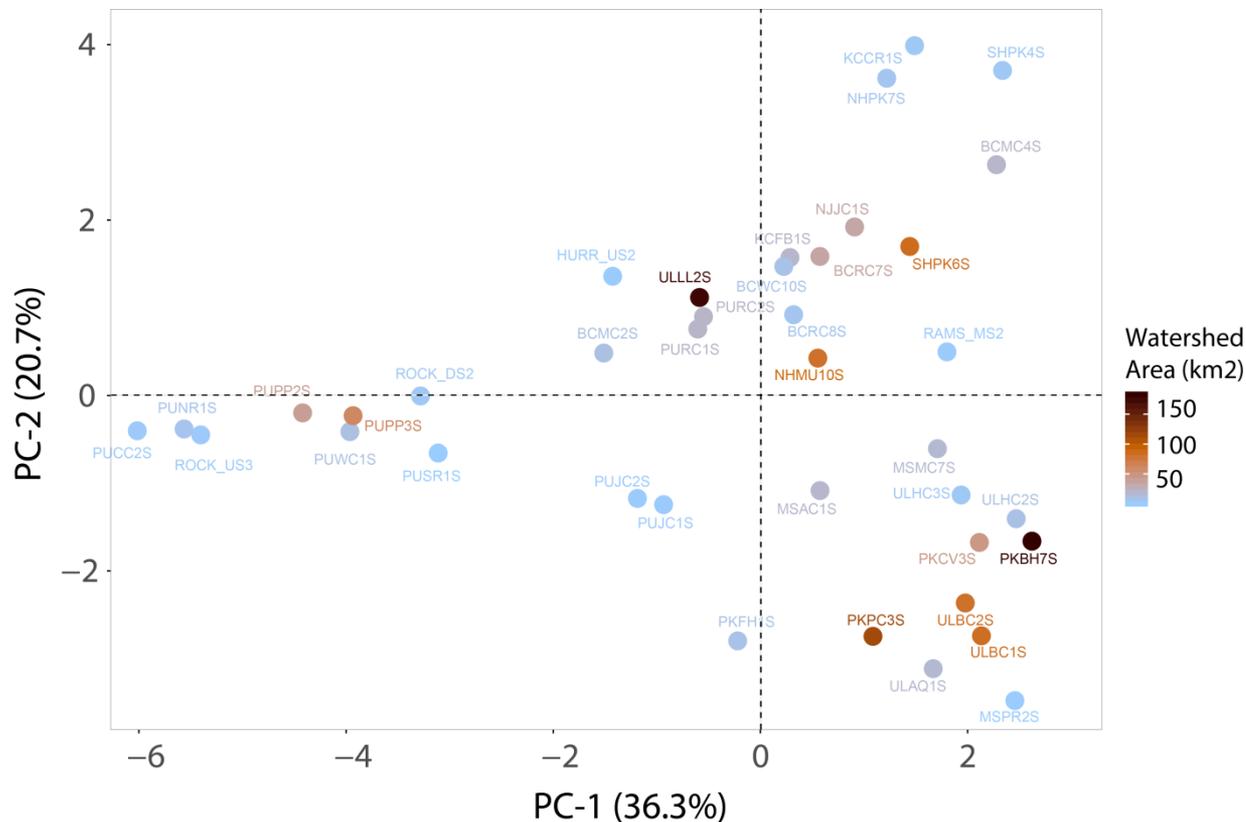
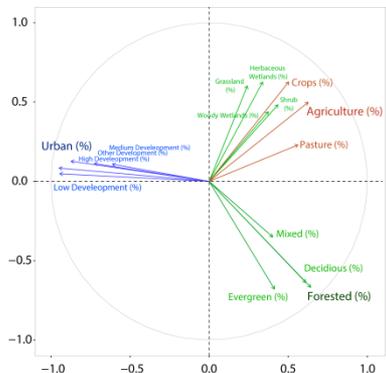
- Collaborators:
  - Diana Oviedo-Vargas
  - John Jackson
  - David Bressler
  - David Arscott
  - Charlie Dow
- Citizen scientists



*William Penn*  
W I L L I A M P E N N  
F O U N D A T I O N

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# Land use and stream temperature



50 sites of different size with varying land uses