

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



PennState Extension



BERKS COUNTY
CONSERVATION DISTRICT



Woodstown High School
Learning is our mission
Once a Wolverine, Always a Wolverine



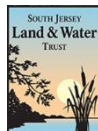
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GREEN VALLEYS
WATERSHED
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French & Pickering
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WHITE CLAY CREEK
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Ours to Enjoy. Ours to Protect.

Aquashicola Pohopoco
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Primrose Creek WATERSHED ASSOCIATION

UPPER PERKIOMEN HIGH SCHOOL



Tookany/Tacony-Frankford
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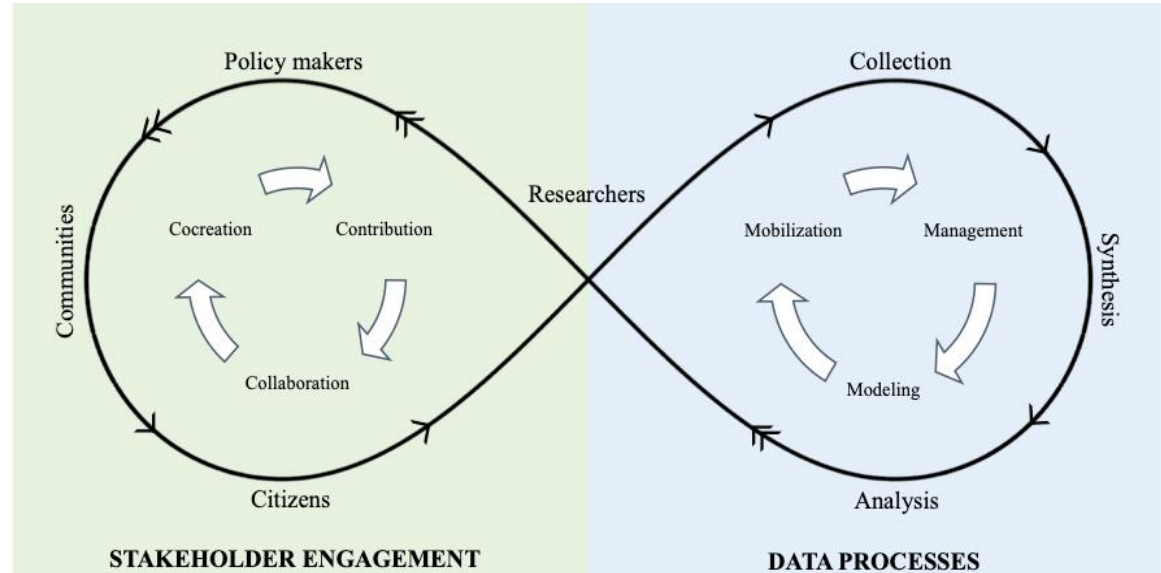
AMERICAN LITTORAL SOCIETY
Caring for the Coast

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LAFAYETTE

No PhDs needed: how citizen science is transforming research



What can we learn from their data?



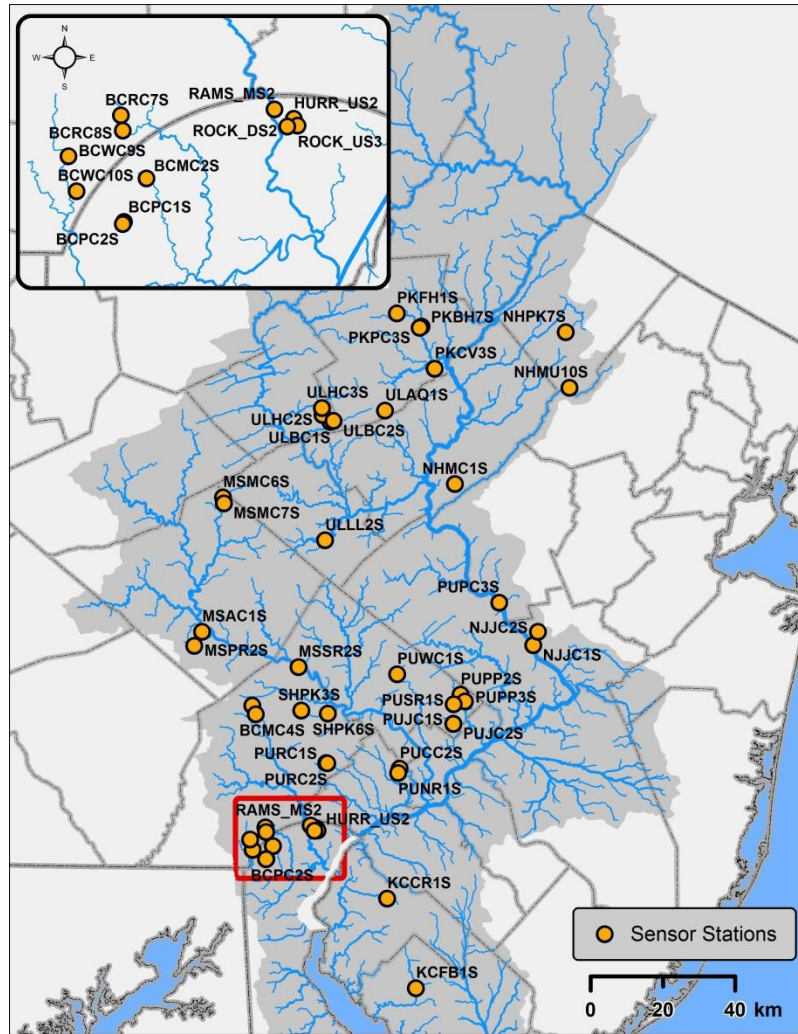
What can we offer in return?



EnviroDIY sensor stations

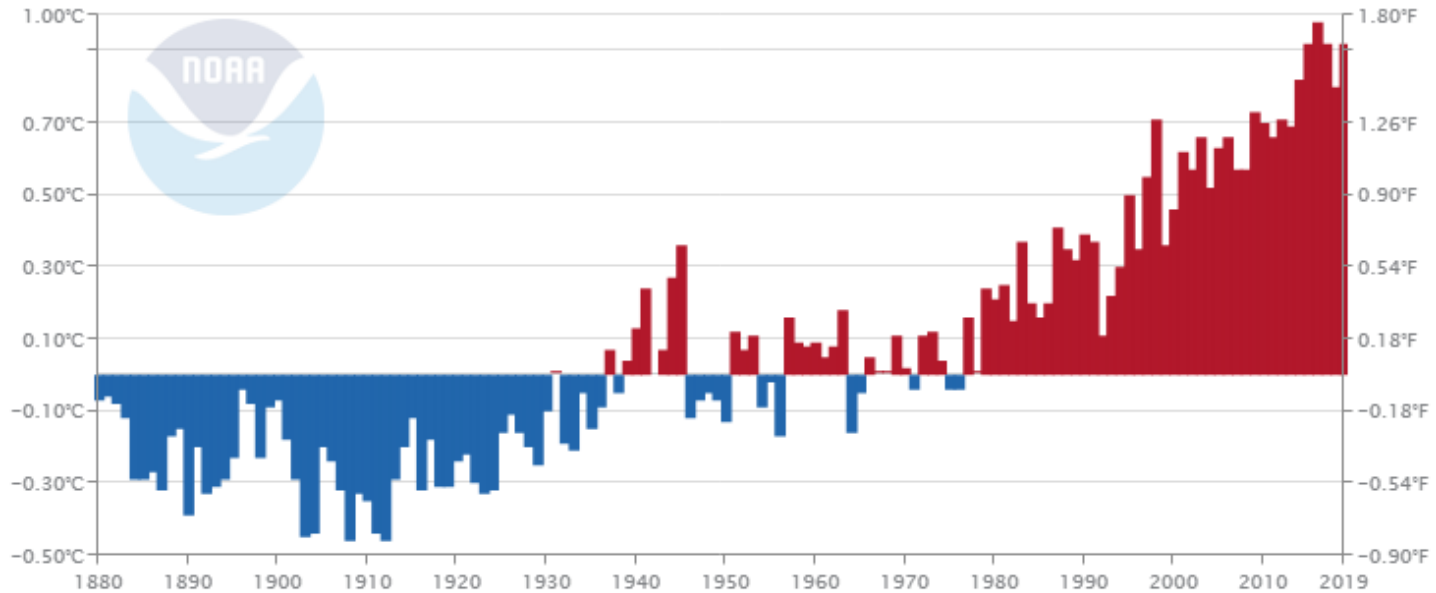
- Conductivity
- Water Temperature
- Depth
- Dissolved Oxygen

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

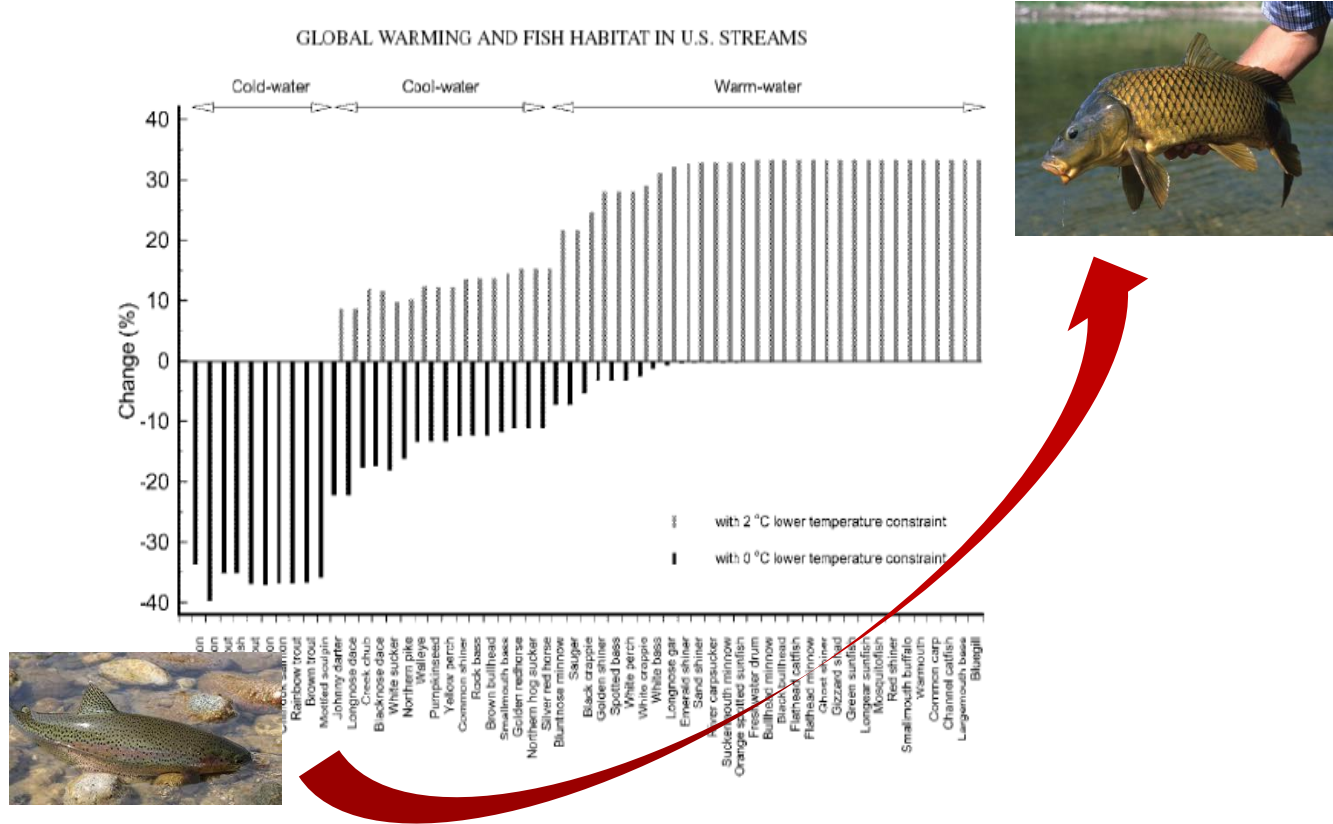


Change in mean March-August temperature 1980-2018
Gauges chosen based on most consistent observational record.
Source: USGS

Consequences of Increasing Temperatures

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

Changes in fish community composition

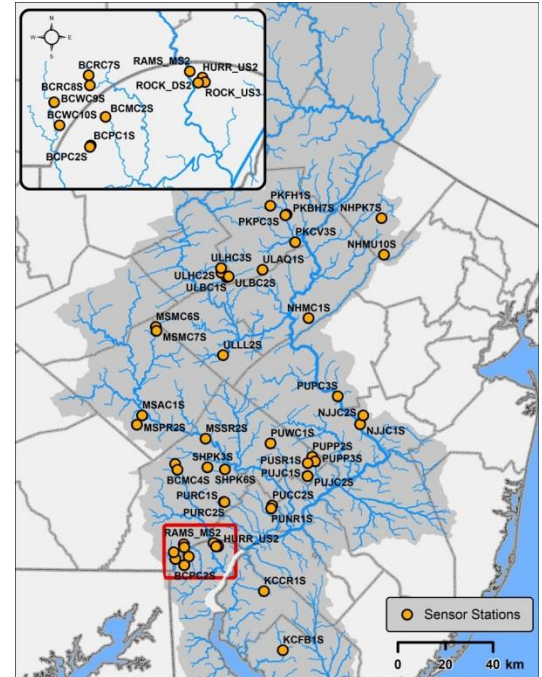


For Today's purposes:

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

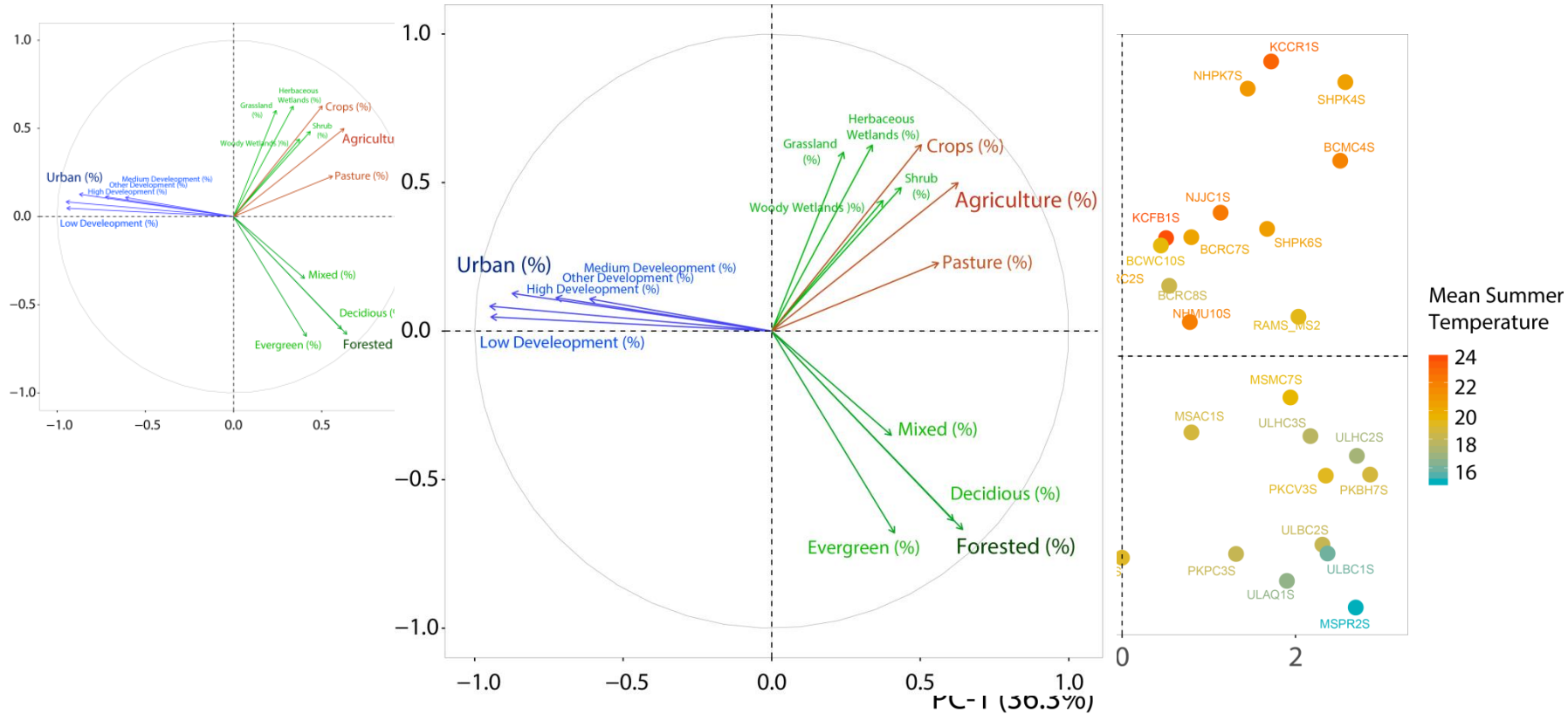


For Today's purposes:

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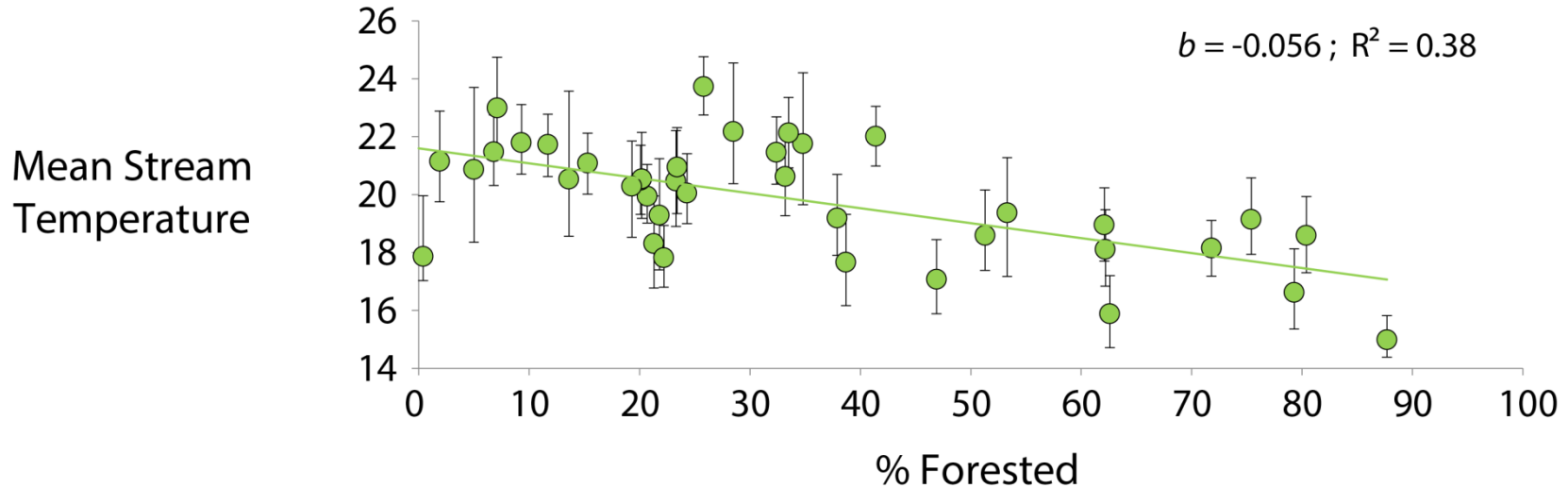
- Relationships between land use and stream summer temperature in the Delaware Watershed

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

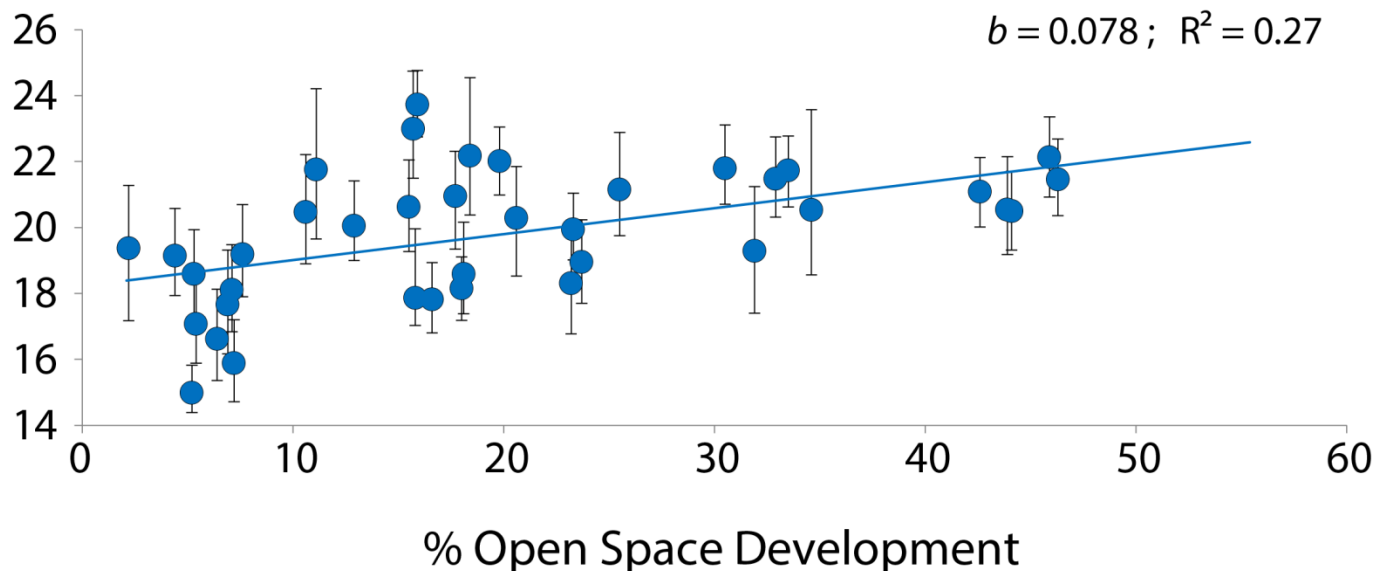
Urban Development and stream temperature

Open
development



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

Mean Stream
Temperature



For Today's purposes:

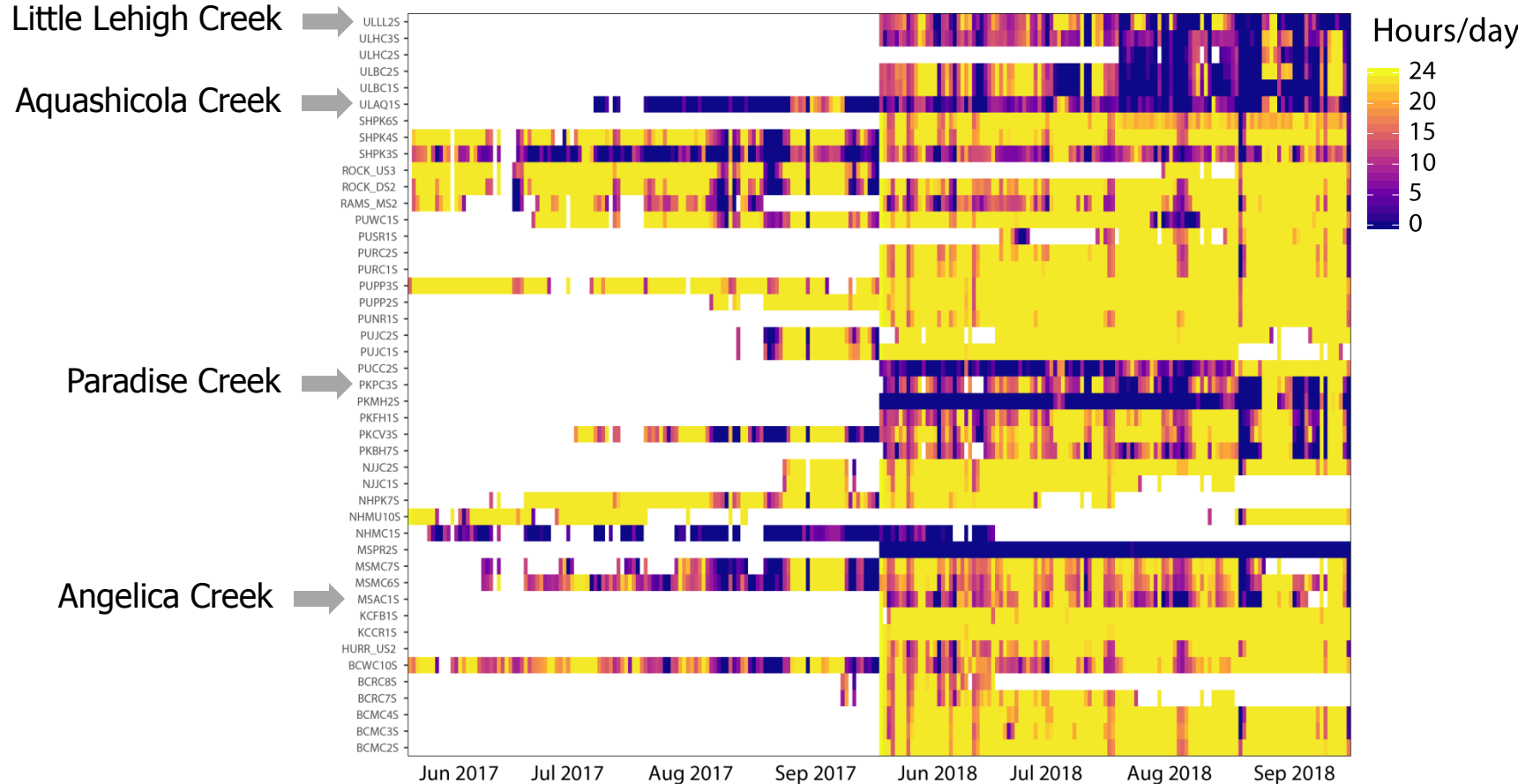
a preliminary assessment of summer temperatures in the Delaware River Watershed

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

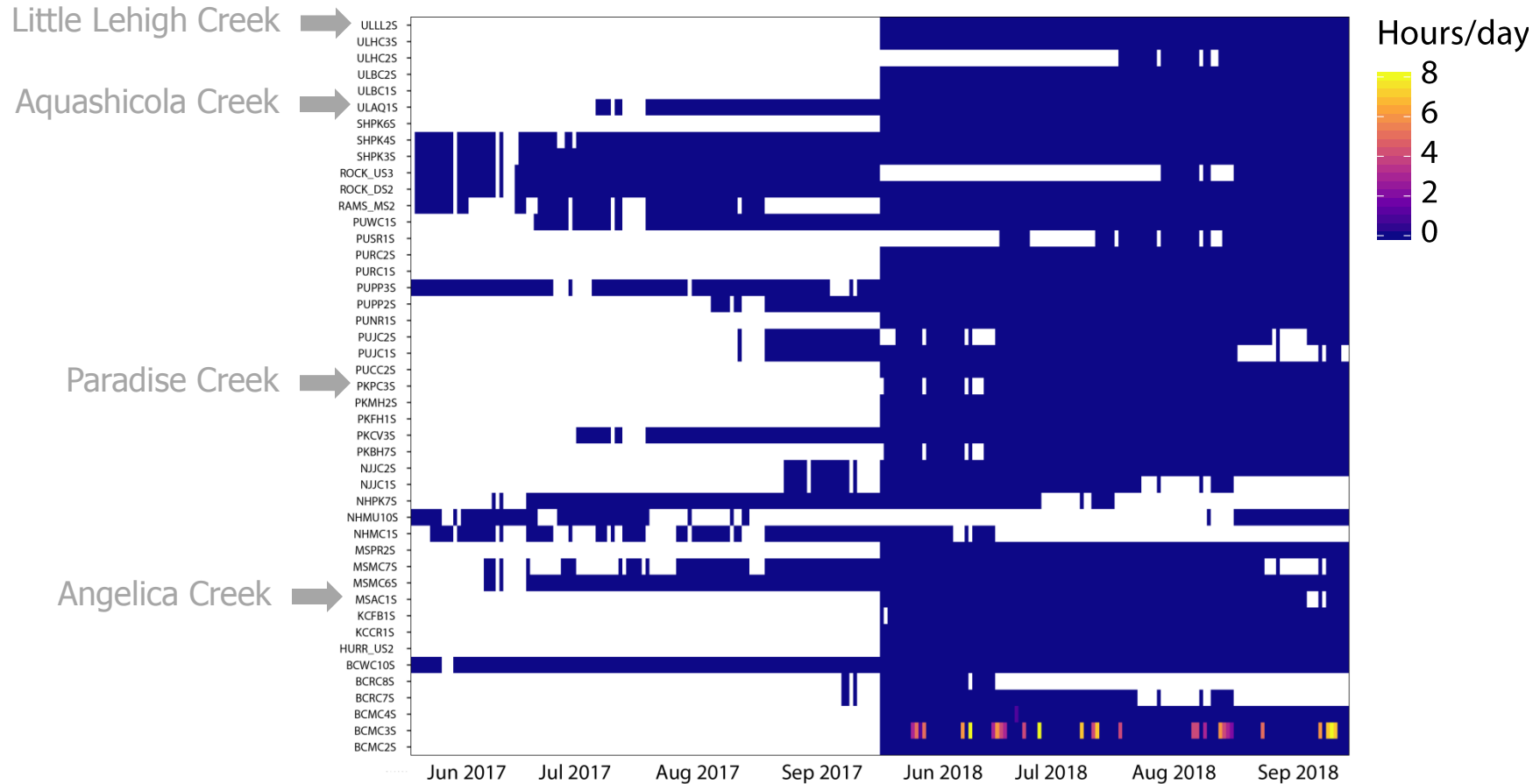
Temperature Criteria in the Watershed

- **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:

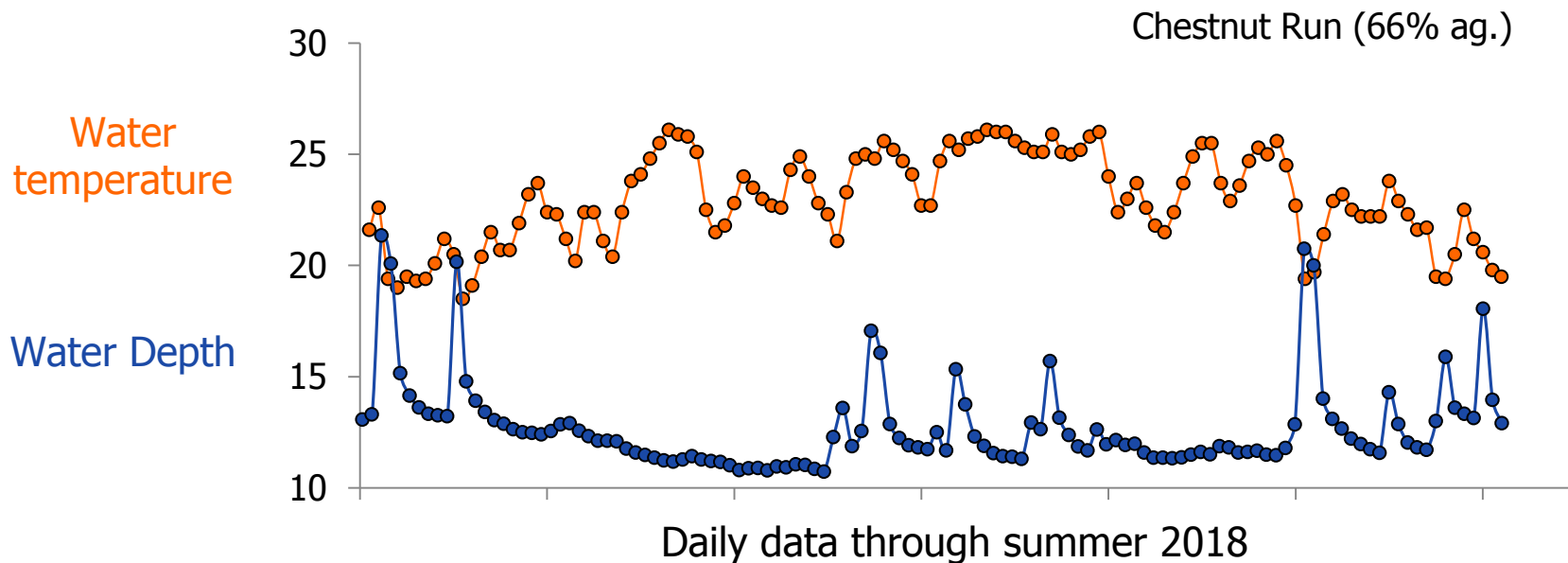
a preliminary assessment of summer temperatures in the Delaware River Watershed

- 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

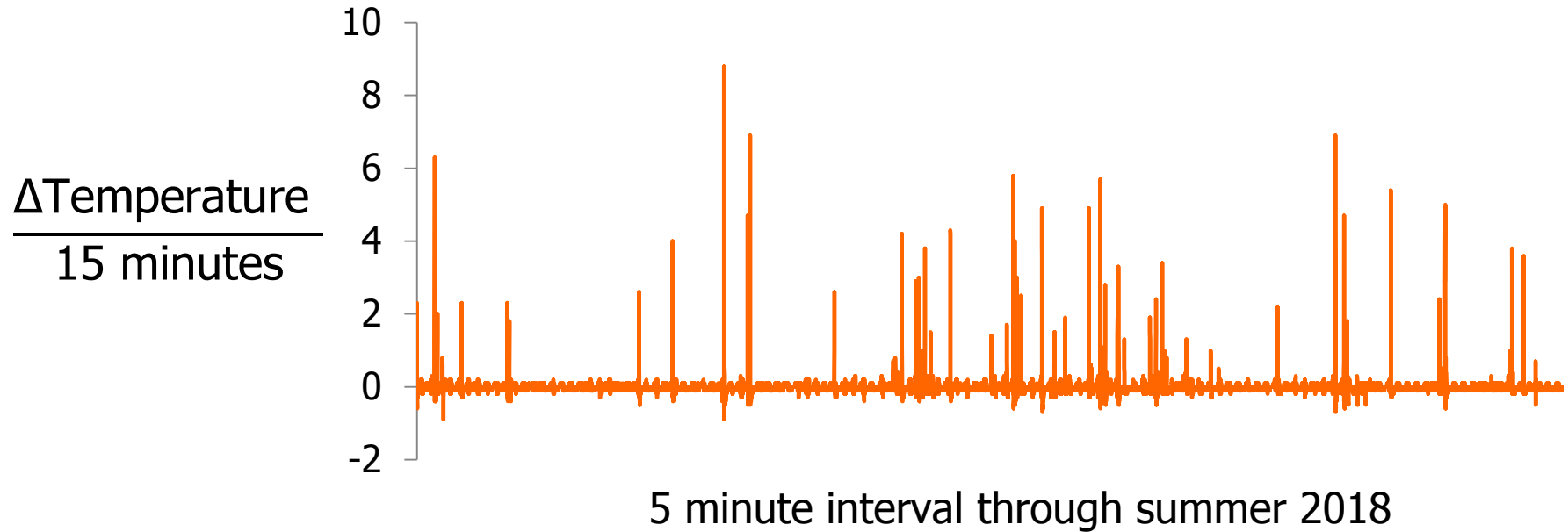
No evidence of temperature surge in most forested and agricultural streams



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

Temperate 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

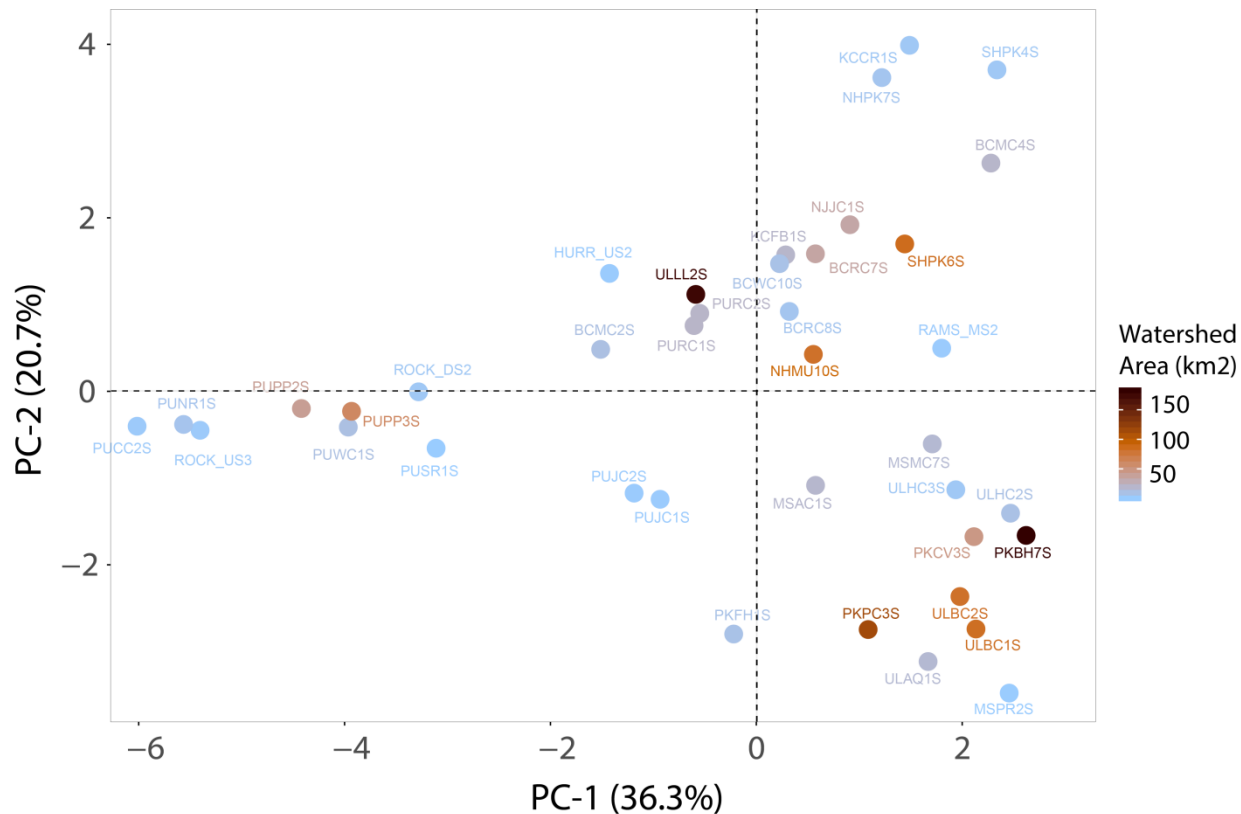
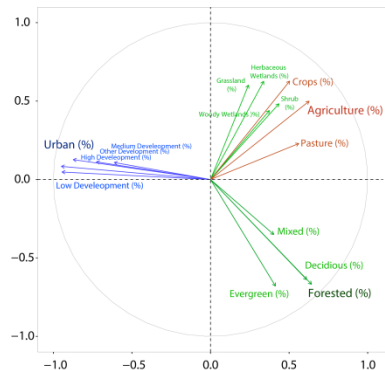
- Collaborators:
 - Diana Oviedo-Vargas
 - John Jackson
 - David Bressler
 - David Arscott
 - Charlie Dow
- Citizen scientists



William Penn
W I L L I A M P E N N
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Land use and stream temperature



50 sites of different size with varying land uses