# Stream temperature monitoring and some applications in NJ's Delaware basin

EnviroDIY in the Delaware River Basin – April 2024 Meeting

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# Agenda

- Why stream temperature?
- Approaches to monitoring temperature
- Example applications of monitoring data to NJ conservation planning

***~35 minutes – feel free to interrupt***

***Delaware River Basin Policy and Practice Work Group's Putting Stream Temperature Data to Work.***

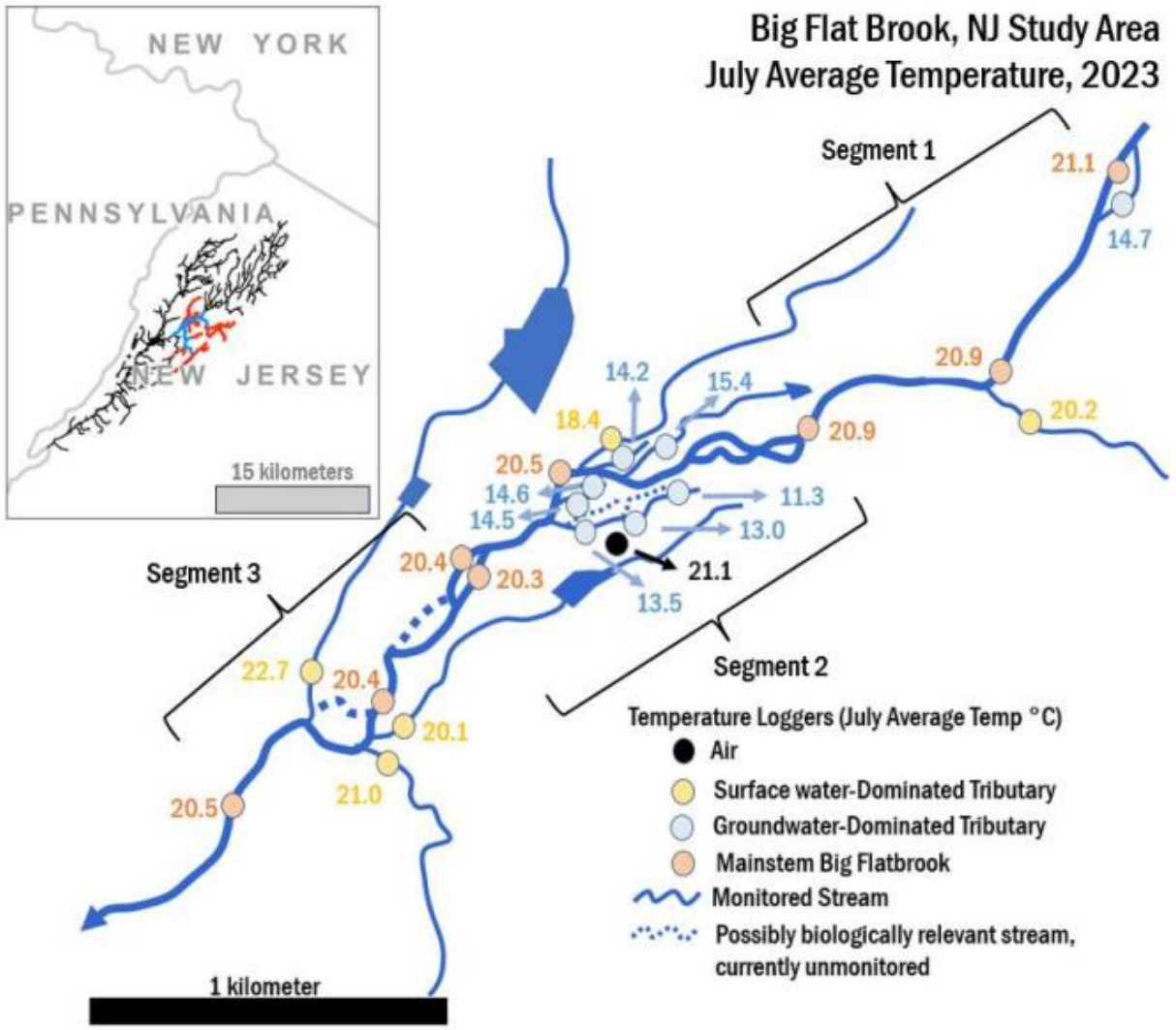
# Why (monitor) stream temperature?

- Varies across stream networks
- Master variable controlling biological performance
- Impacts other aspects of water quality (nutrients, cyanobacteria, bacteria, nutrient and metals toxicity)
- States set temperature water quality standards
- Solutions to reduce temperature encompass many general approaches to river conservation
- Increasing with climate change

More info: Caissie. D. 2006. The thermal regimes of rivers: a review. Freshwater Biology 51, 1389-1406.

# Temps varies in space

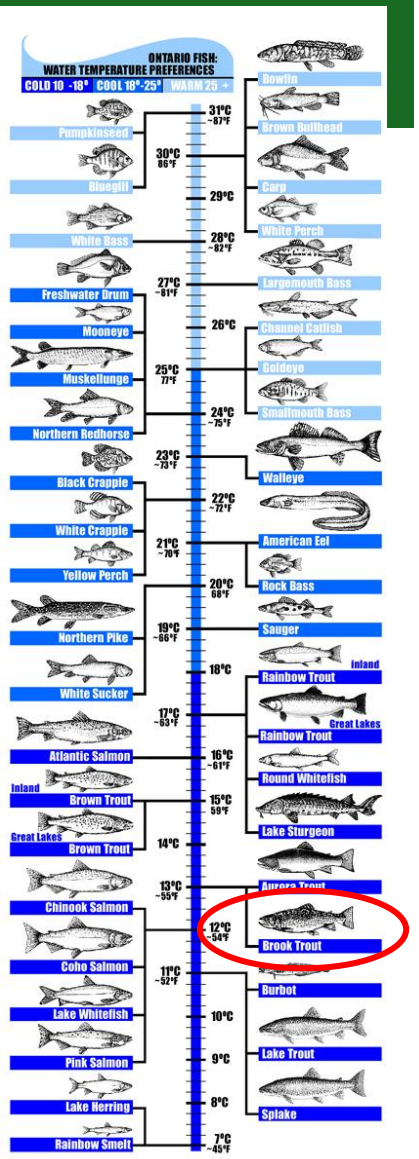
## Which is warmest? Coldest? Why?




More info: Steel, EA, Beechie, TJ, Torgersen, CE, and AH Fullerton. 2018. Envisioning, quantifying, and managing thermal regimes on river networks. Bioscience 67, 506-522.

# Temps control biology




Ontario Ministry of Natural Resources 2004

More info: DeWeber, JT, and T Wagner. 2018. Predicting brook trout occurrence in stream reaches throughout their native range in the eastern United States. Transactions of the American Fisheries Society 144, 11-24.

# States set temp water quality standards

THIS IS A COURTESY COPY OF THIS RULE. ALL OF THE DEPARTMENT'S RULES ARE COMPILED IN TITLE 7 OF THE NEW JERSEY ADMINISTRATIVE CODE.

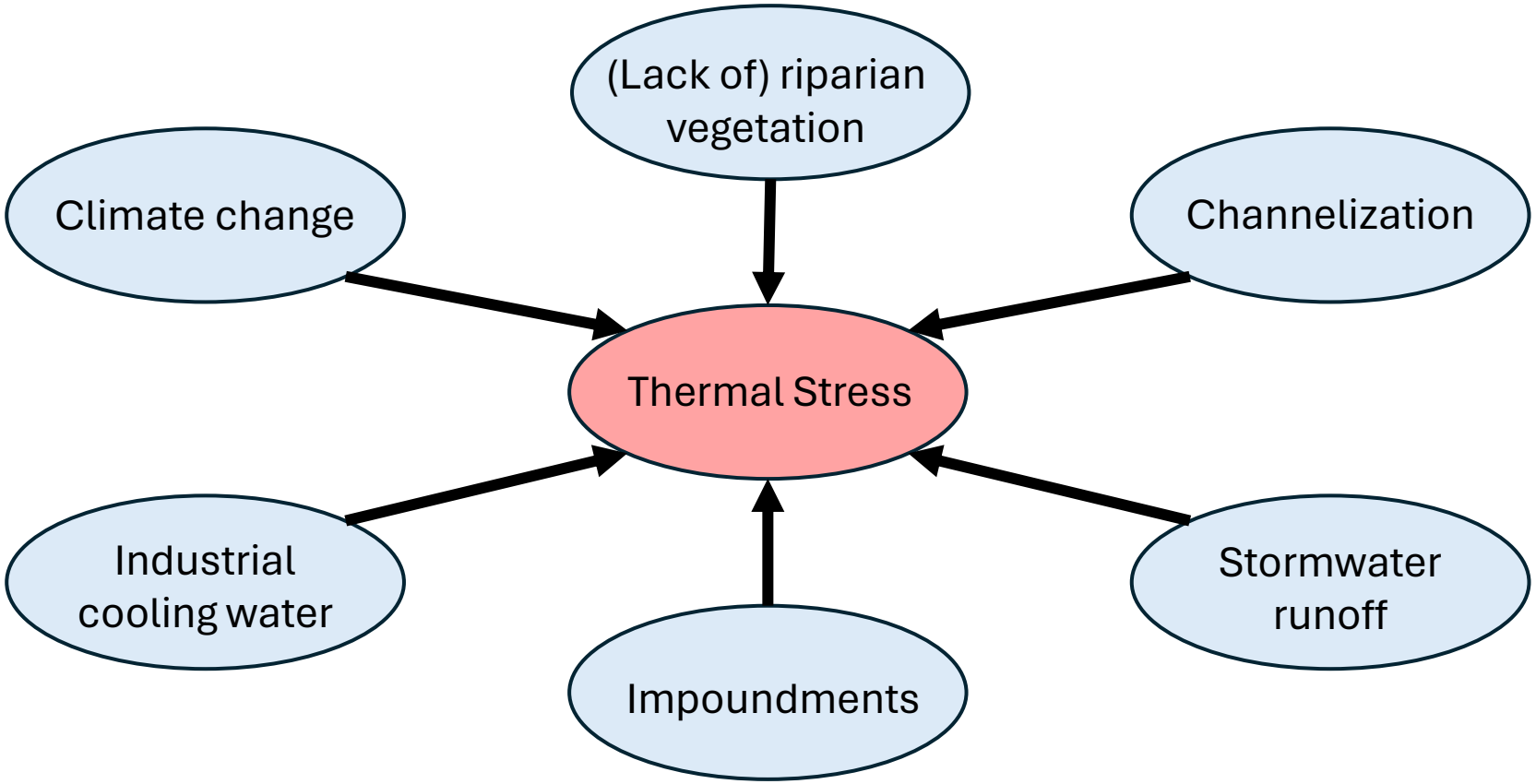
7:9B-1.14(d) General Surface Water Quality Criteria for FW2, SE and SC Waters:
(Expressed as Maximum concentrations unless otherwise noted)

| | Substance | | Criteria | Classifications |
|---|---|---|---|---|
| 11. | Temperature | i. | Temperatures shall not exceed a daily maximum of 22 degrees Celsius or rolling seven-day average of the daily maximum of 19 degrees Celsius, unless due to natural conditions | FW2-TP |
| | | ii. | Temperatures shall not exceed a daily maximum of 25 degrees Celsius or rolling seven-day average of the daily maximum of 23 degrees Celsius, unless due to natural conditions | FW2-TM |
| | | iii. | Temperatures shall not exceed a daily maximum of 31 degrees Celsius or rolling seven-day average of the daily maximum of 28 degrees Celsius, unless due to natural conditions | FW2-NT |
| | | iv. | No thermal alterations which would cause temperatures to exceed 29.4 degrees Celsius (85 degree Fahrenheit) Summer seasonal average | SE |

More info:

Delaware River Basin Policy and Practice Work Group. 2023. Putting Stream Temperature Data to Work.
McCullough, DA. 2010. Are coldwater fish populations of the United States actually being protected by temperature standards? Freshwater Reviews 3, 147-199.
McCullough, DA. 2011. The impact on coldwater-fish populations of interpretive differences in the application of the US Clean Water Act 1972 by individual state legislatures. Freshwater Reviews 4, 43-79.

# We understand sources of thermal stress




Vermont SWMS Thermal Stress Guidance

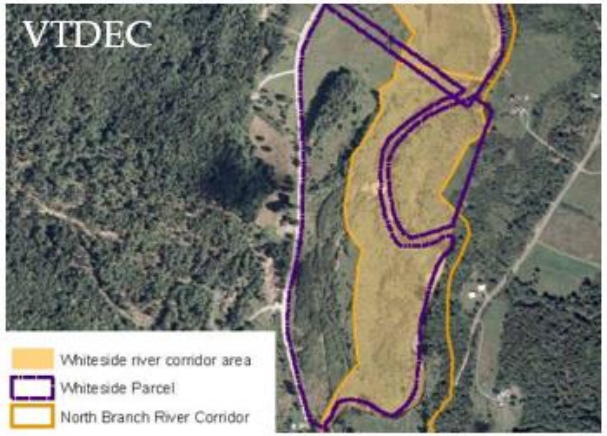
# Solutions exist to protect/restore thermal habitat

Dam Removal

Reconnecting Habitat

Buffer Planting


Stream Protections




Non-Native Removal

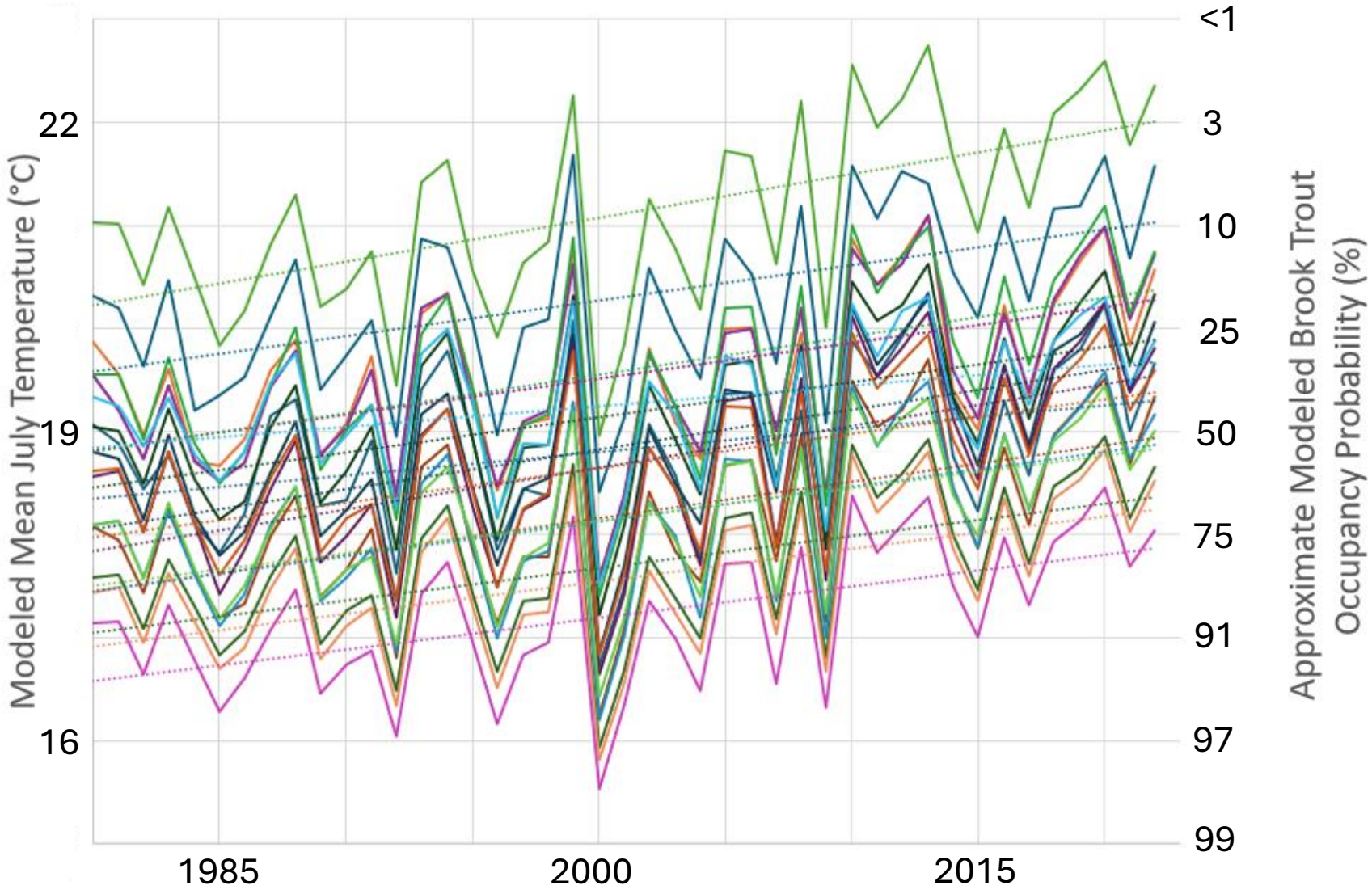
Habitat Improvement


Ficklin et al. 2023. Rethinking river water temperature in a changing, human-dominated world. Nature Water 1, 125-128.

Kurylyk et al. 2015. Preserving, augmenting, and creating cold-water thermal refugia in rivers: concepts derived from research on the Miramichi River, New Brunswick (Canada). Ecohydrology 8, 1095-1108.

Oullet et al. 2020. River temperature research and practice: recent challenges and emerging opportunities for managing thermal habitat conditions in stream ecosystems. Science of the Total Environment 736, 139679.

# Temps increasing with climate change




**NJFW Wild Brook Trout Fisheries**

Bear Swamp Brook
Beatty's Brook
Brass Castle Creek
Hickory Run
India Brook
Lake Ames Tributary
Primrose Brook
Rinehart Brook
Rocky Run
S. Br. Raritan River
Stephensburg Brook
Stony Brook
Teetertown Brook
Turkey Brook
Trout Brook
Van Campens Brook
Willoughby Brook

More info: Eaton, JG, and RM Scheller. 1996. Effects of climate warming on fish thermal habitat in streams of the United States. Limnology and Oceanography 41, 1109-1115.

ONJSC :: Historical Monthly Summary Tables (rutgers.edu)

USGS Ecosheds

# Agenda

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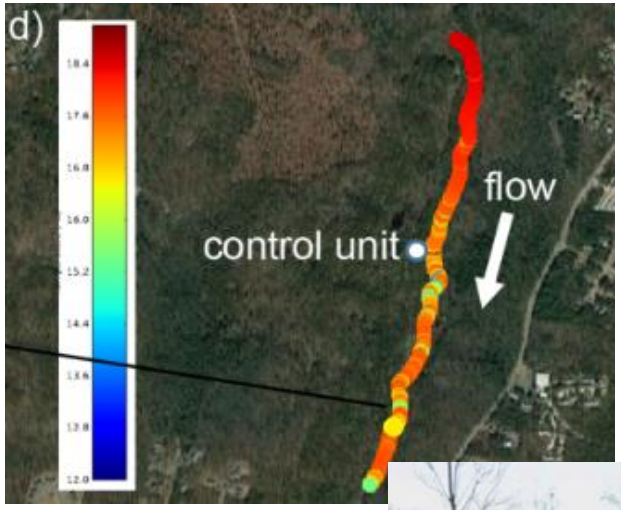
# Collecting stream temperature data

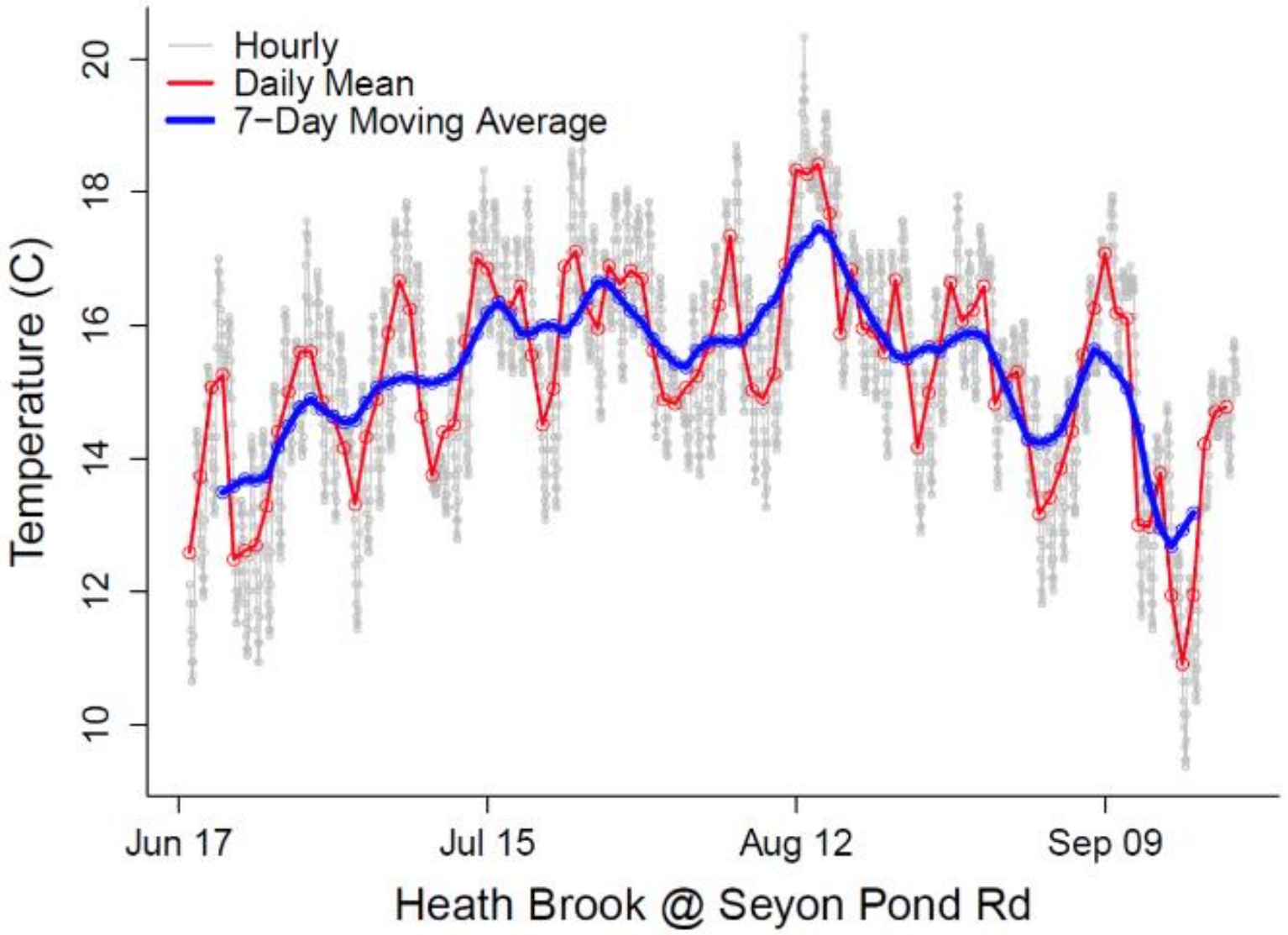




Oullet et al. 2020. River temperature research and practice: recent challenges and emerging opportunities for managing thermal habitat conditions in stream ecosystems. Science of the Total Environment 736, 139679.

# Continuous monitoring

- Sensors record <hourly readings
- High accuracy; regulatory and assessment applications
- Real-time data potential
- Data can be aggregated to relevant biologically predictive metrics



# Continuous monitoring

- $50 -$1000+ per site
- Requires moderate ability for field deployment and maintenance
- Requires moderate technical ability for launching, downloading, storing, and analyzing data
- Resource limits on how many sites can be monitored each summer/year

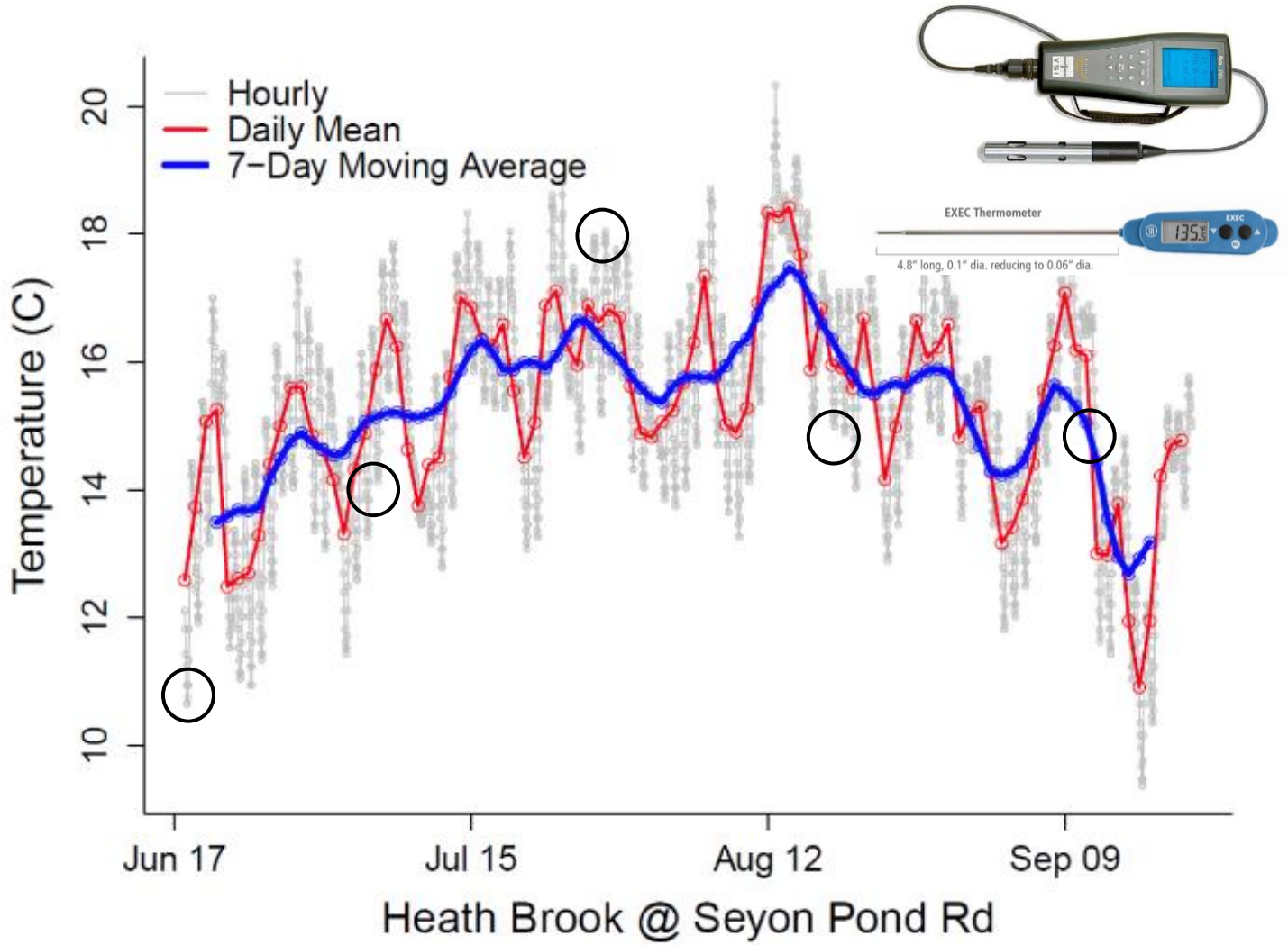



[Stream Temperature Monitoring - Trout Unlimited]

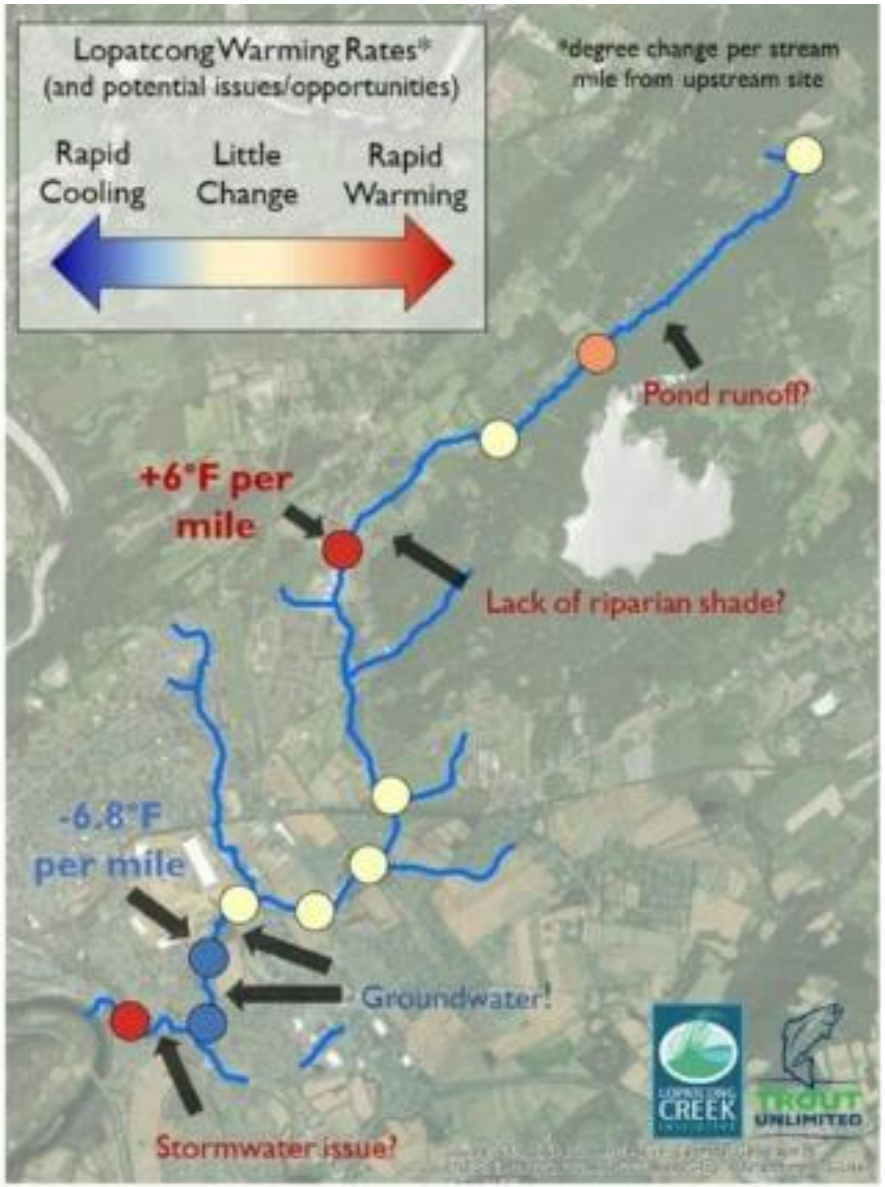
[Volunteer Stream Temperature Monitoring Network (ct.gov)]

# Grab sampling

- Snapshot measurement in time/space
- One site visit may have little context/meaning
- Multi-date sampling can be averaged for more value, but adds labor
- Synoptic sampling (synchronized across space) can provide a snapshot of spatial thermal variability
- Basic field and data skills needed
- ~$35 thermometer + staff/volunteer time = dozens or more sites
- Few limits on how many sites can be monitored each summer/year

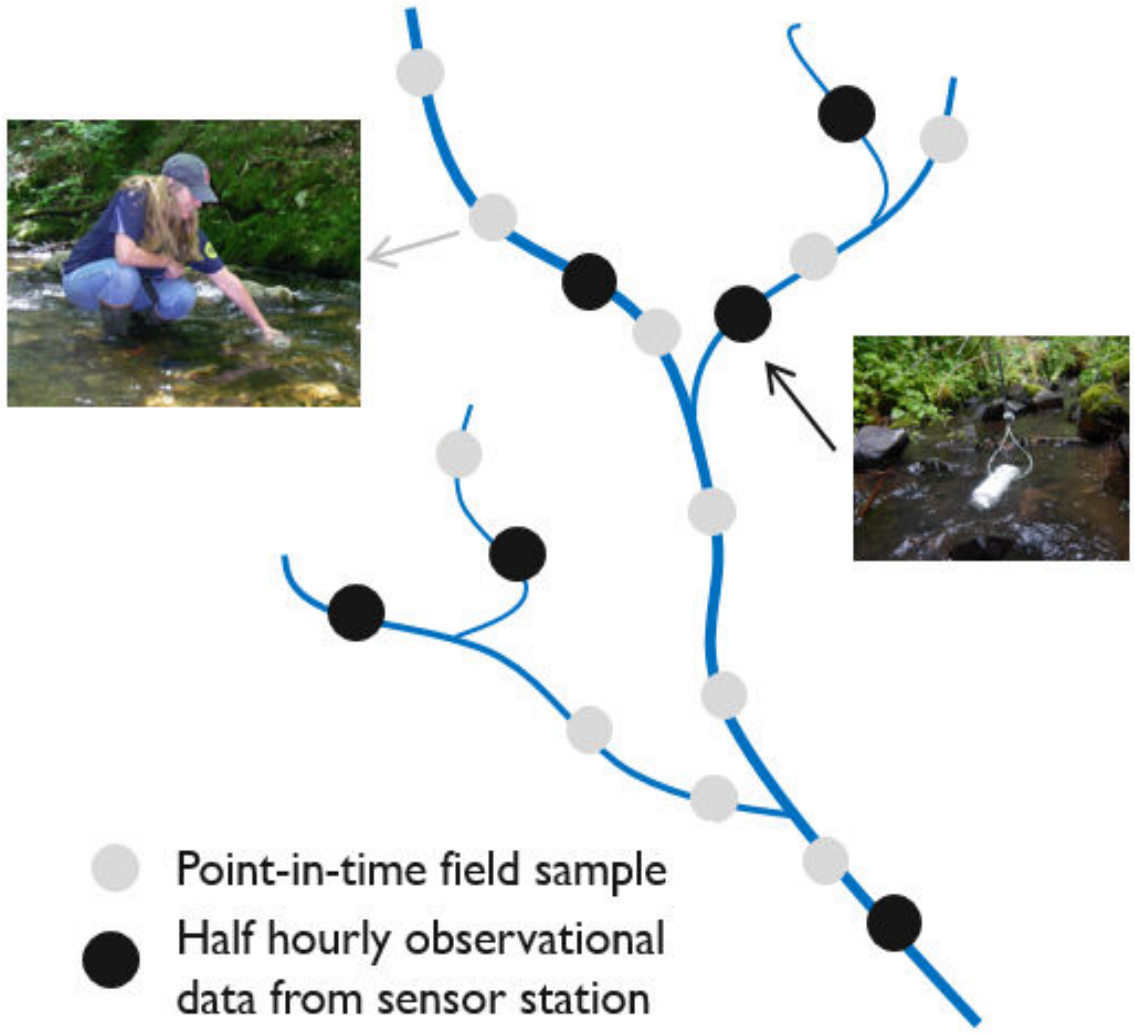


# Grab sampling

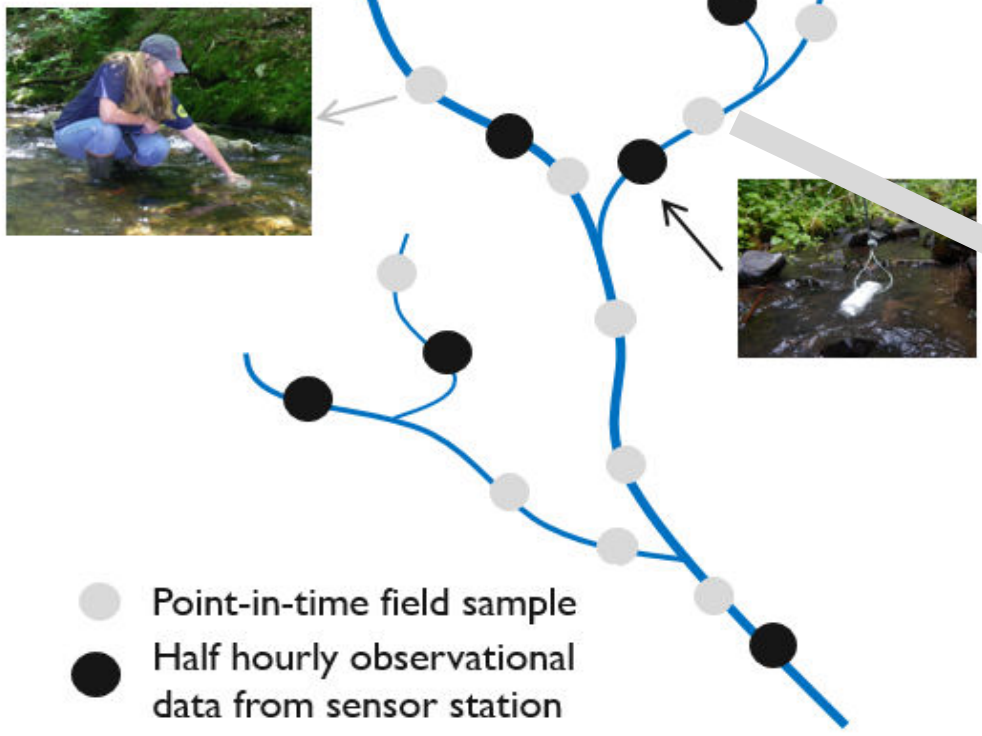



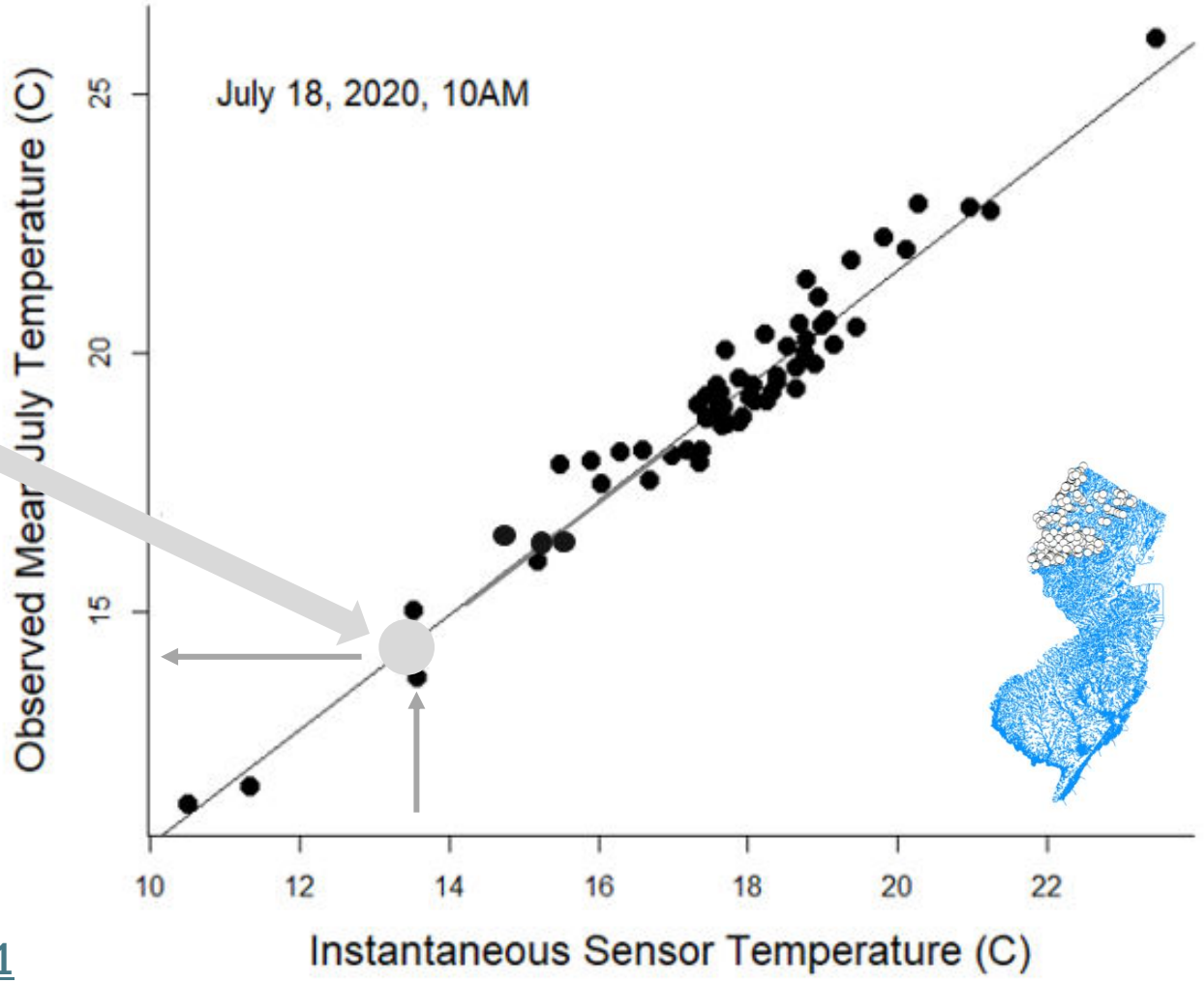
# Integrated grab sampling and continuous monitoring

Can we integrate grab sampling and continuous data to increase the quality of our data (i.e., time-average metrics) at more sites?



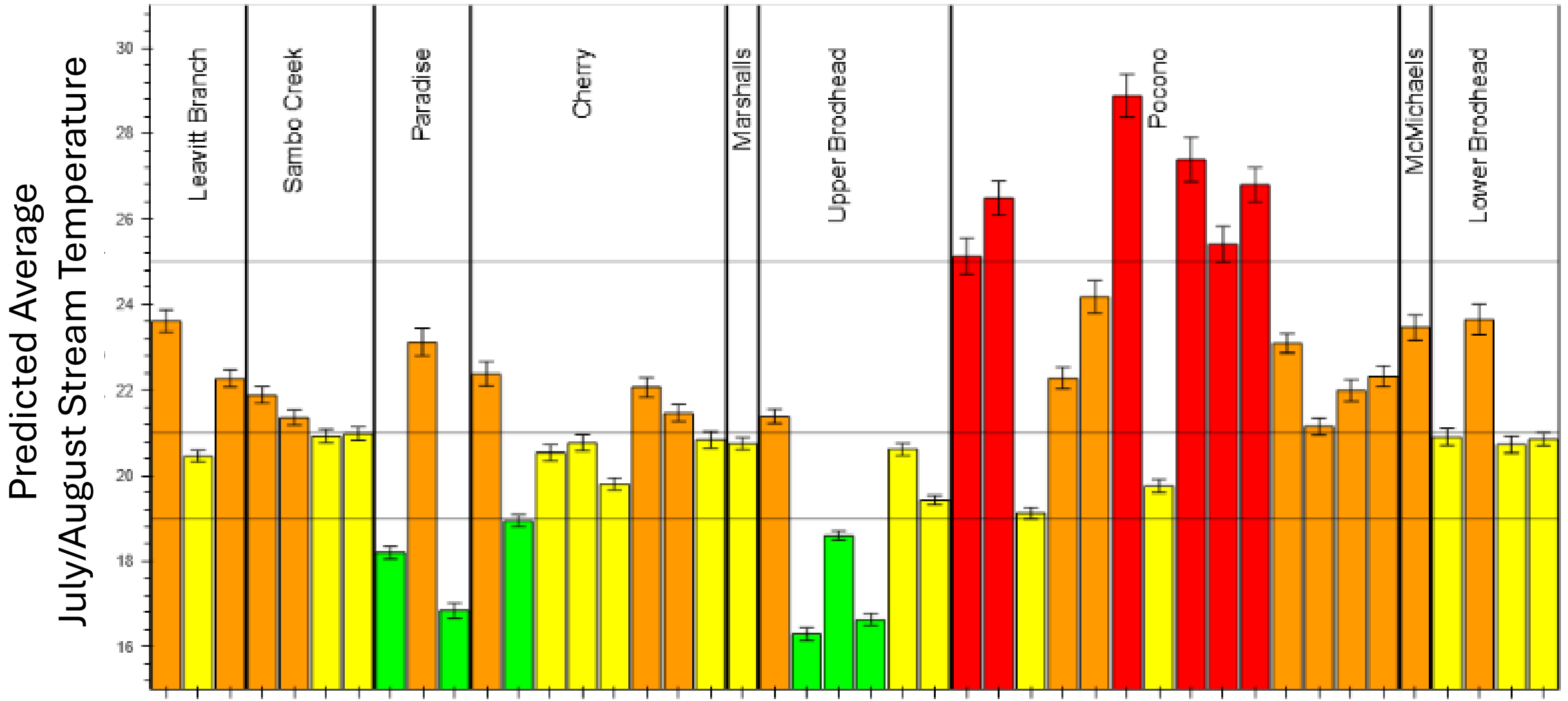
# Simple regressions translate grab data into summer average temperatures




Fritschie, Cottingham, Collenburg, and Letcher 2023 Thesis Chapter 1

# Brodhead Watershed Association



# Agenda

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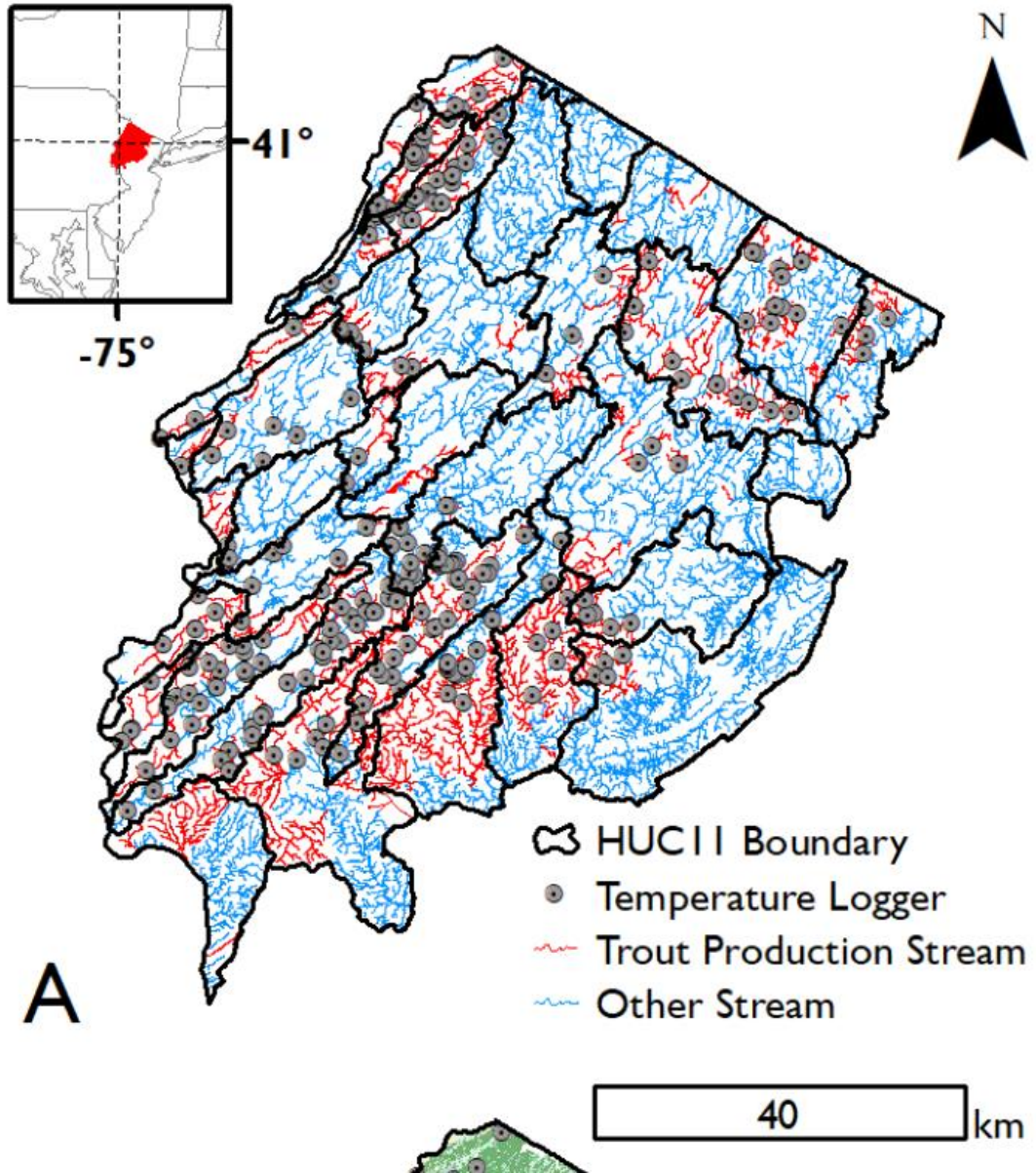
- **Example applications of monitoring data to NJ conservation planning**

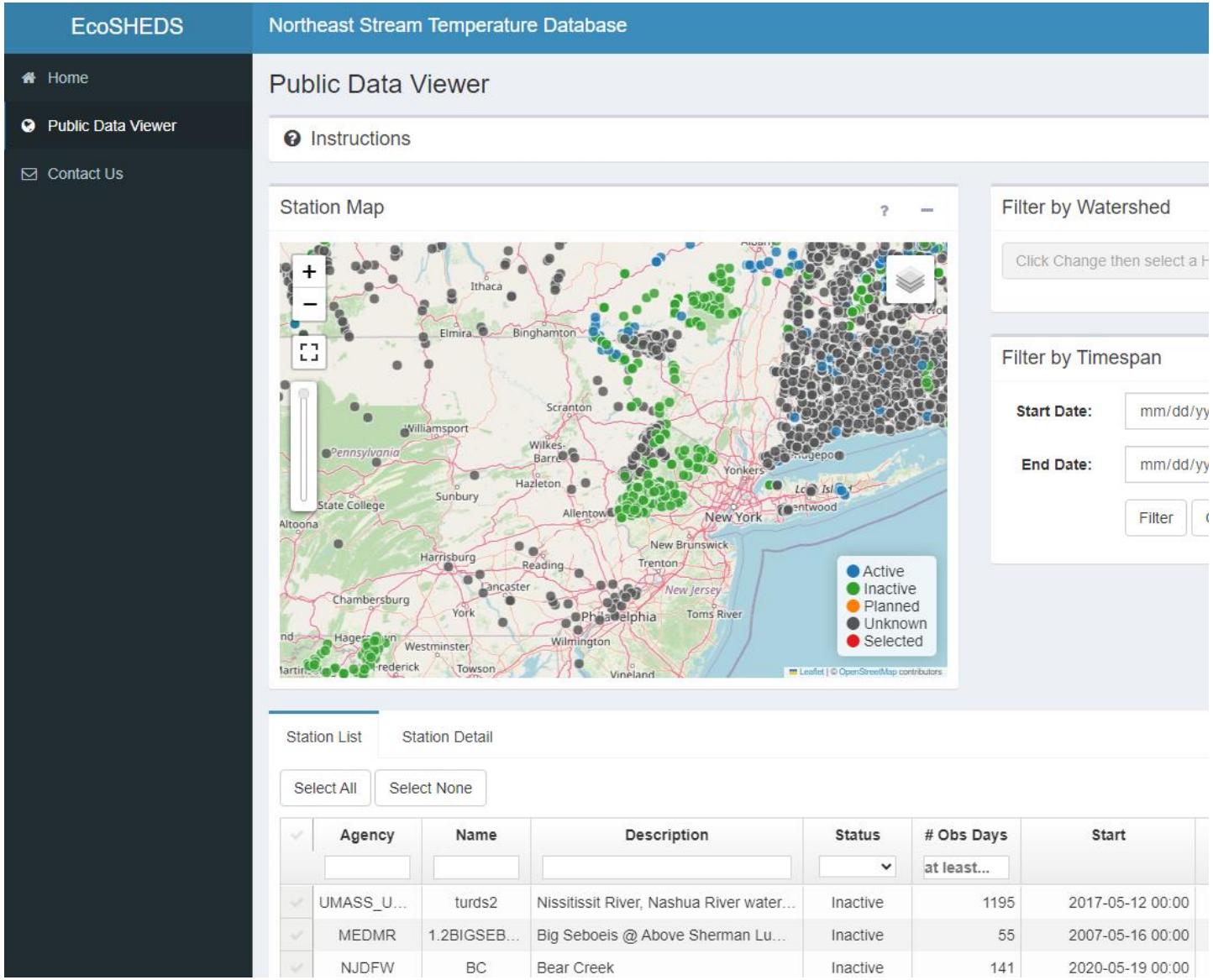
# Continuous data vignette

- New Jersey Fish and Wildlife, Trout Unlimited, Musconetcong Watershed Association, The Nature Conservancy, Lopatcong Creek Initiative, Wallkill River Watershed Management Group, USGS
- 260+ stream temperature monitoring sites
- Each org has different purposes for data collection and different methods



# Share data to spread impact beyond your org

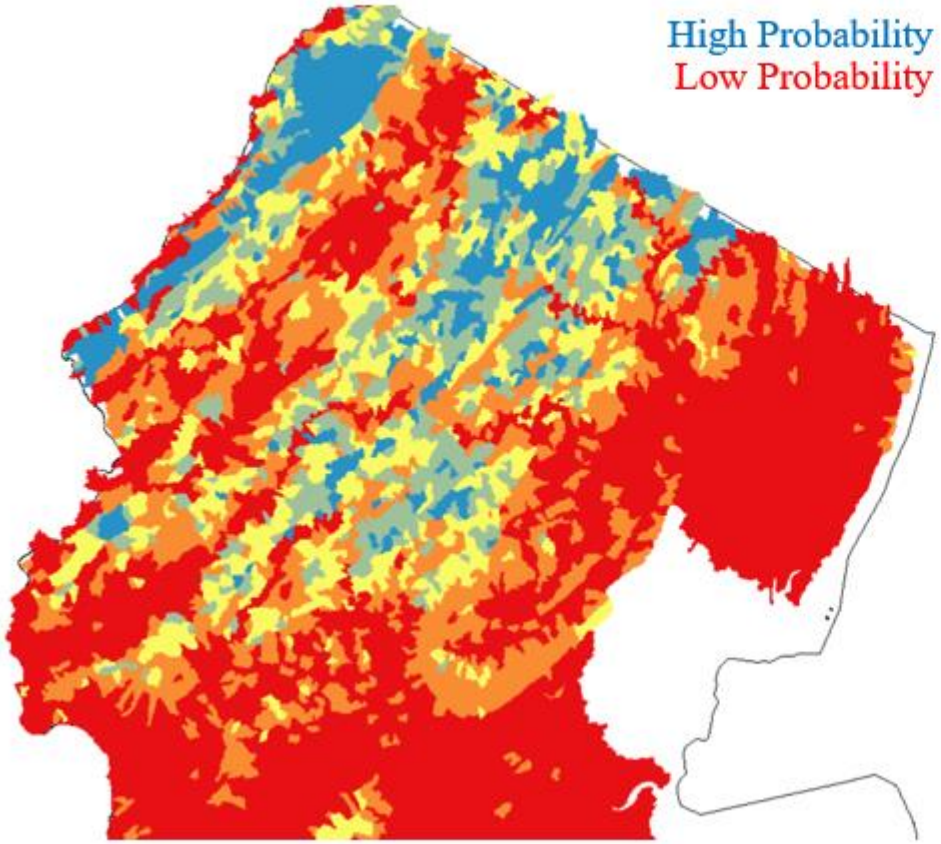
- Easier for you to store/view/download
- Easier for others *with different goals* to store/view/download
- Informs broadscale analyses and models
- Improves local predictions



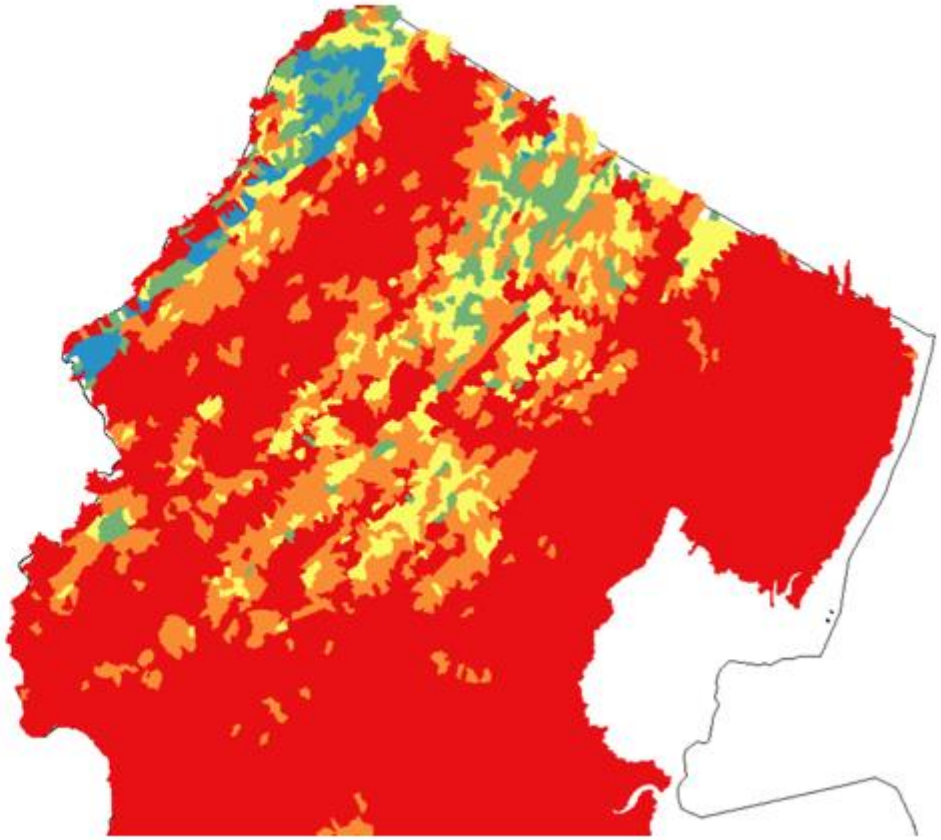

[Northeast Stream Temperature Database (ecosheds.org)]

# Sharing improves models for communication

Current Brook Trout Occupancy



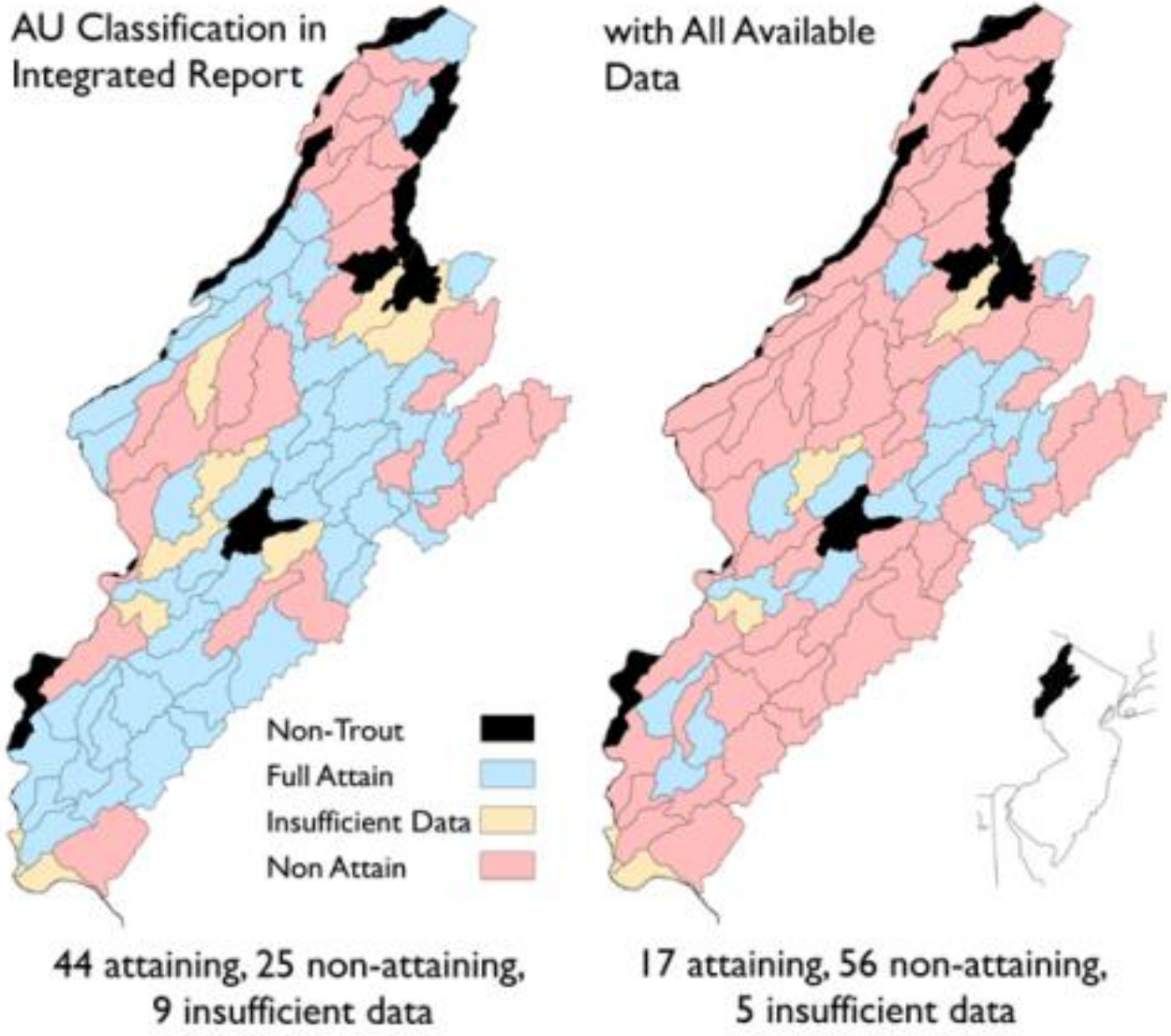

Future Occupancy (+2°C Air Temperature)



Stream Temperature and Brook Trout Occupancy in the Northeast | ICE (usgs.gov)

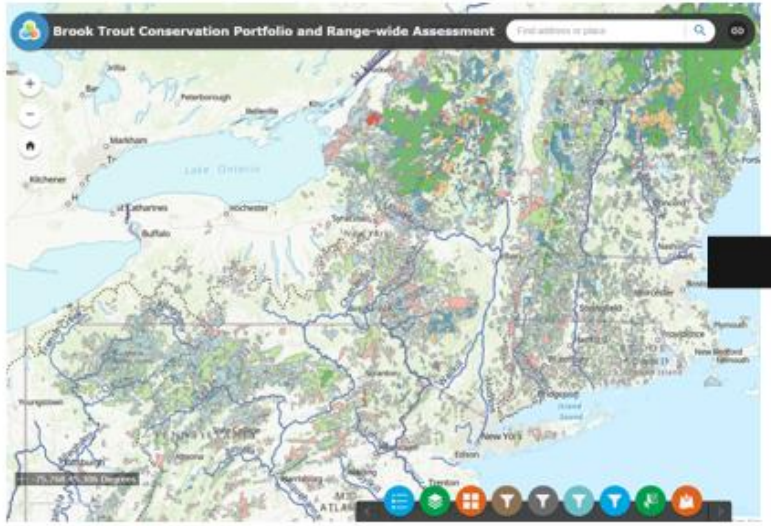
# Sharing informs formal water resource assessments

- NJDEP reports on water quality biennially: Integrated Water Quality Report
- Asked NJDEP to consider partners' Ecosheds submissions in future (200+ sites)
- Partner data suggested many more temp impairments than NJDEP first considered
- In next report, ~20 new watersheds flagged as thermally impaired
- Formally identifying impairments is first step to gaining support/funding
  - E.g., TMDL/watershed-based plan
  - Targeted funding

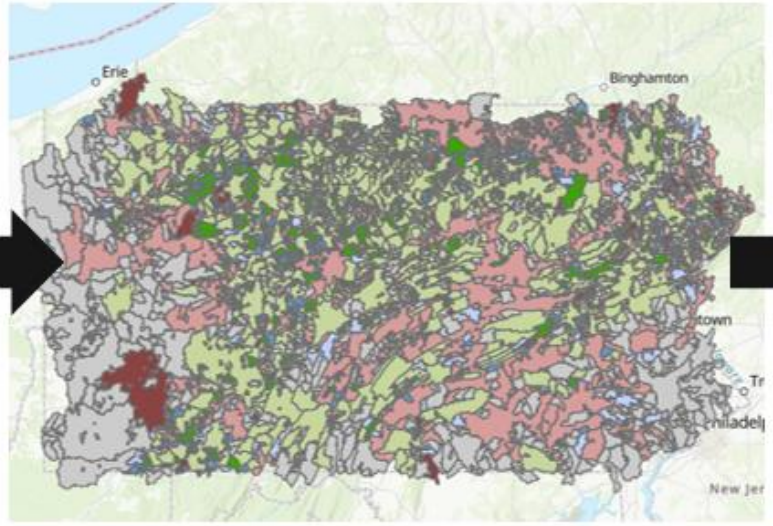


# Grab sample data vignette

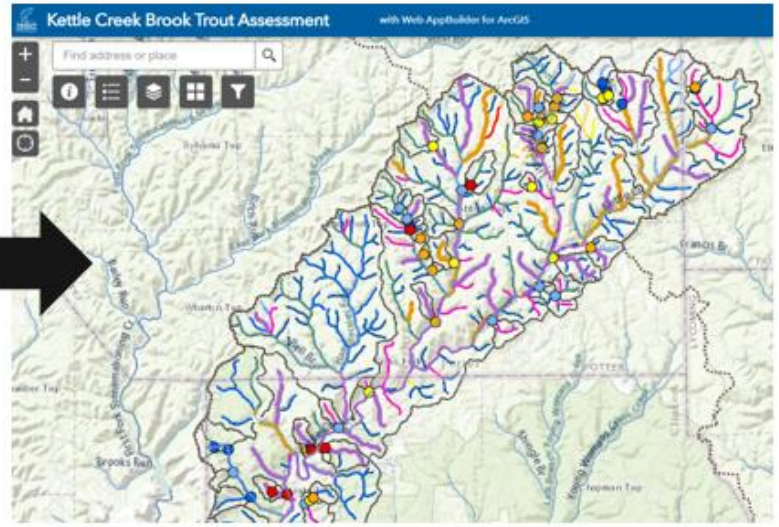
Range-wide




State-wide



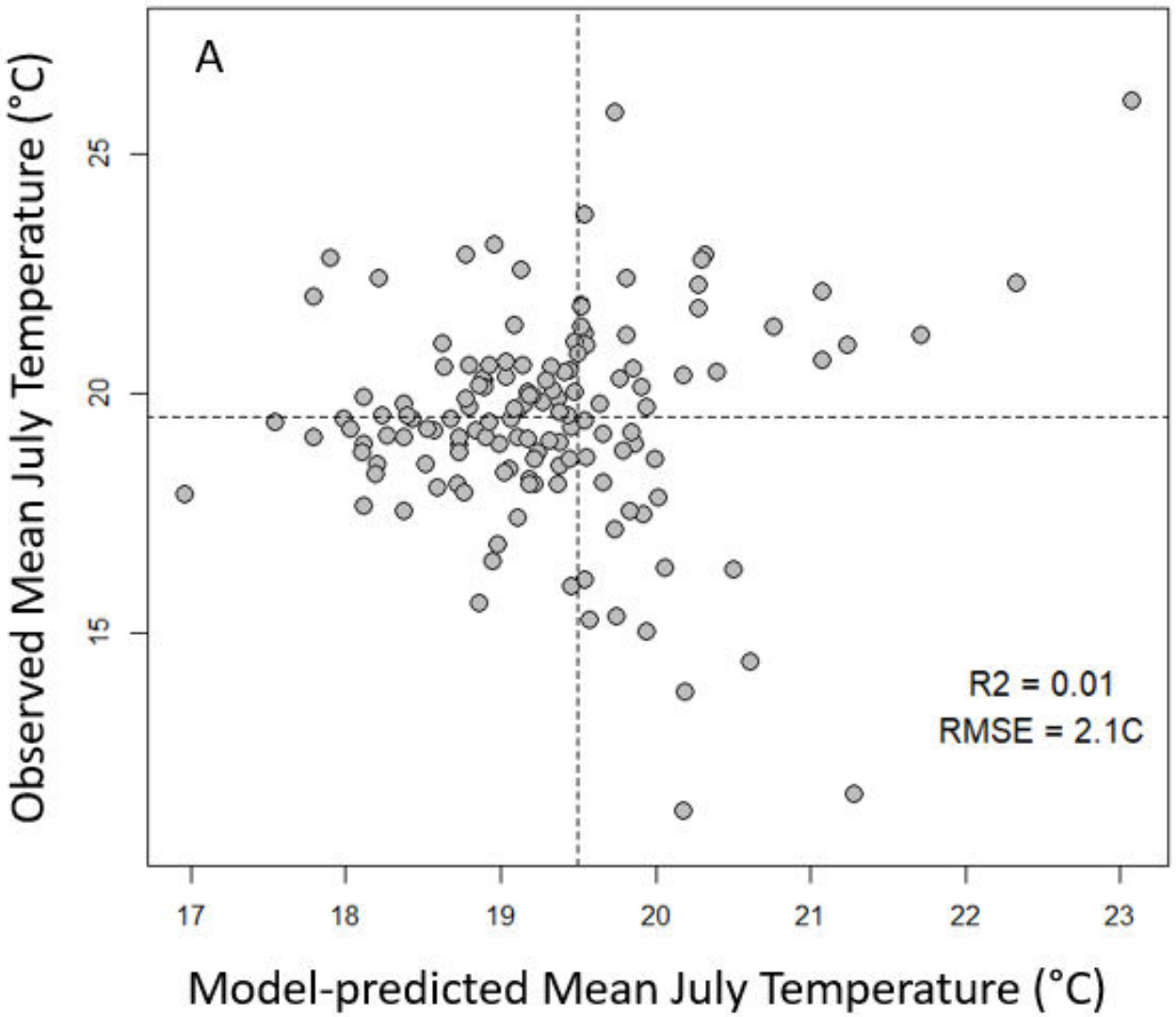

Local Planning Scale




Delaware River Basin Brook Trout Portfolio Elements

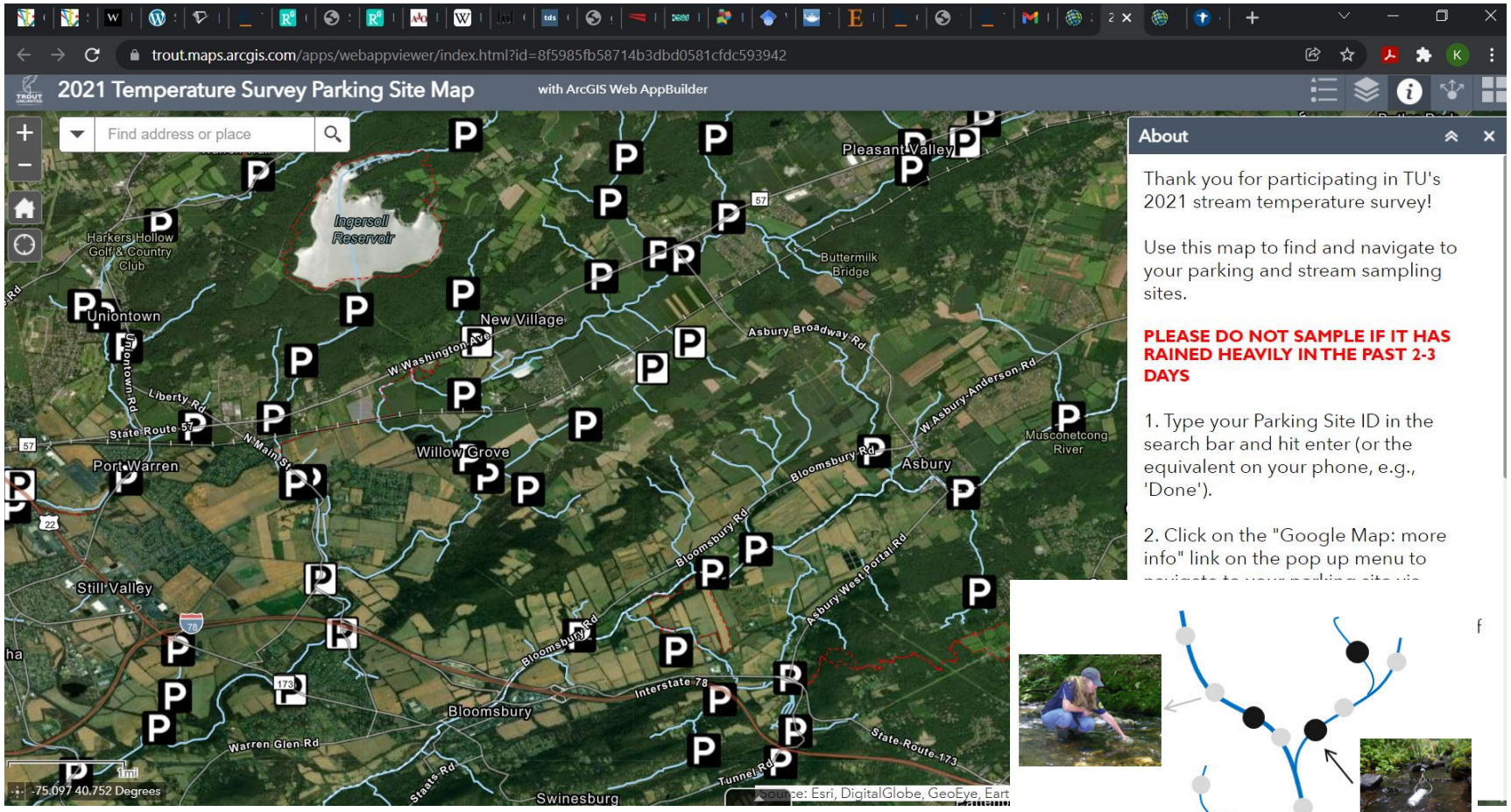
- TU conservation portfolios/plans ID places to protect and restore within a watershed
- Identify projects like culvert upgrades, dam removals, buffer restoration, in-stream habitat improvement
- ***Rely on as much continuous monitoring data as possible, but use regional models to fill gaps***

# Regional models not always good at filling gaps



# Volunteer grab sampling informs plan development

- **25 volunteers**
  - Avg. 13 sites per volunteer
  - Avg. 2.5hrs total per vol.
- **325 grab samples**
  - Dams, canopy gaps
  - Trib pour points
  - Equal intervals along mainstems
- **70 continuous sites (4 orgs)**




[Site Navigation Map] and [Volunteer Sampling Guidance]

# Used data for Flatbrook trout conservation plan

- 43 dams
- 27 crossing upgrades
- 5.6 acres of riparian restoration
- >10km of wood addition suggested


[Prioritization Results Interactive Map ]and [Methods Description]

# Wrap up

- Why stream temperature?
- Approaches to monitoring temperature
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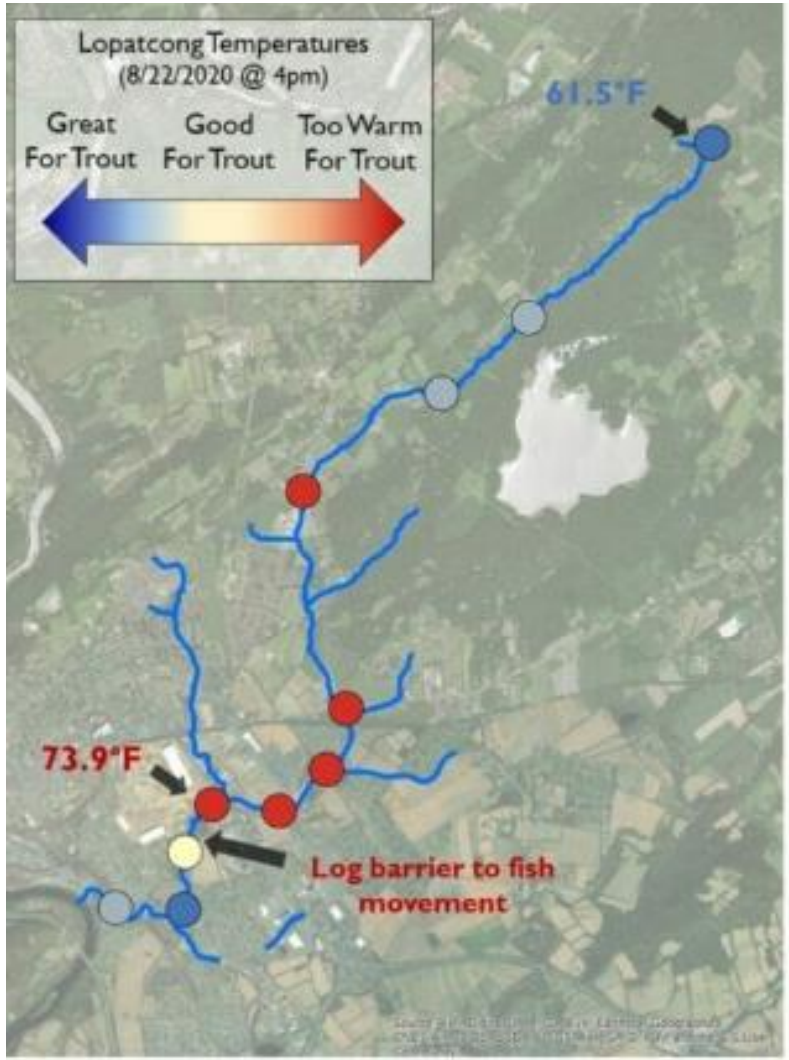
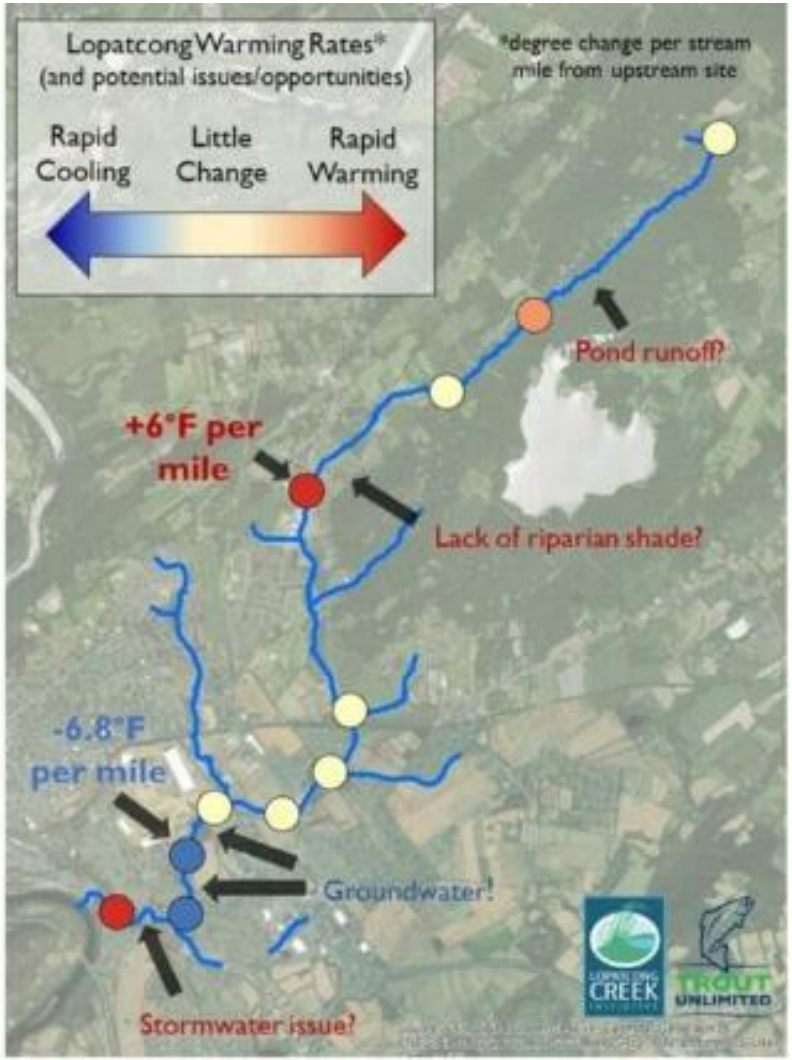
# Questions/comments?



# Grab method is more accurate than regional model