Urbanization in Southeastern NH: Does it impact stream temperature?

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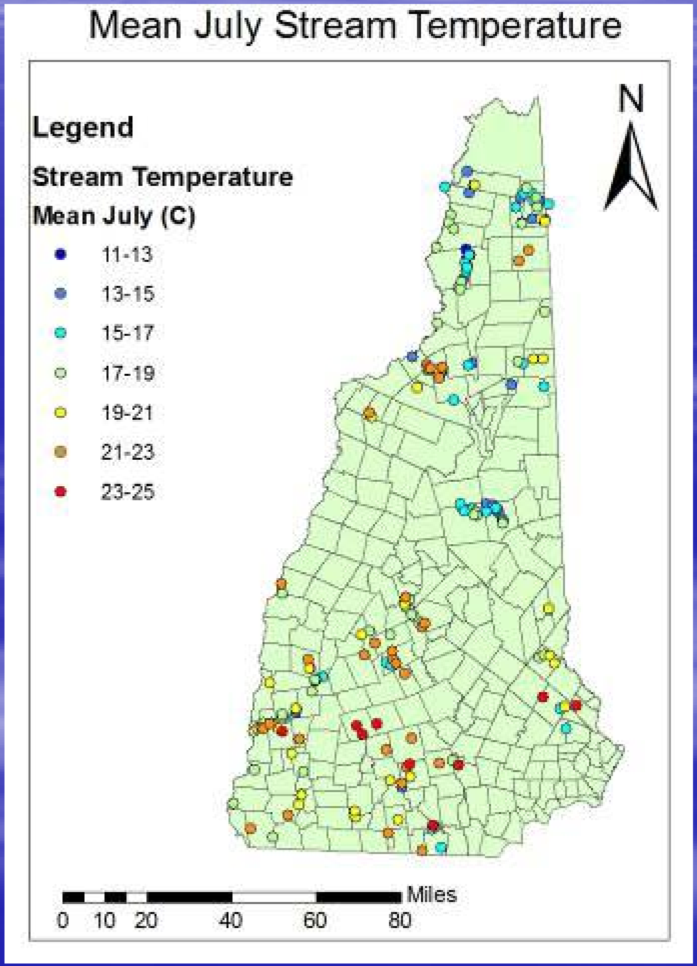
Stream Temperature

- Spatial
  - Regional
  - Reach variations (< 1m)
- Temporal
  - Diurnal (daily) fluctuations
  - Long term trends
  - Storm events



Data Source: NH Fish and Game

Stream Temperature

- Primary stream health indicator
- Fisheries classification
- Limited knowledge

Urbanization Features

- Land use change
- Impervious surfaces
- Road crossings
- Stormwater BMPs
- Groundwater withdrawals
- Wastewater discharge
- Dams

Research Questions

How do culverts affect

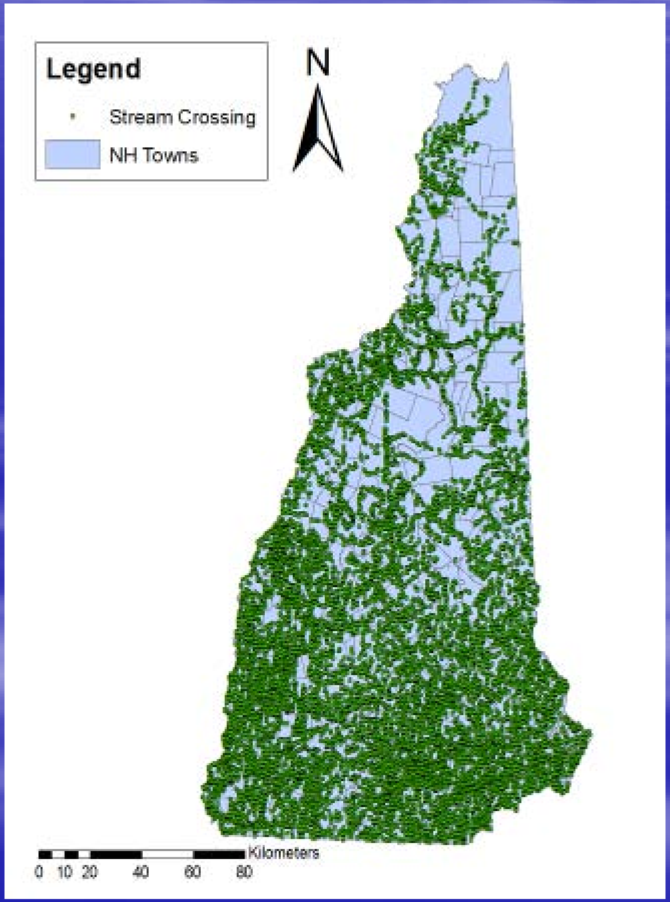
a. diurnal temperature ranges?
b. mean temperatures?
c. storm temperature surges?

How does impervious area within a stream's watershed effect

a. diurnal temperature ranges?
b. mean temperatures?
c. storm temperature surges?

Road Crossings

- Previous Research
  - Thermal impacts not yet studied
  - Stream channel changes (Bates, 2003)
    - Armoring
    - Bank erosion
- Over 16,500 in NH as of 2008
- Focus on culverts



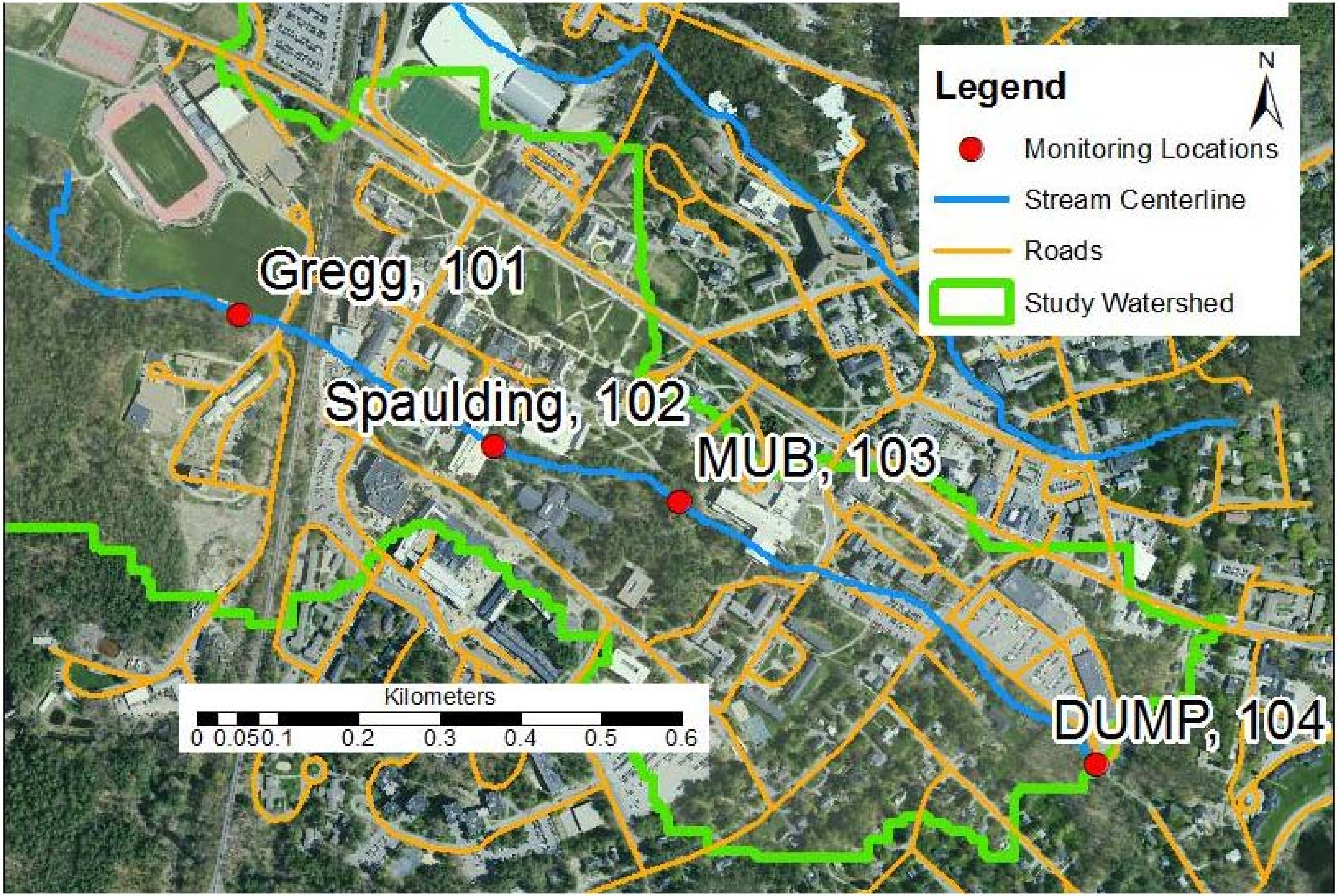
Impervious Area

- Previous Research
  - Lowers stream health (Deacon et al., 2005)
  - Elevated runoff temperatures (Herb et al., 2009)
  - Stream temperature surges (Nelson and Palmer, 2007)
- Coastal NH Imperviousness
  - 4.00 % in 1990
  - 5.85 % in 2000
  - 6.91 % in 2005

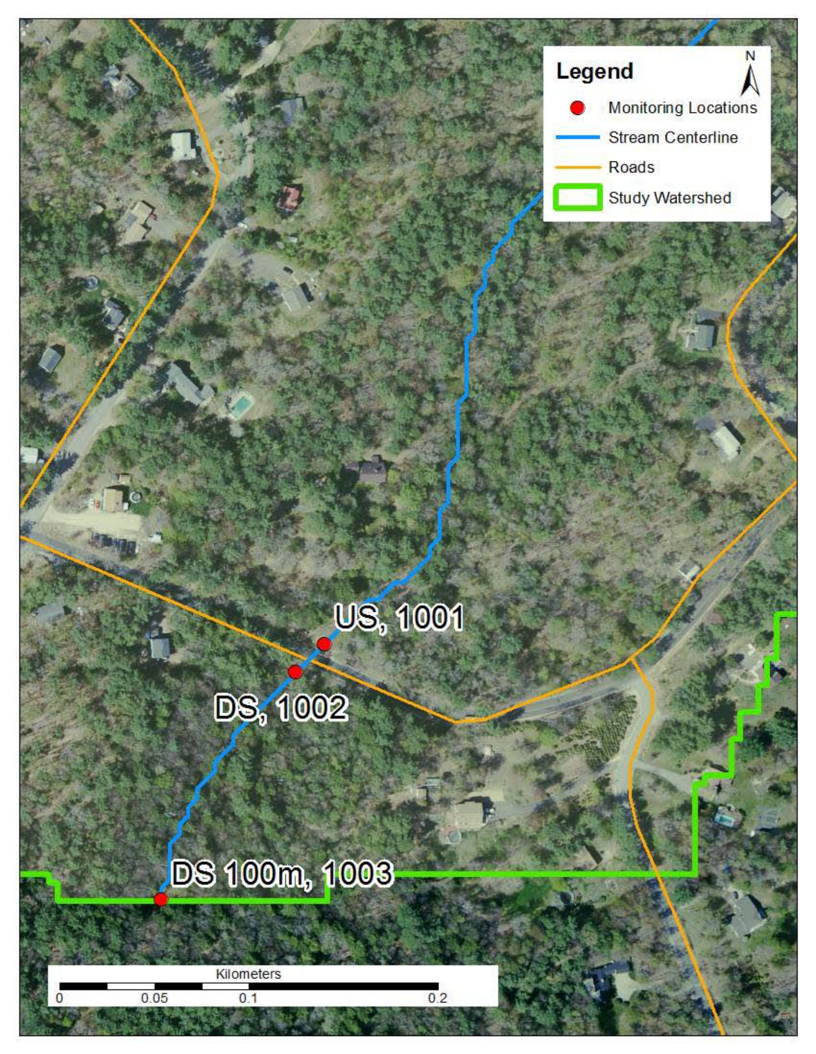
Point Monitoring Experiment

- 9 study streams
  - 1.14 to 9.26 km^2
  - 3.4 to 43% impervious
  - 1 to 11 road crossings
- Study period: 7/08 to 12/09
- Data collection
  - Stream temperature (15 min)
  - Hourly weather data
  - Stage where possible

College Brook

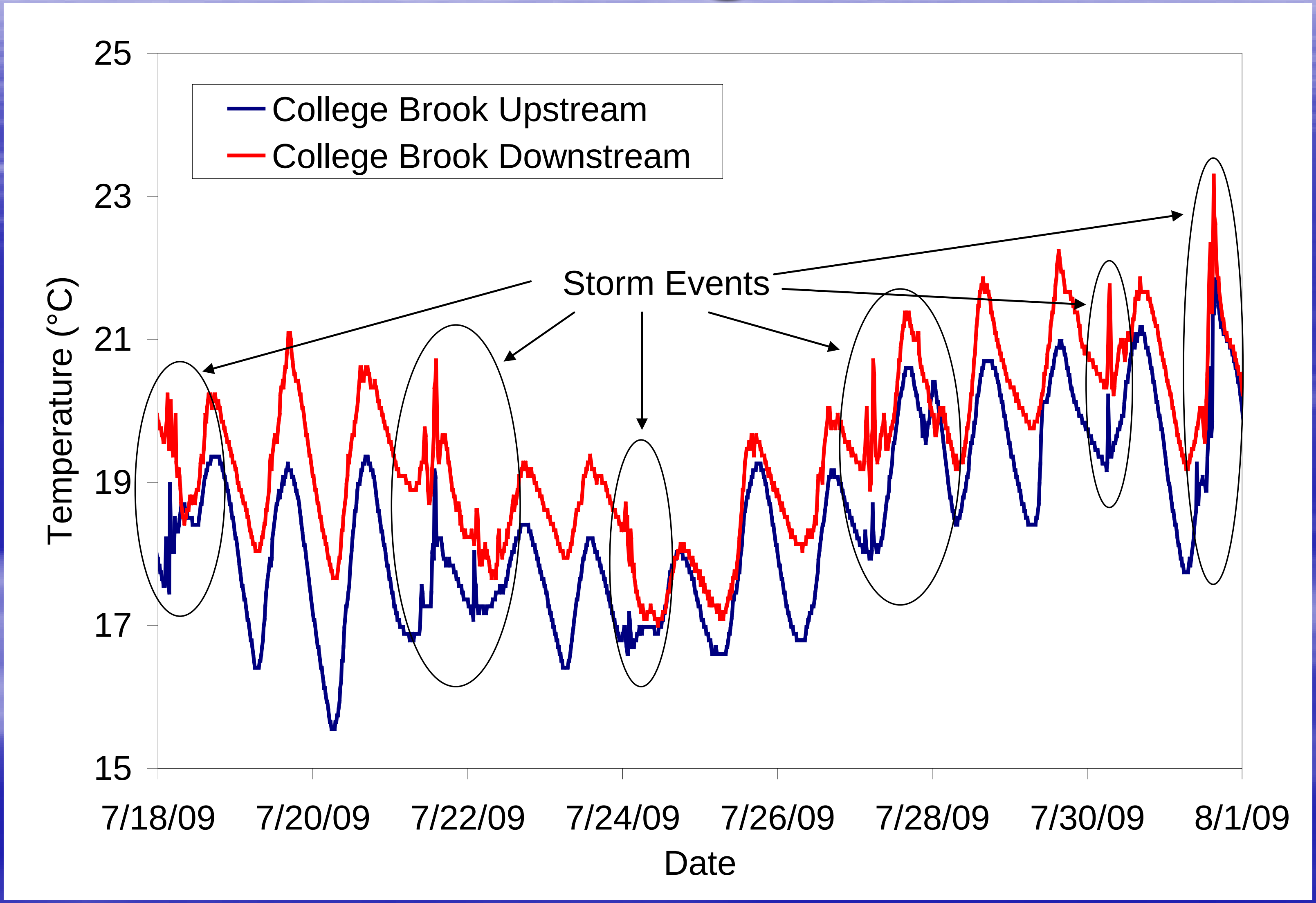


Wednesday Hill Brook



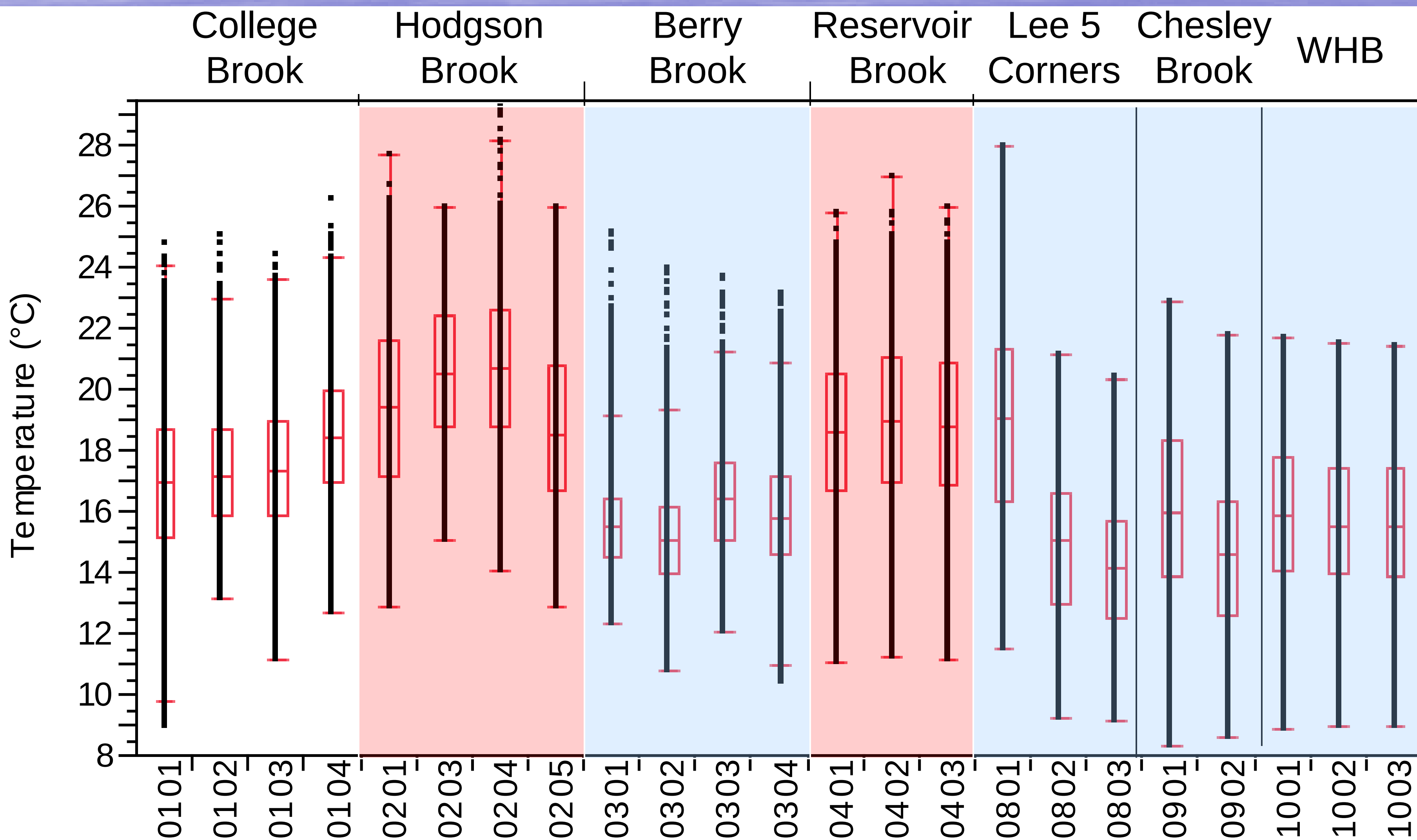
Experimental Results

Point Monitoring Time Series



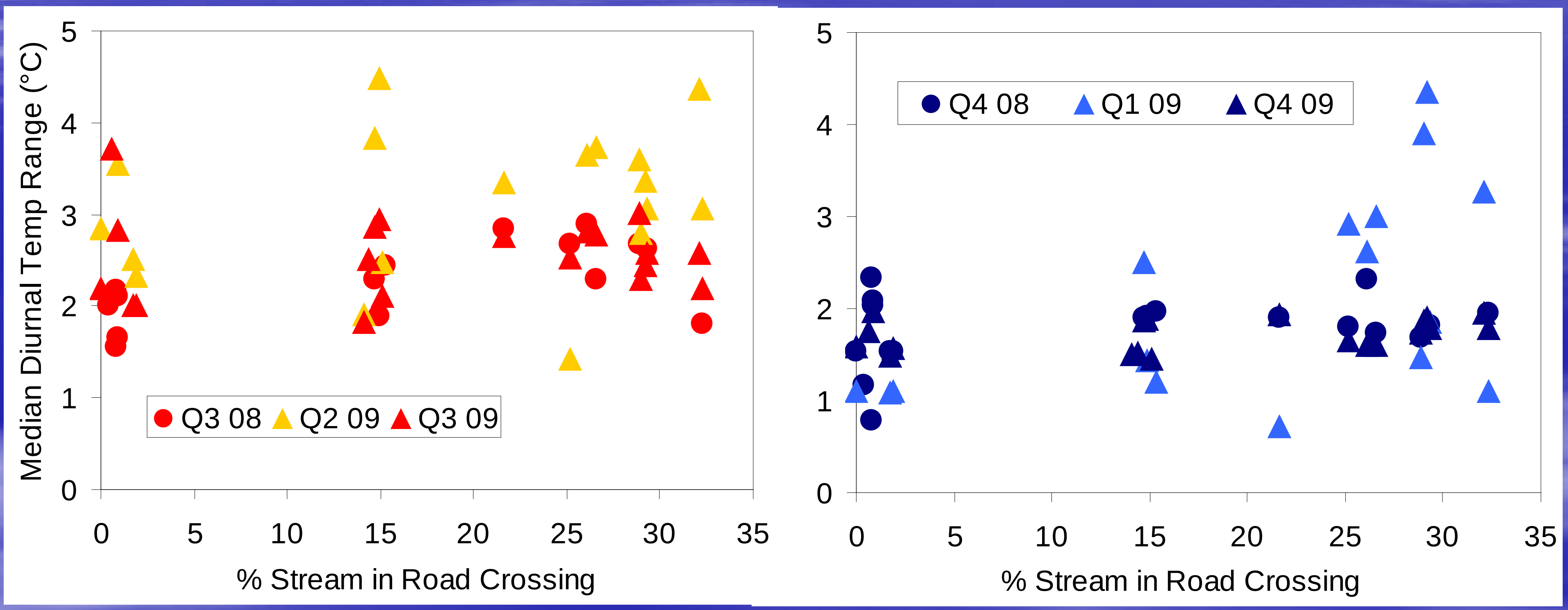
Q3 2009

- Site-site and stream-stream variations



Hypothesis 1a

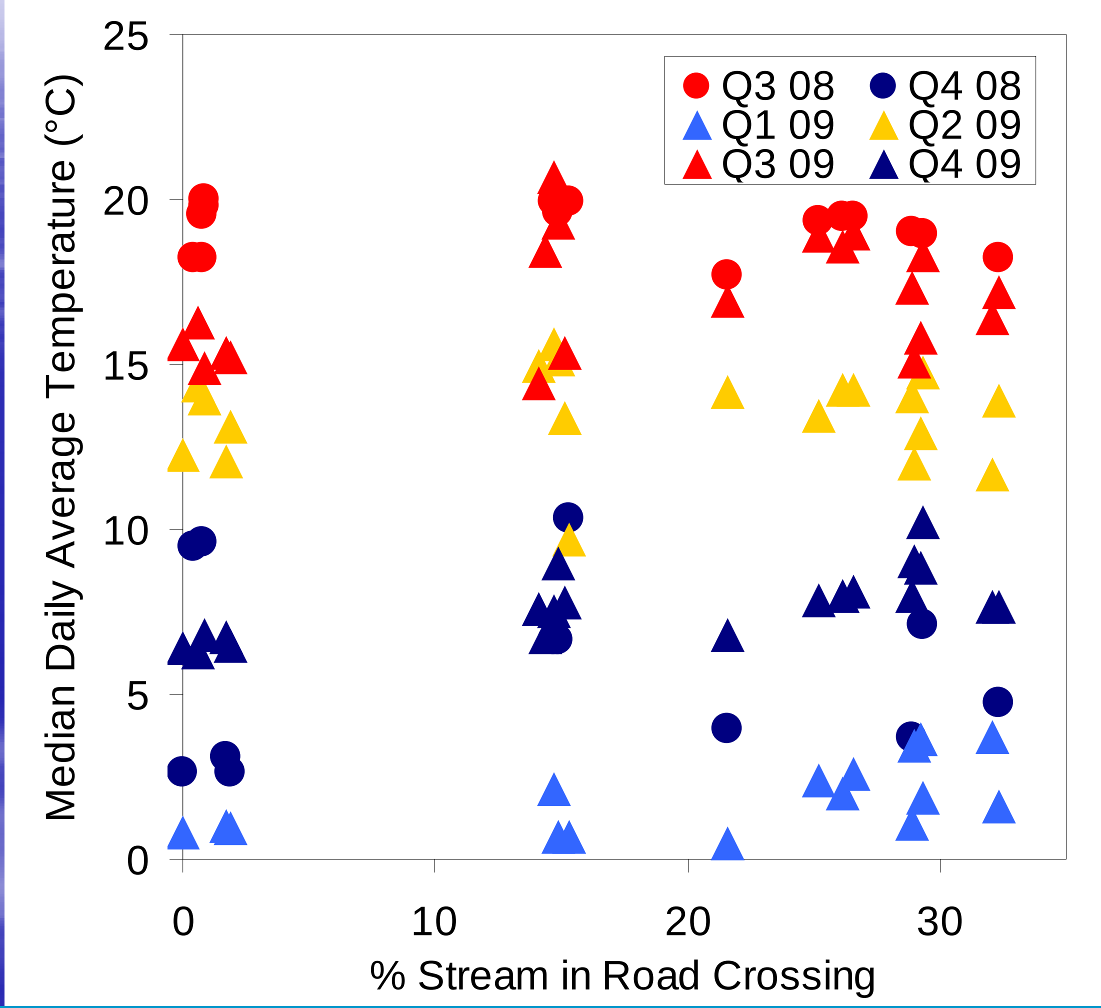
Culverts will increase diurnal temperature ranges



Culverts do not appear to increase diurnal temperature ranges, refuting hypothesis

Hypothesis 1b

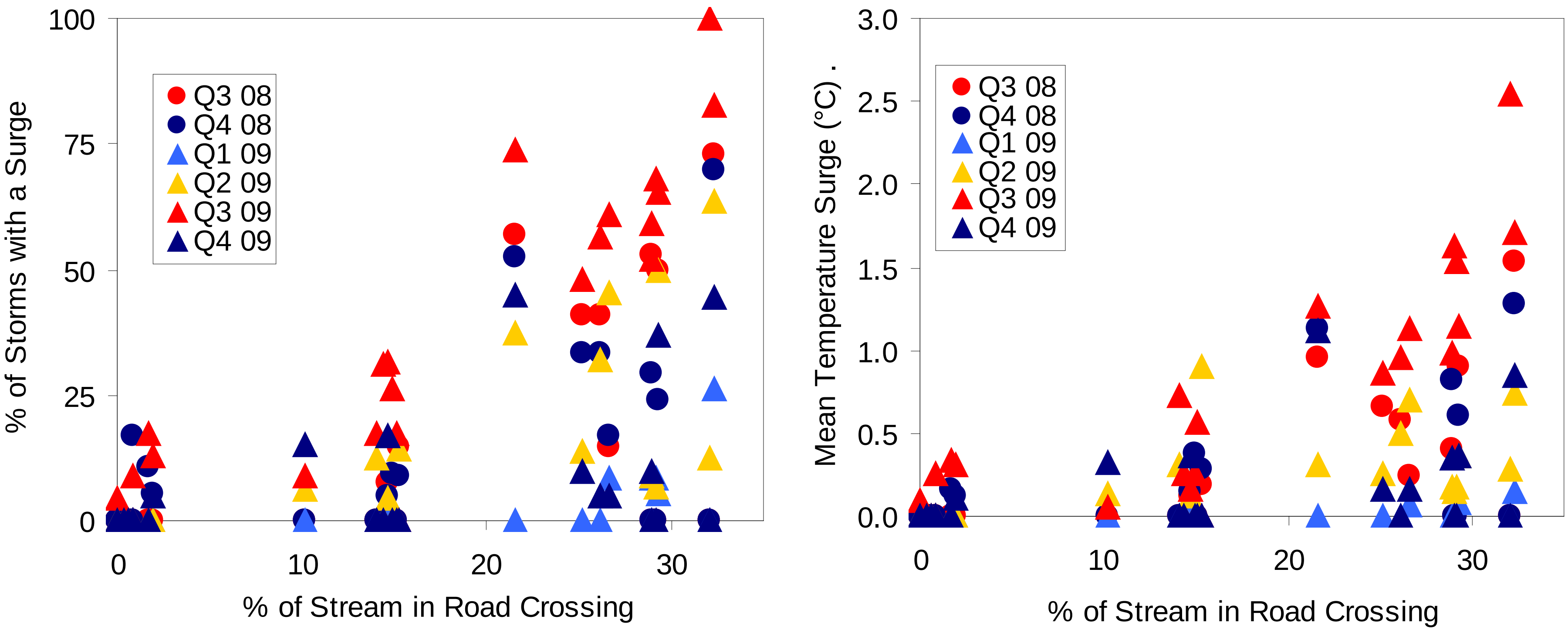
Culverts will not change mean temperatures



Some evidence of warming in winter, but generally inconclusive and cannot reject hypothesis

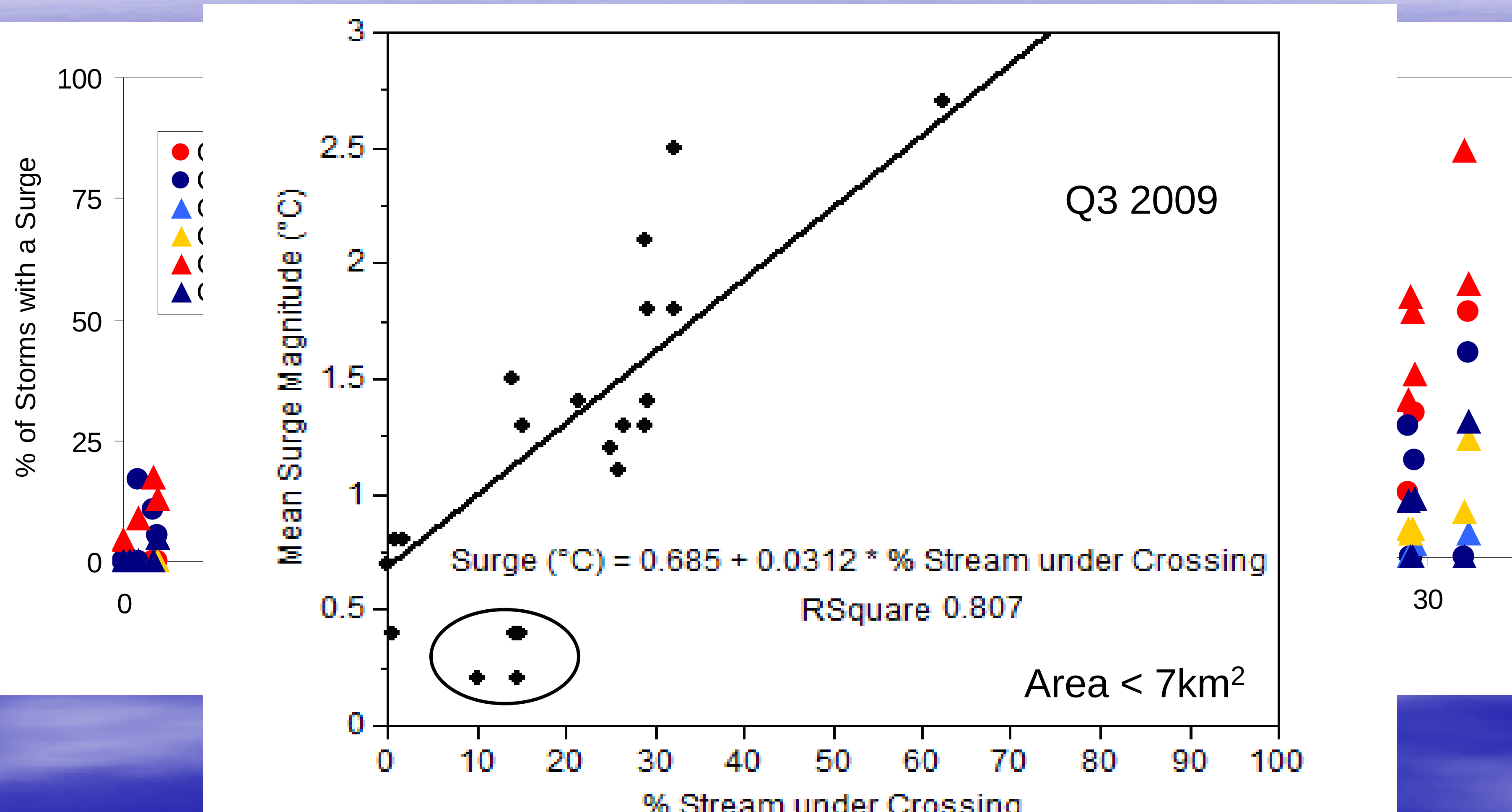
Hypothesis 1c

Culverts will not change storm temperature surges



Hypothesis 1c

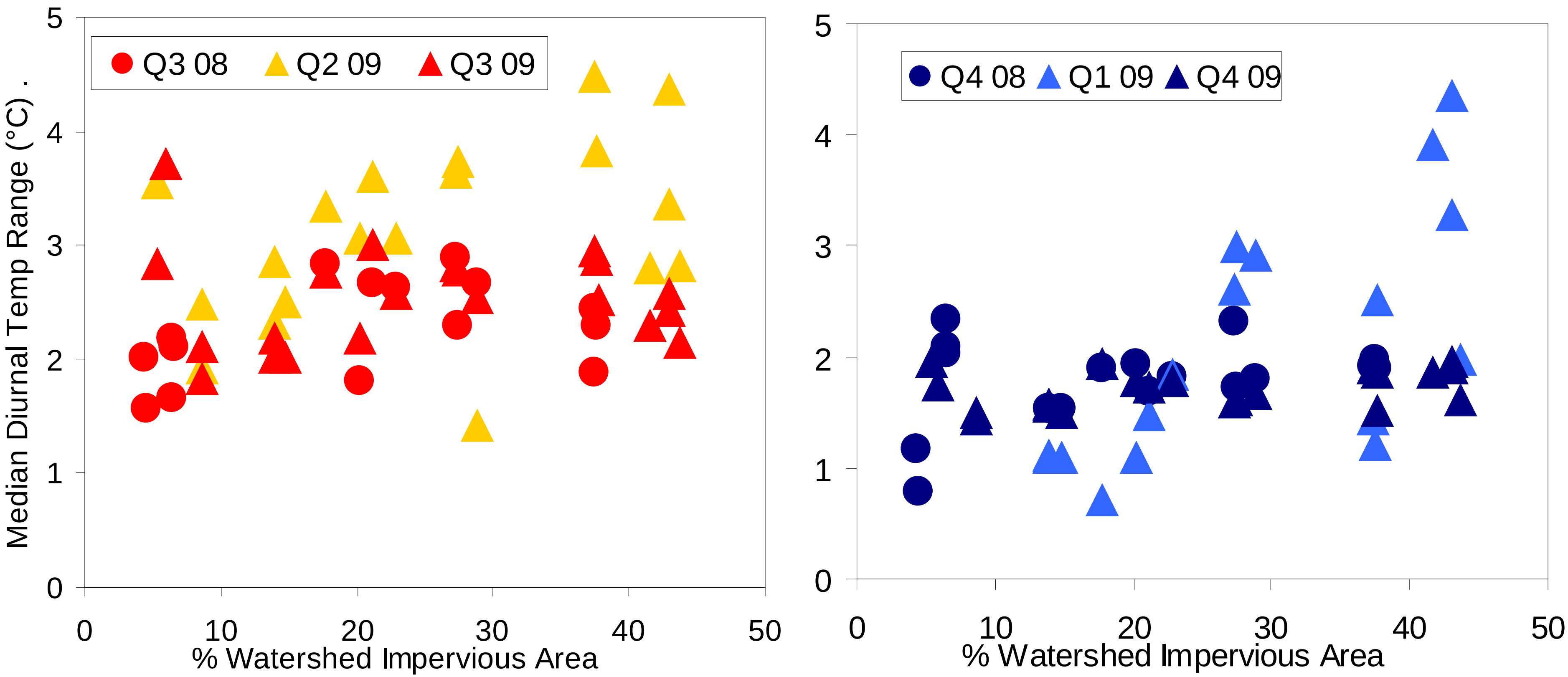
Culverts will not change storm temperature surges



Road crossings are positively correlated with storm surge frequency and magnitude, refuting hypothesis

Hypothesis 2a

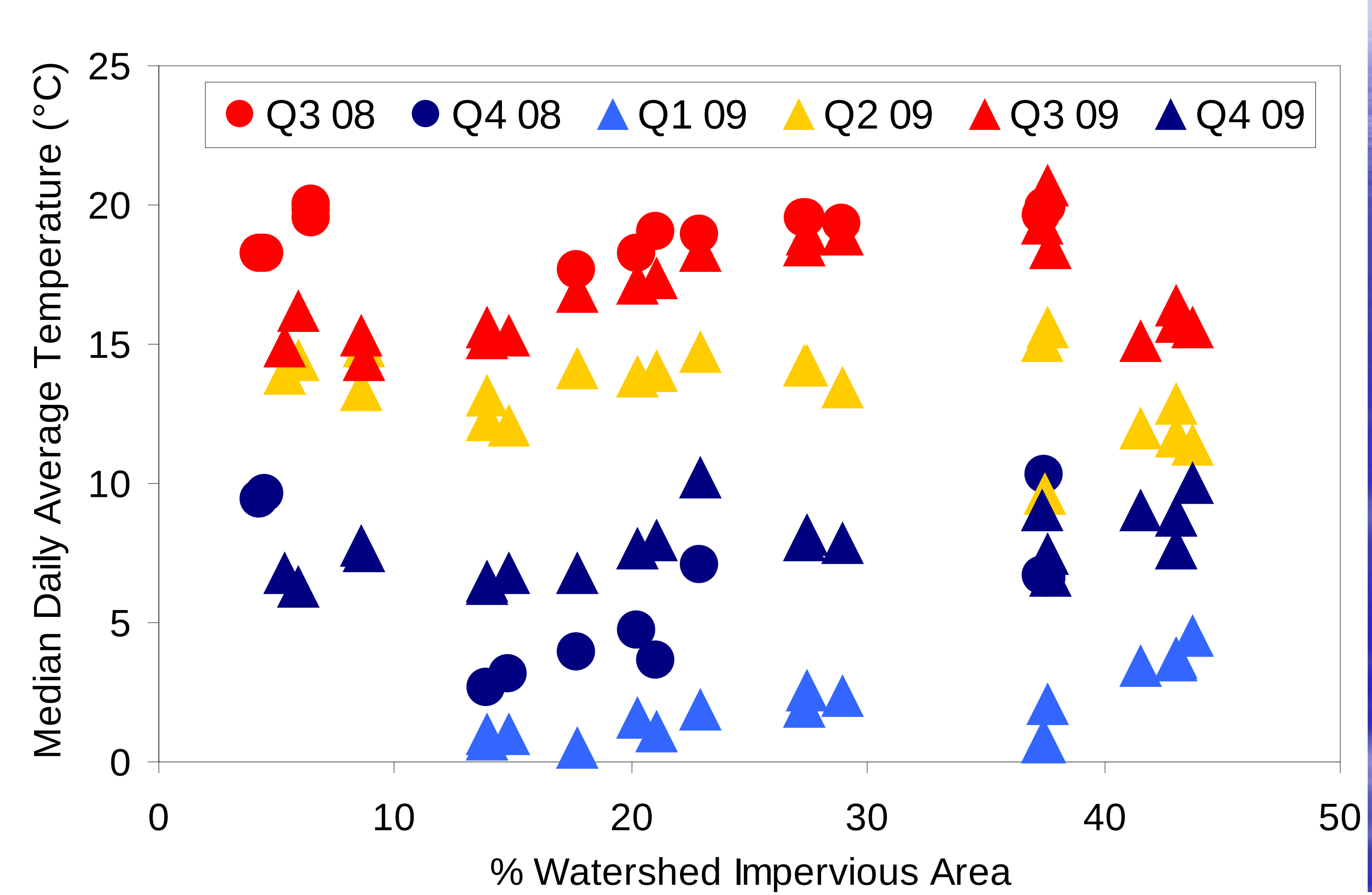
Impervious area will increase diurnal temperature range



Hypothesis reasonable for wintertime, not for summertime, inconclusive for other seasons

Hypothesis 2b

Impervious area will increase mean temperatures

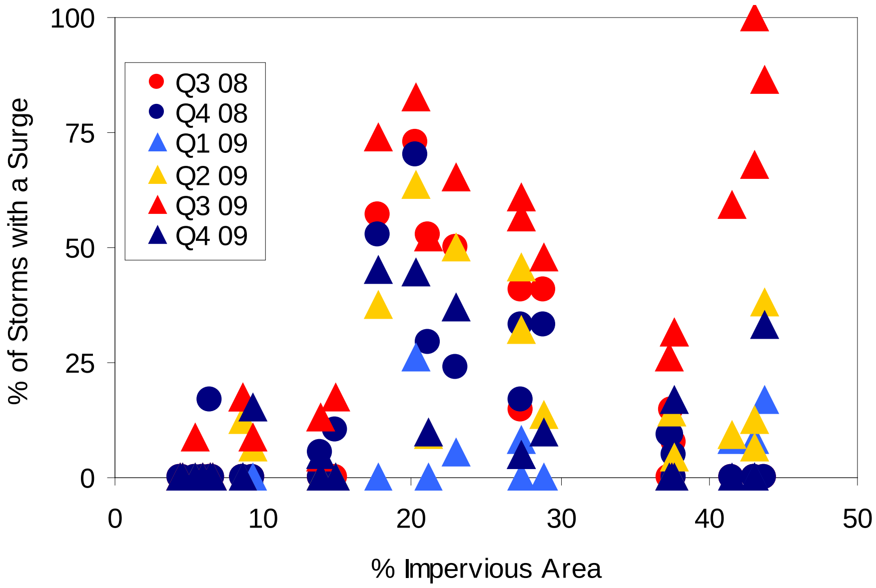


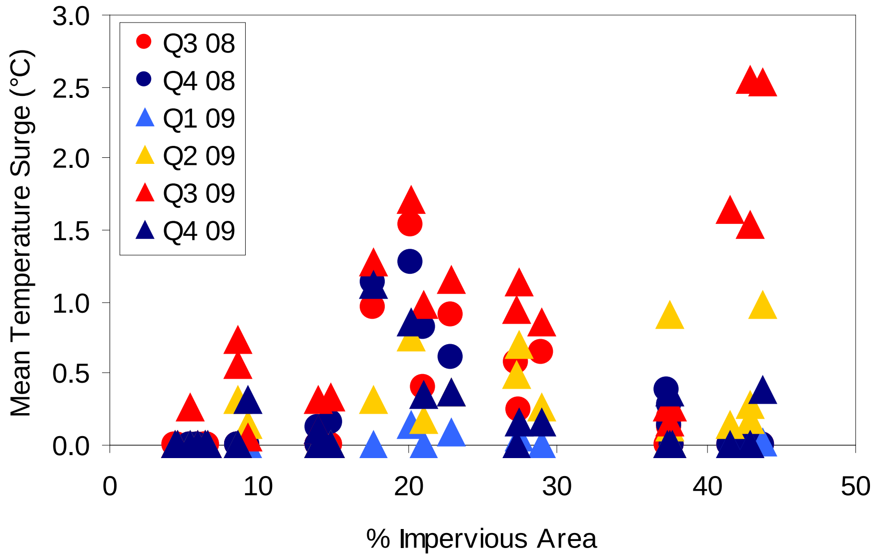
$$T_{Q3-2009} = 0.1813 Area + 0.1430 \% Impervious - 0.0502 \% Stratified + 14.33$$

Hypothesis not rejected for Q2/Q3, rejected for Q1/Q4

Hypothesis 2c

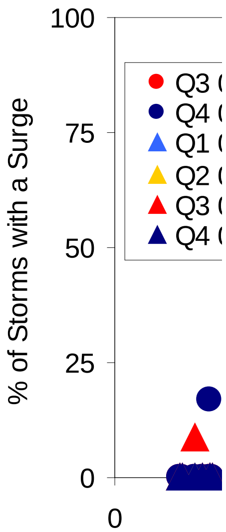
Impervious area will increase storm temperature surges

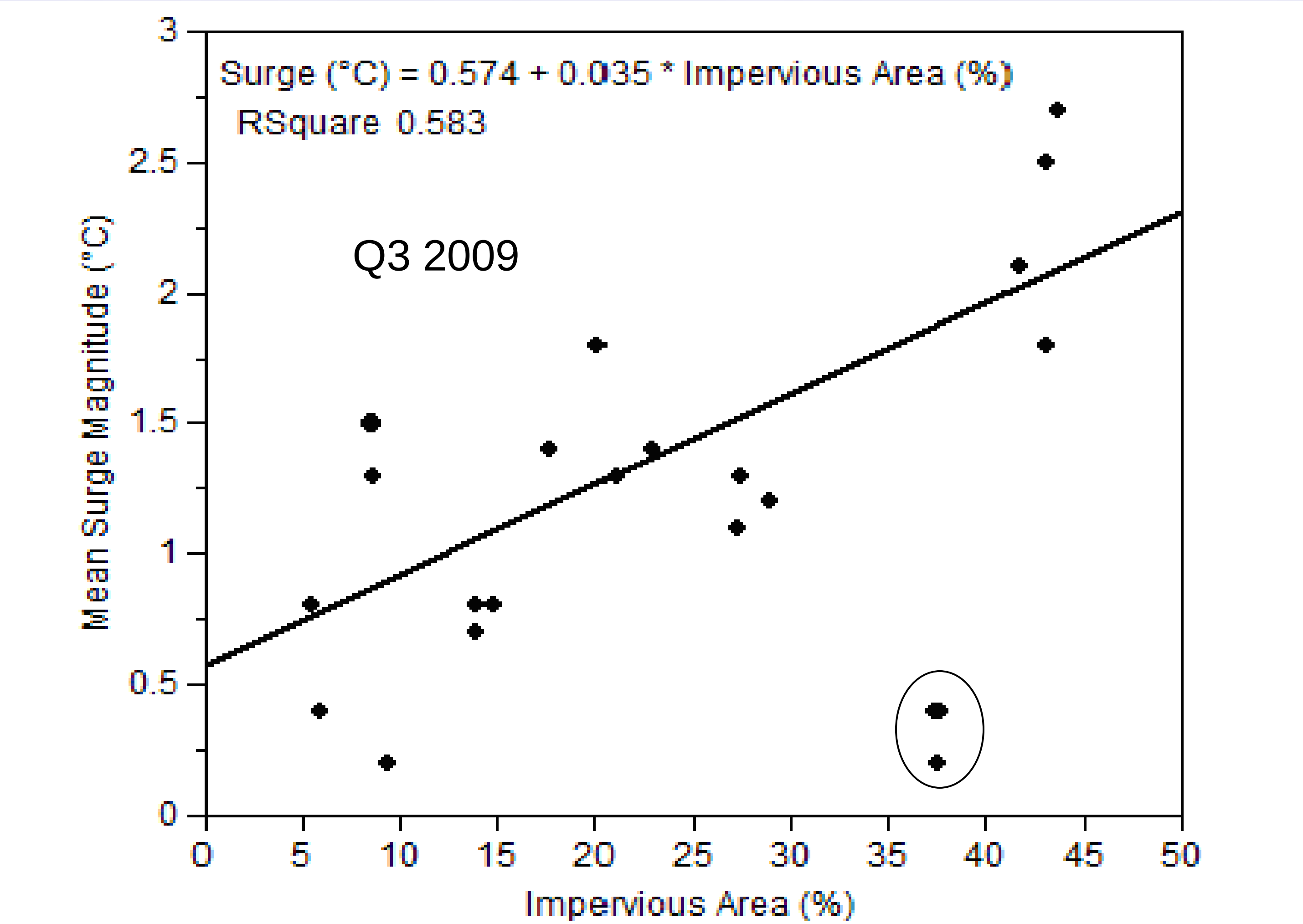


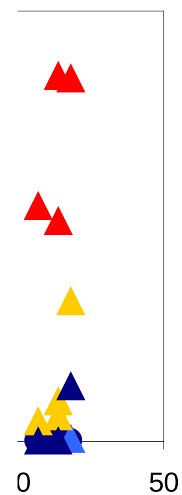


Hypothesis 2c

Impervious area will increase storm temperature surges







Some evidence of increased surges,
but impacts differed by analysis method,
so hypothesis cannot be accepted or refuted

Summary of Findings

	Road Crossing	Impervious Area
Diurnal Range	NO	YES: Q1
Mean Daily	NO	YES: Q2 and Q3 w/ stratified drift
Storm Surges	YES	MAYBE: weak relationship

New Research Questions

- What are the physical processes causing:
  - – Culverts to impact temperature surges
  - – Storm surges to differ among analysis methods
    - Gradients, magnitude, frequency
- How can we predict thermal impacts of urbanization?
  - – Different issues for baseflow and stormflow
  - – Thermal impact mitigation using BMPs

Results in Context

- Aquatic Impacts
  - Warming from impervious area reduces coldwater habitat during baseflow periods
  - Increased storm surge temperatures from road crossings have the potential to cause temperatures to exceed acute limits
- Aquatic Impact Limitations
  - Biota’s temperature tolerances not fully understood
  - Important temperature metrics are seldom available

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Questions?