

# CT, MA, NH Temperature Data Analysis

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# Overview

- Background
- New England Regional Temperature Regimes
  - NH, MA, and CT Summary
  - High-Quality Coldwater Streams in New England (USEPA)
- Related Stream Temperature Research
  - Reach Scale Temperature Sensing and Modeling
  - Urbanization and Stream Temperature
  - Temperature Prediction using Statistical Models

# Thermal Regime Significance

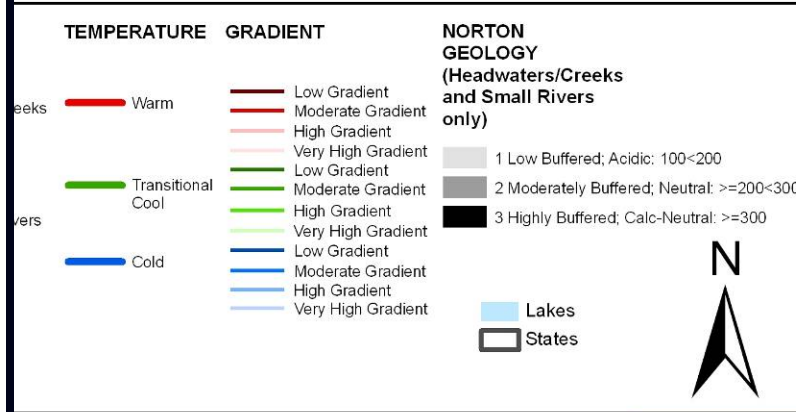
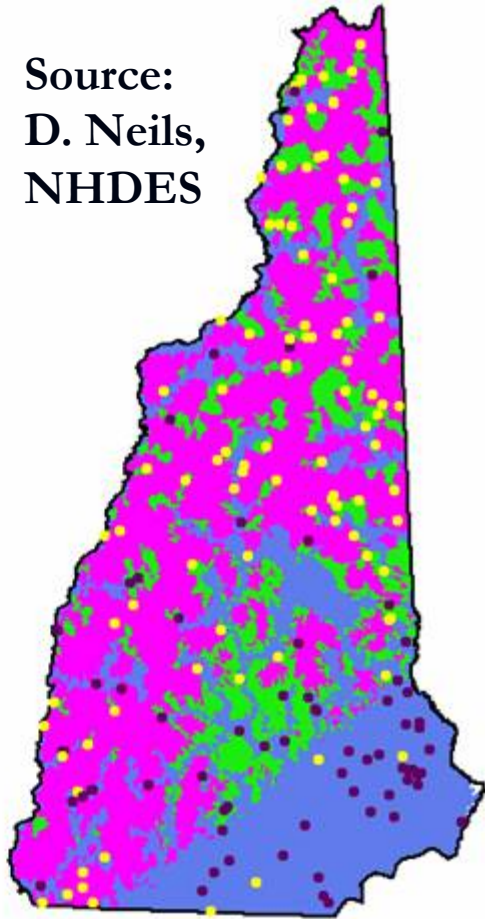
- Primary stream health indicator
- Fisheries classification
  - Coldwater: 18°C (65°F)
  - Cool (Mixed) Water
  - Warm Water: 22°C (72°F)
  - Upper Lethal Temp  
25-30°C (77-86°F)
- Current knowledge limited
- Drivers only recently studied



Pictures Credit:  
NJ Freshwater Fish Identification

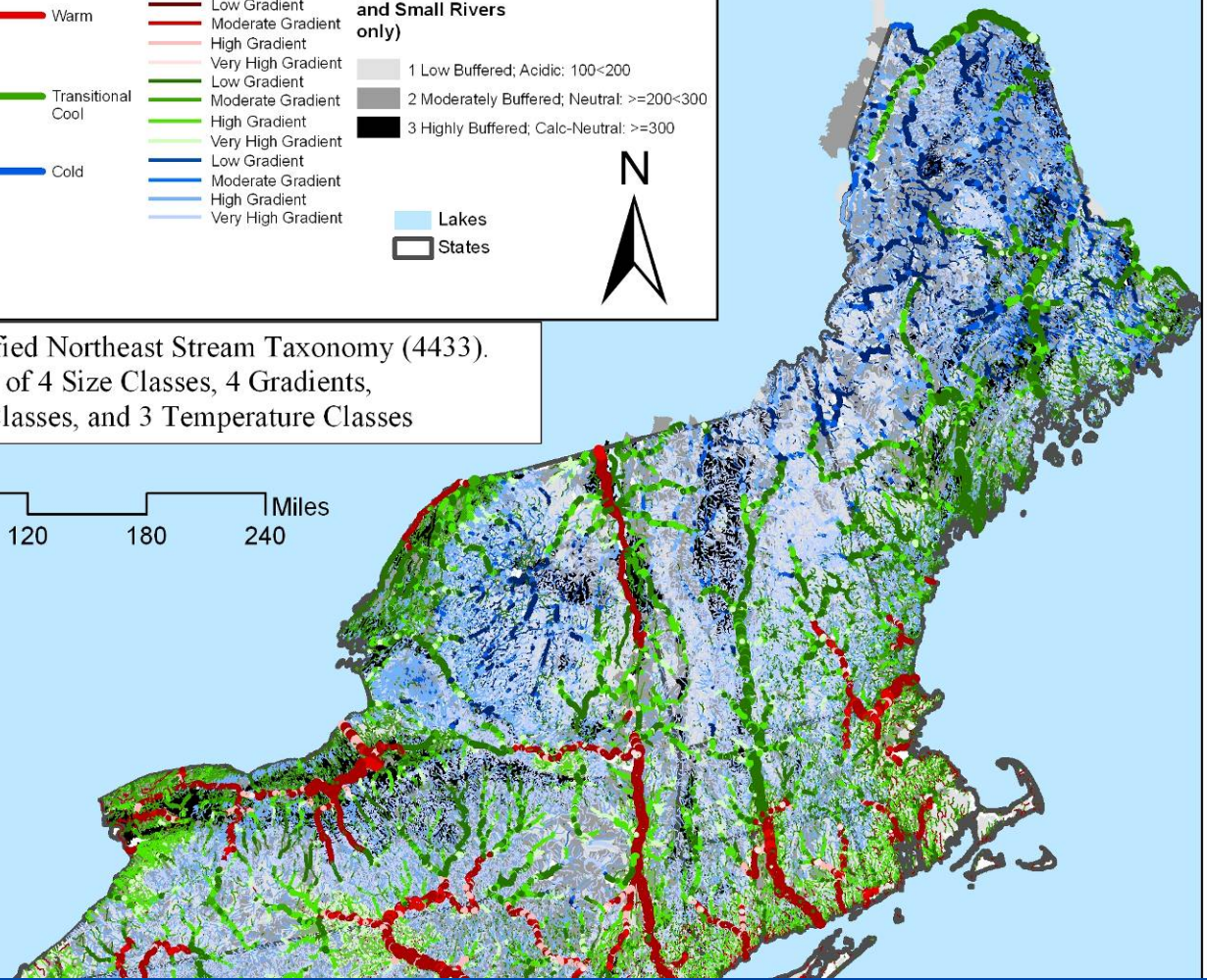
# NE Regional Scale Taxonomy

Source:  
D. Neils,  
NHDES



Simplified Northeast Stream Taxonomy (4433).  
Summary of 4 Size Classes, 4 Gradients,  
4 Geology Classes, and 3 Temperature Classes

Miles  
120 180 240



# Regional Temperature Regime Characteristics of High-Quality Coldwater Streams in New England (USEPA)

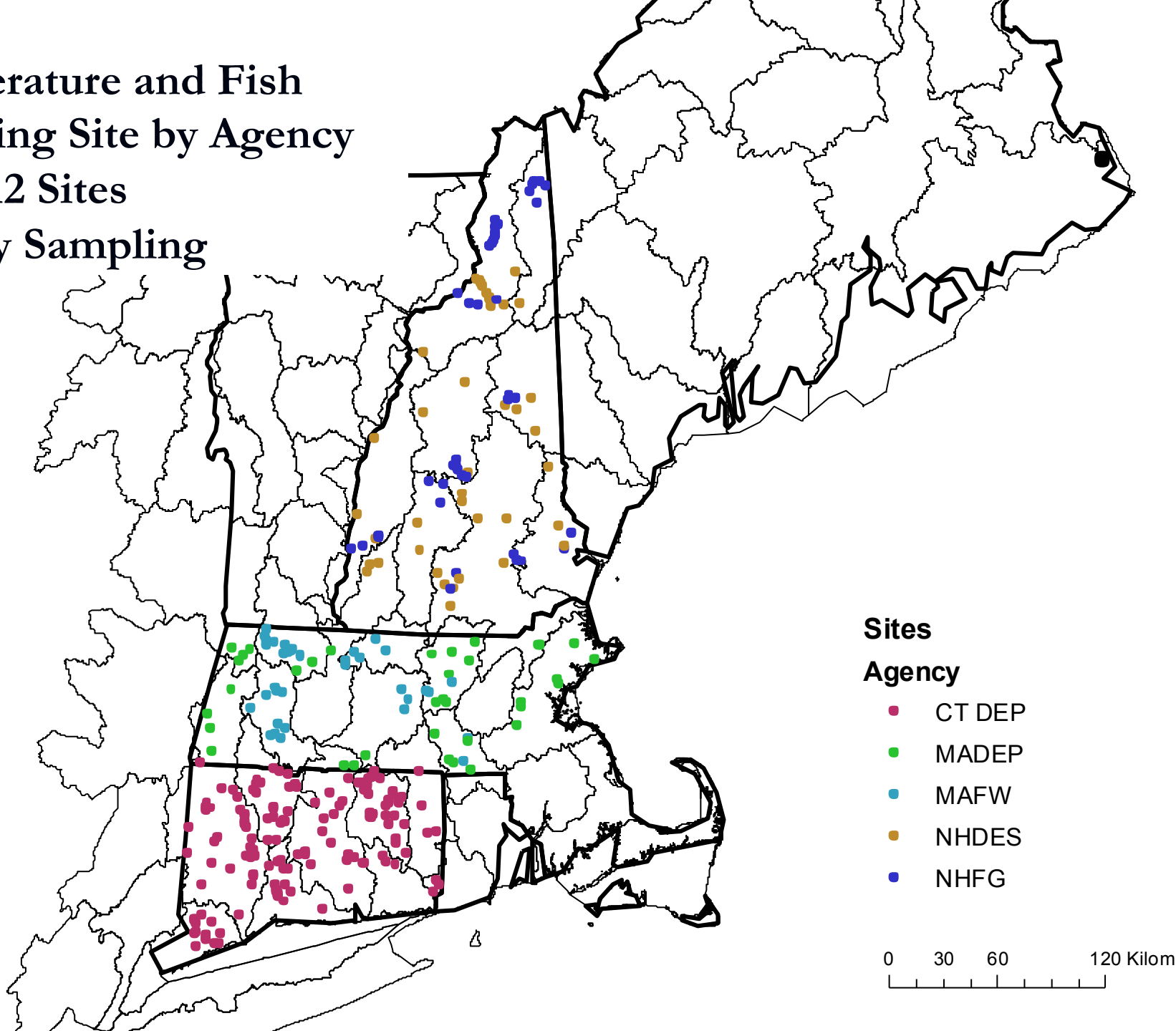
- **Task 1: Develop a stream temperature database**
- **Task 2: Quantify stream temperature regimes**

Magnitude  
Frequency  
Timing  
Duration  
Rate of Change

# Temperature and Fish Sampling Site by Agency

N = 312 Sites

Hourly Sampling



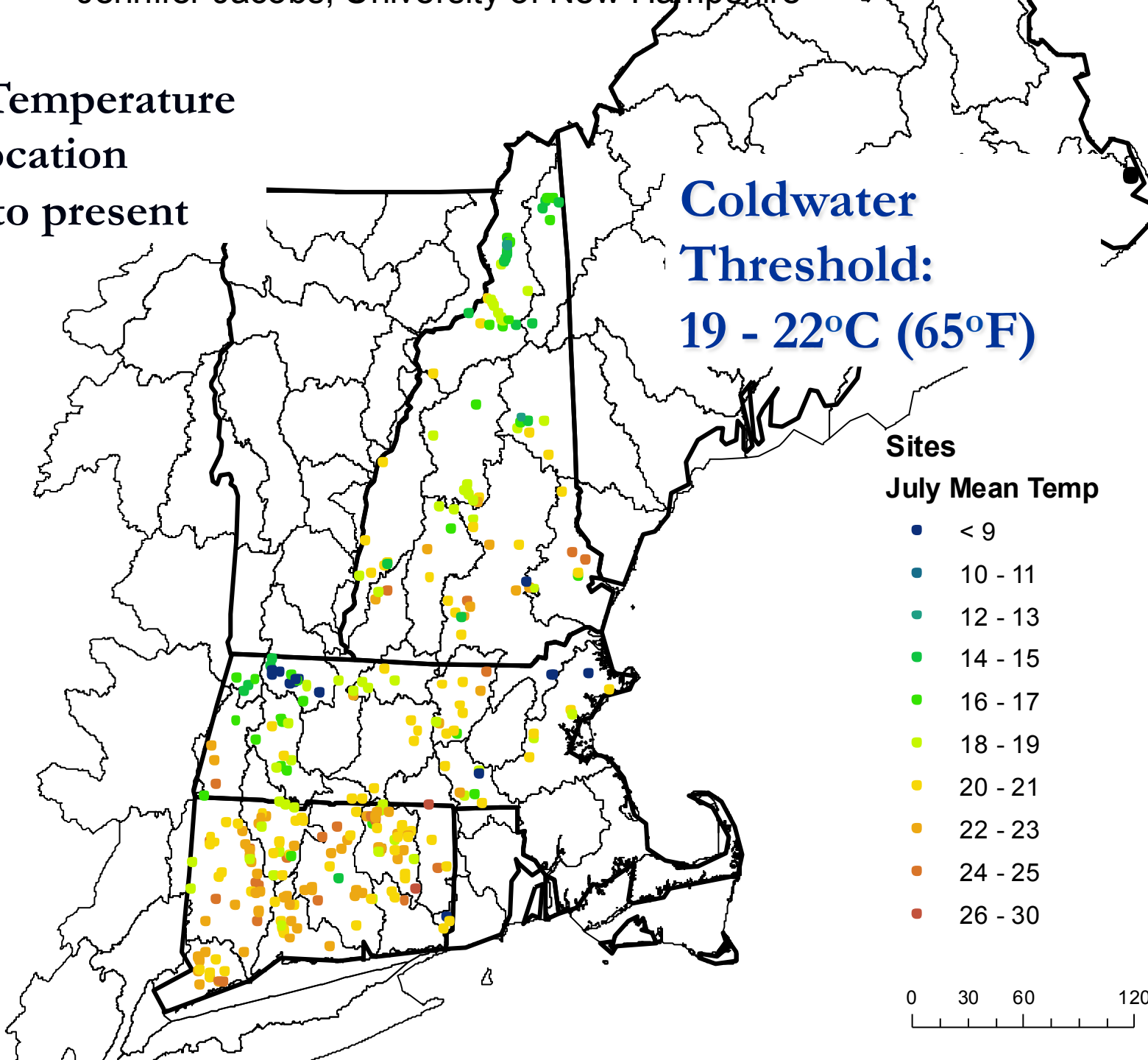
## Sites Agency

- CT DEP
- MADEP
- MAFW
- NHDES
- NHFG

0 30 60 120 Kilom

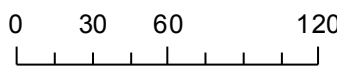
# July Temperature by Location 2000 to present

**Coldwater  
Threshold:  
19 - 22°C (65°F)**



**Sites  
July Mean Temp**

- < 9
- 10 - 11
- 12 - 13
- 14 - 15
- 16 - 17
- 18 - 19
- 20 - 21
- 22 - 23
- 24 - 25
- 26 - 30



# MAGNITUDE: Mean Daily Temperatures

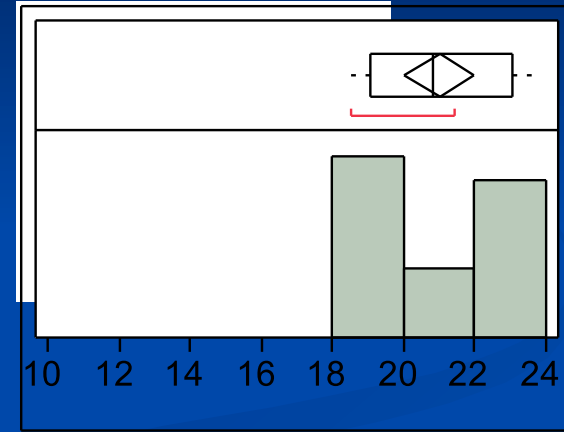
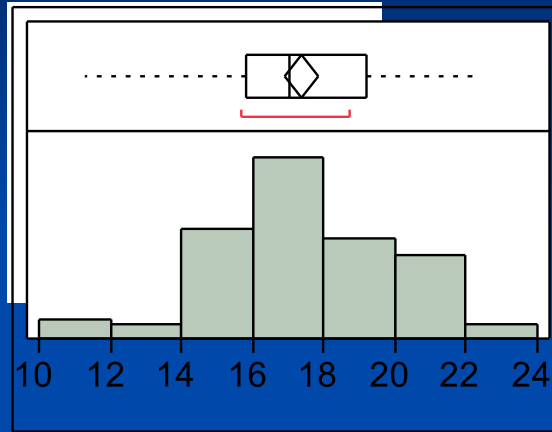
## Coldwater Species

Present

Absent

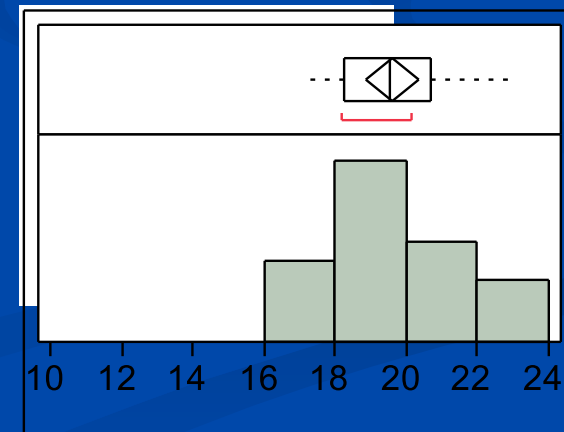
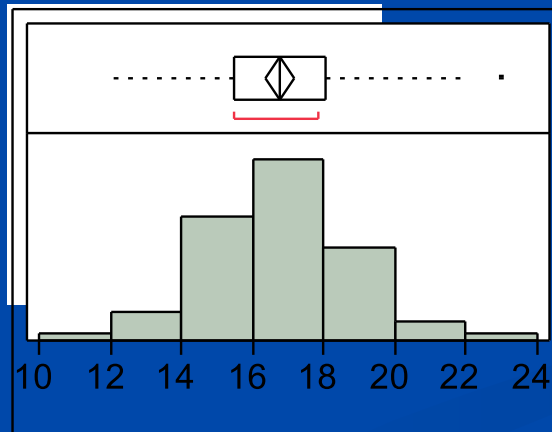
JULY

No. of Streams



AUGUST

No. of Streams



Temperature

Temperature

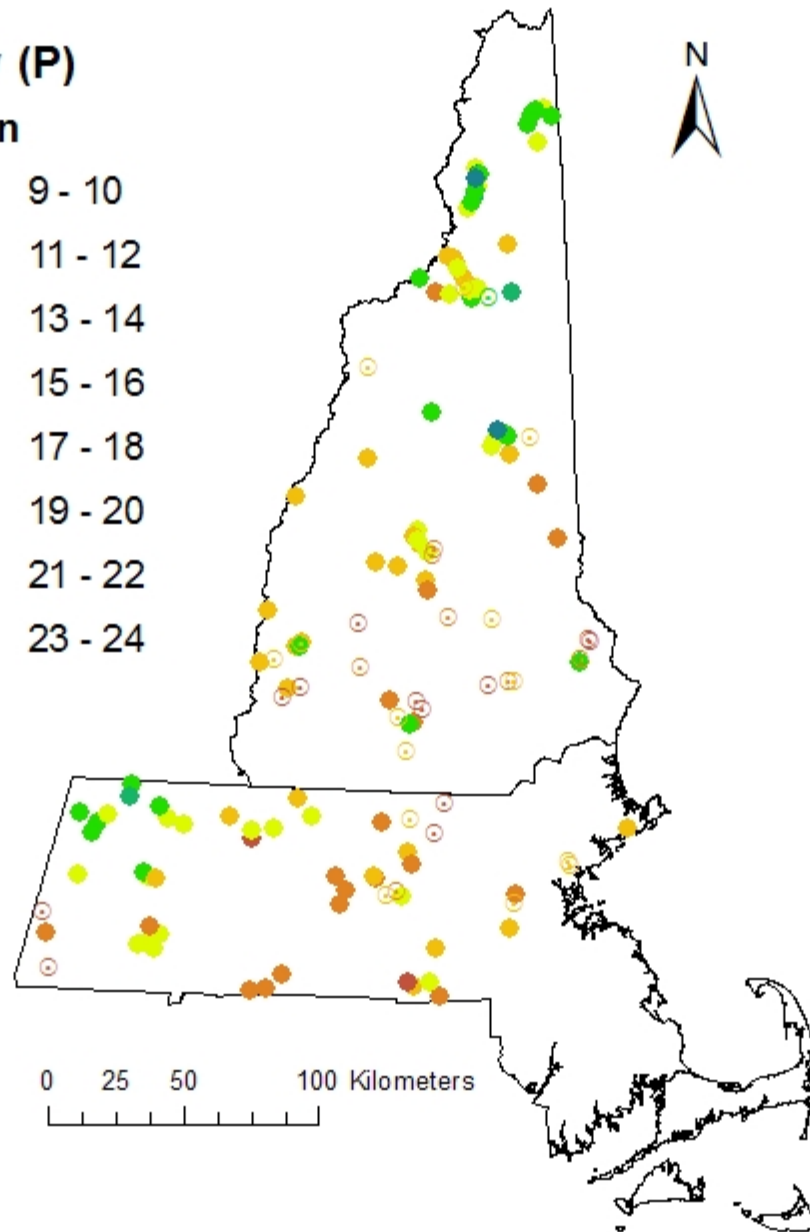


# Brook Trout Present (solid) and Absent (hollow)

July (P)

Mean

- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24



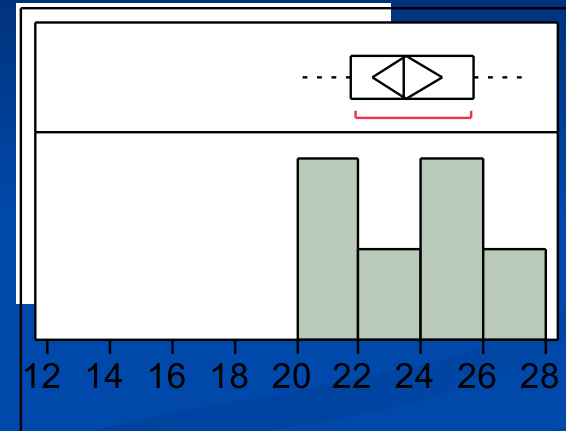
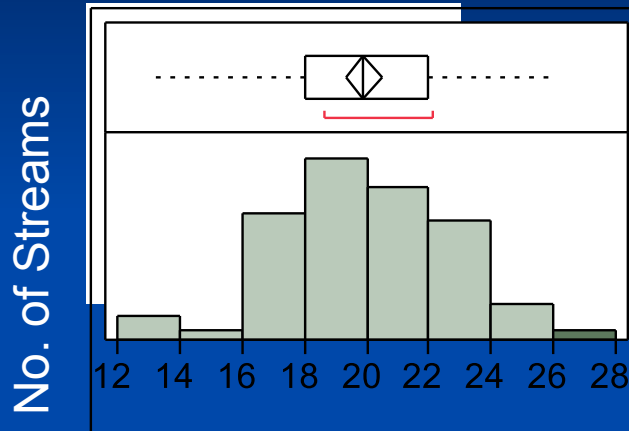
# MAGNITUDE: Maximum Daily Temperatures

## Coldwater Species

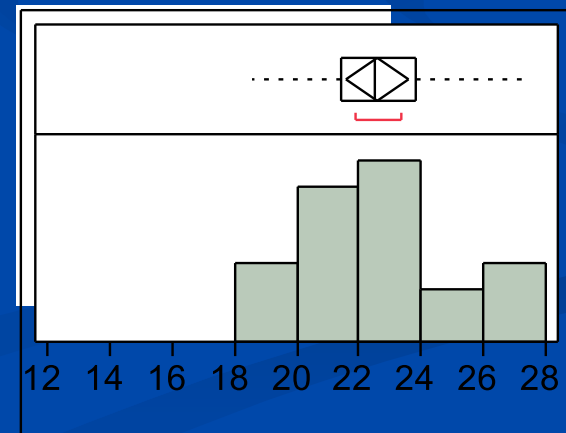
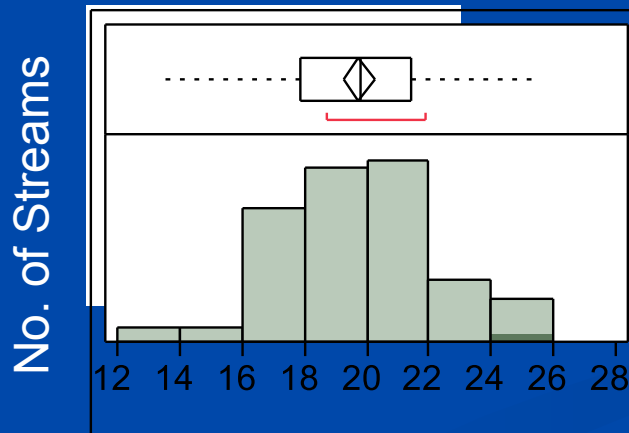
Present

Absent

JULY



AUGUST



Temperature

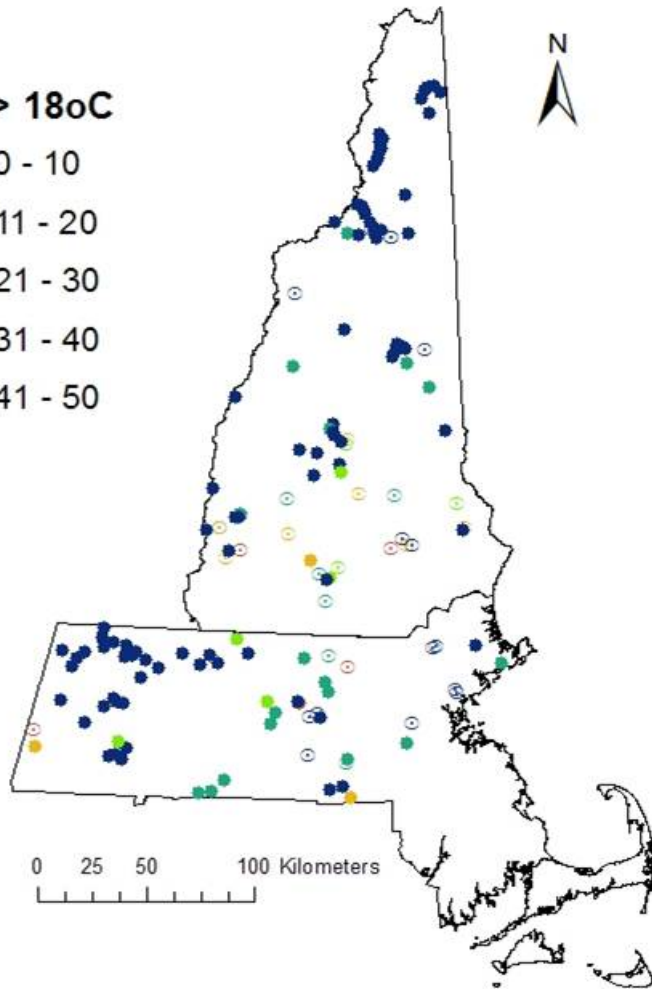
Temperature

# FREQUENCY: % of Days $>$ Threshold

Brook Trout Present (solid) and Absent (hollow)

Days  $>$  18oC

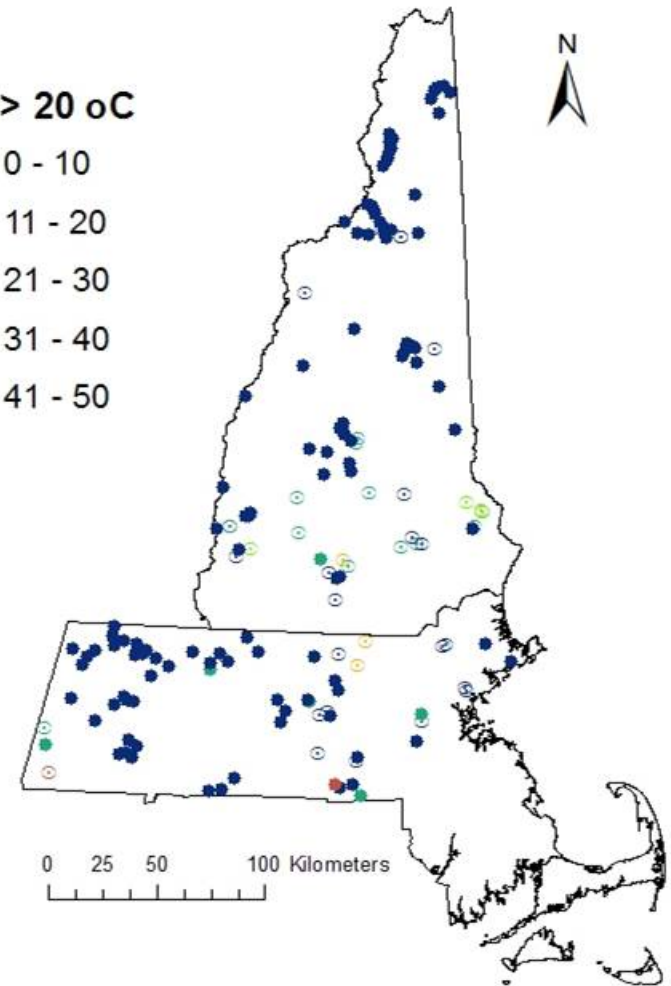
- 0 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50



Brook Trout Present (solid) and Absent (hollow)

Days  $>$  20 oC

- 0 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50



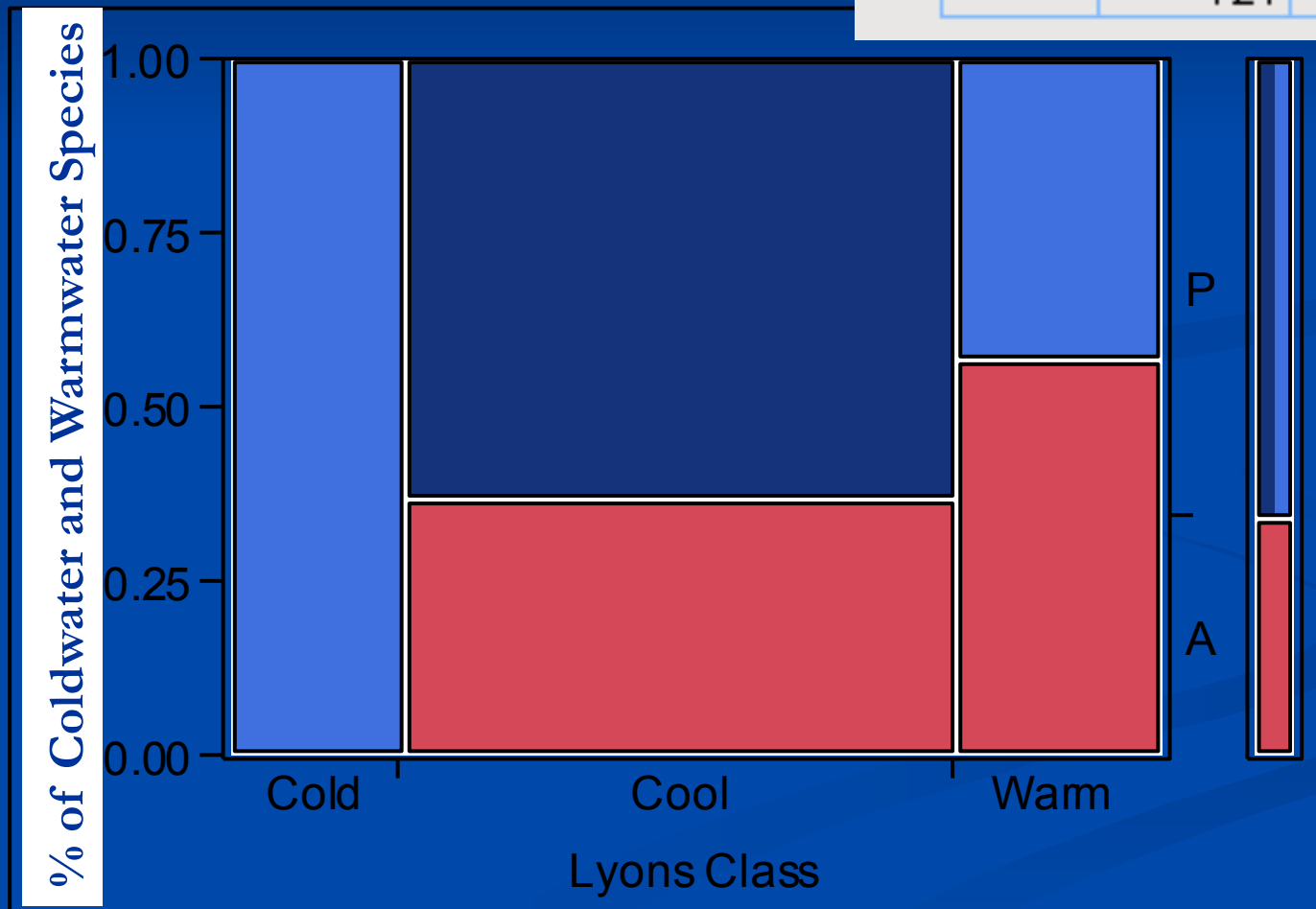
# Can Temp Observations Predict Coldwater Fish?

## Metric 1: Lyons et al. Classification (Michig & Wisc)

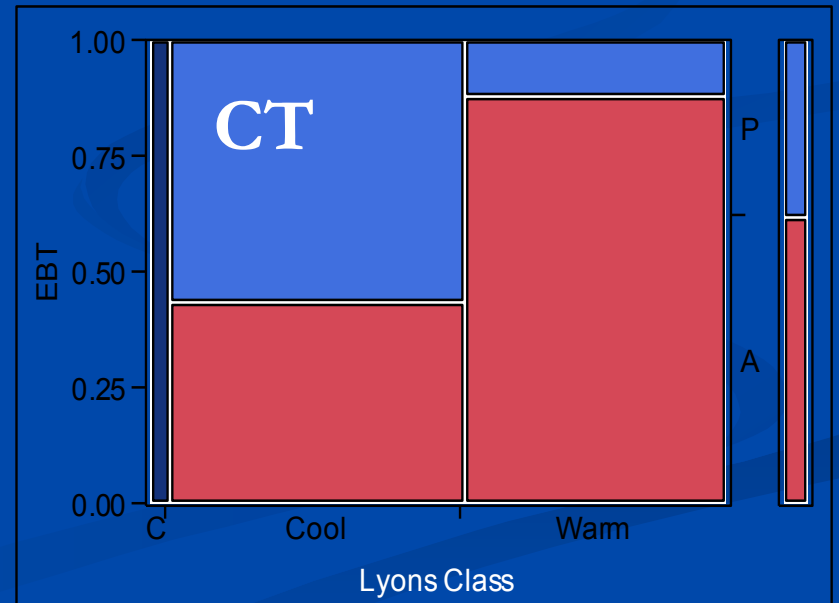
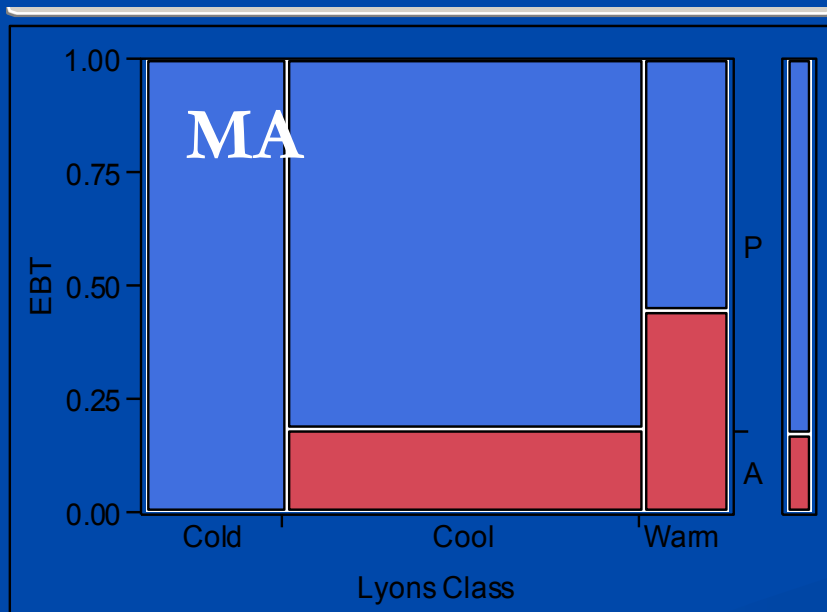
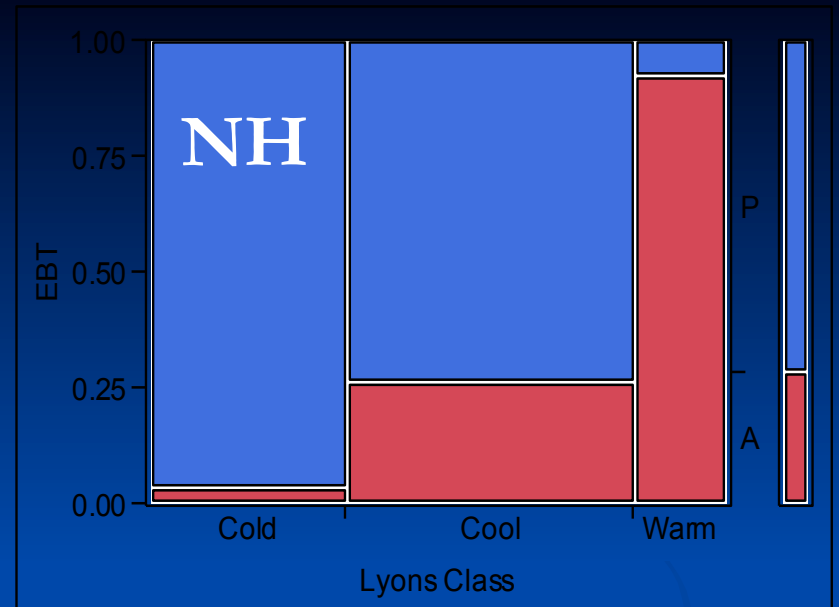
Stream Class	June – Aug Average	July Average	Warmest Day of Yr
Coldwater	<17	< 17.5	< 20.7
Coolwater	17 – 20.5	17.5 – 21.0	20.7 – 24.6
Warmwater	> 21	>21	> 24.6

# Lyons Classification: All Sites

Lyons Class	Count	Absent	Present	
Cold		1	48	49
Cool		51	105	156
Warm		75	14	89
		127	167	294



# Lyons Classification: By State



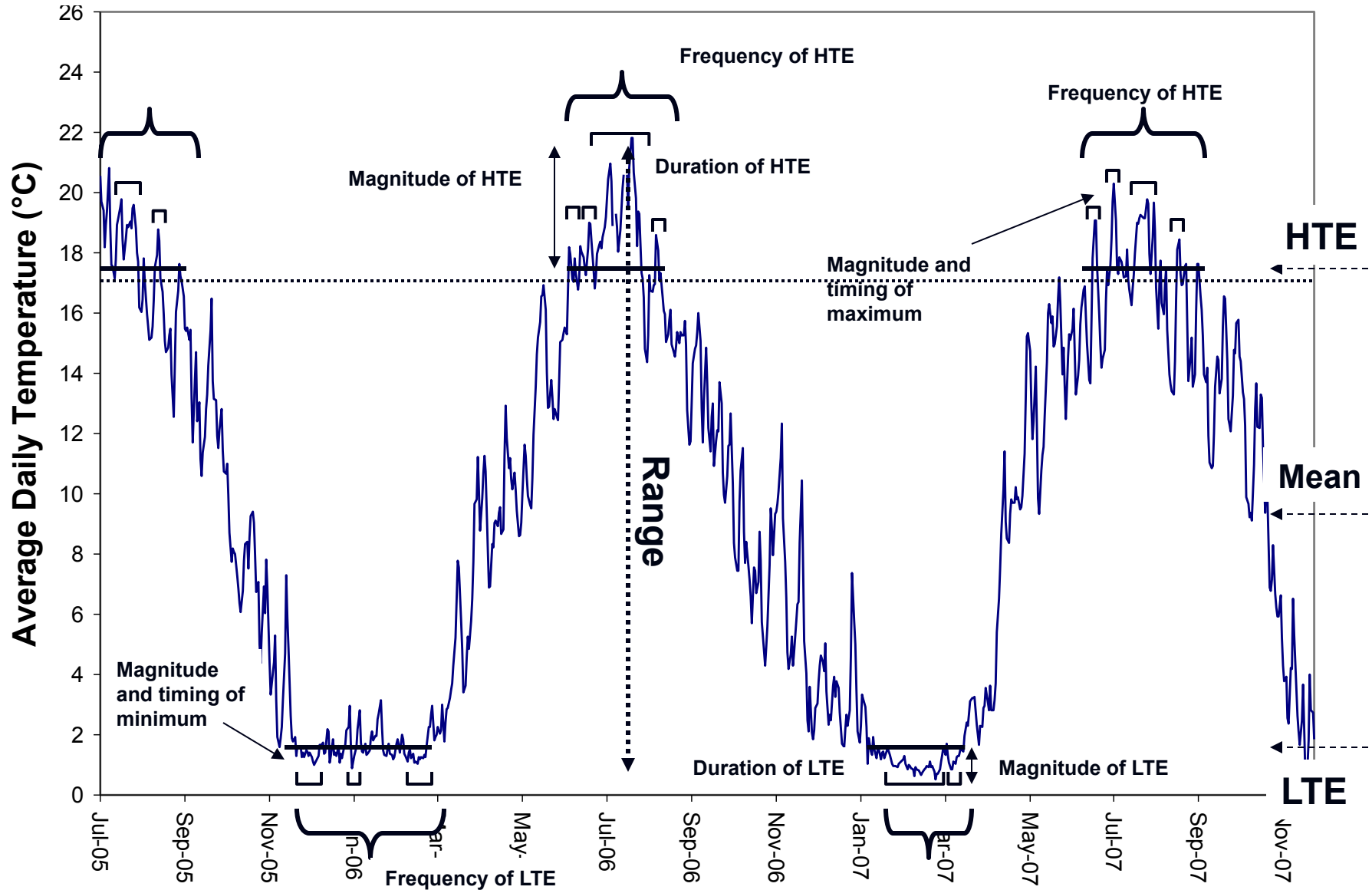
# Lyons and TNC

## Classification Summary

Class	Cold when Present	Cool when Present	Warm when Absent
All States	77% (167)	31% (110)	67% (15)
	98% (49)	67% (156)	84% (89)
NH	77% (74)	30% (10)	0% (0)
	97% (29)	73% (42)	92% (13)
MA	93% (45)	57% (14)	50% (2)
	100% (15)	81% (38)	44% (9)
CT	60% (48)	27% (86)	69% (13)
	100% (5)	56% (67)	88% (76)

# MAFWD: Average Daily Stream Temperature for 36 Coldwater Streams

## A Coldwater Stream's Thermal Regime



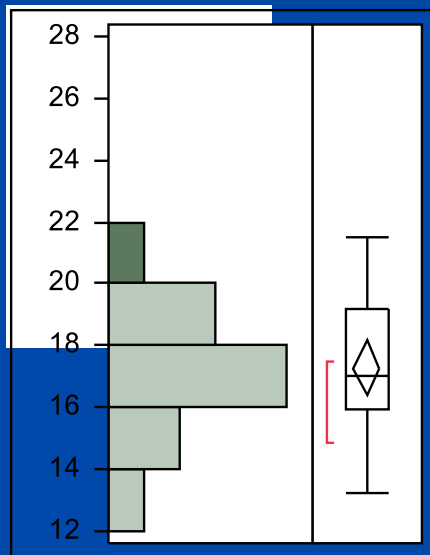


# Regional Temperature Regime

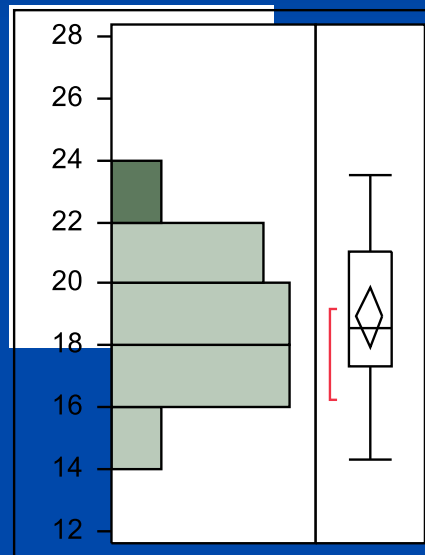
## Characteristics of MAFW

### *High-Quality Coldwater Streams*

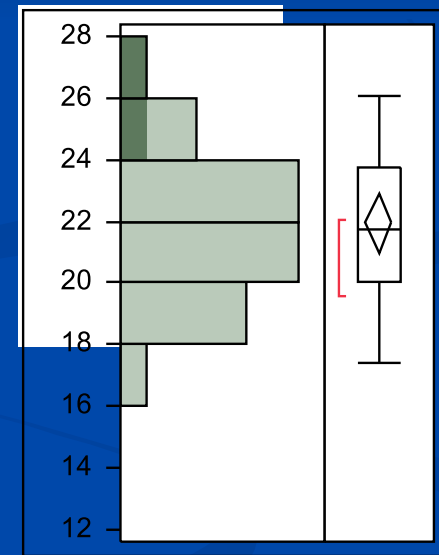
Jun-Aug Mean 2006



July Mean 2006



Maximum Daily Mean 2006



Lyons criteria: June-Aug mean  $< 17^{\circ}\text{C}$ , July mean  $< 17.5^{\circ}\text{C}$ , and max daily  $< 20.7^{\circ}\text{C}$   
MAFW criteria: June-Aug mean  $< 20.1^{\circ}\text{C}$ , July mean  $< 22.3^{\circ}\text{C}$ , and max daily  $< 25.4^{\circ}\text{C}$

# Nashua at Cobb (NA 970459) Upstream at removal



Miller at Lyon (Mi 970445) Upstream at removal

# Reach Temperature Regime Characteristics of Healthy and Impaired Streams

**Goal:** Identify the availability of  
biotic refugia or critical habitat  
(e.g., deep pools, seeps and springs)



# Fiber Optic Temperature



Current precision:  $<+/- 0.01 \text{ deg C}$

Multi mode fiber:  $<25 \text{ km}$

Spatial resolution:  $0.5 - 2 \text{ m}$

\$1 per meter of cable

\$30,000 instrument (\$100,000 in '05)

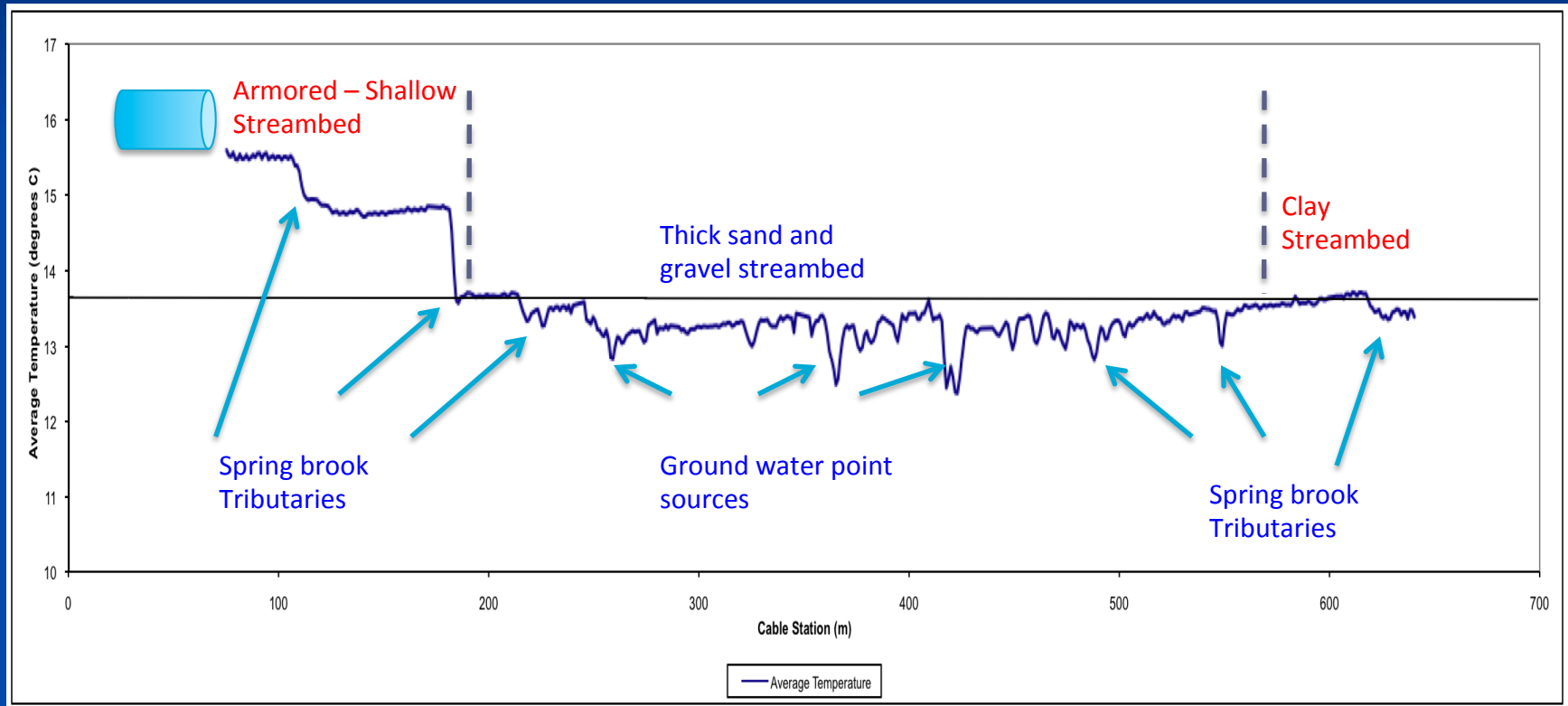
Overview

Regime

Urbanization

Drivers

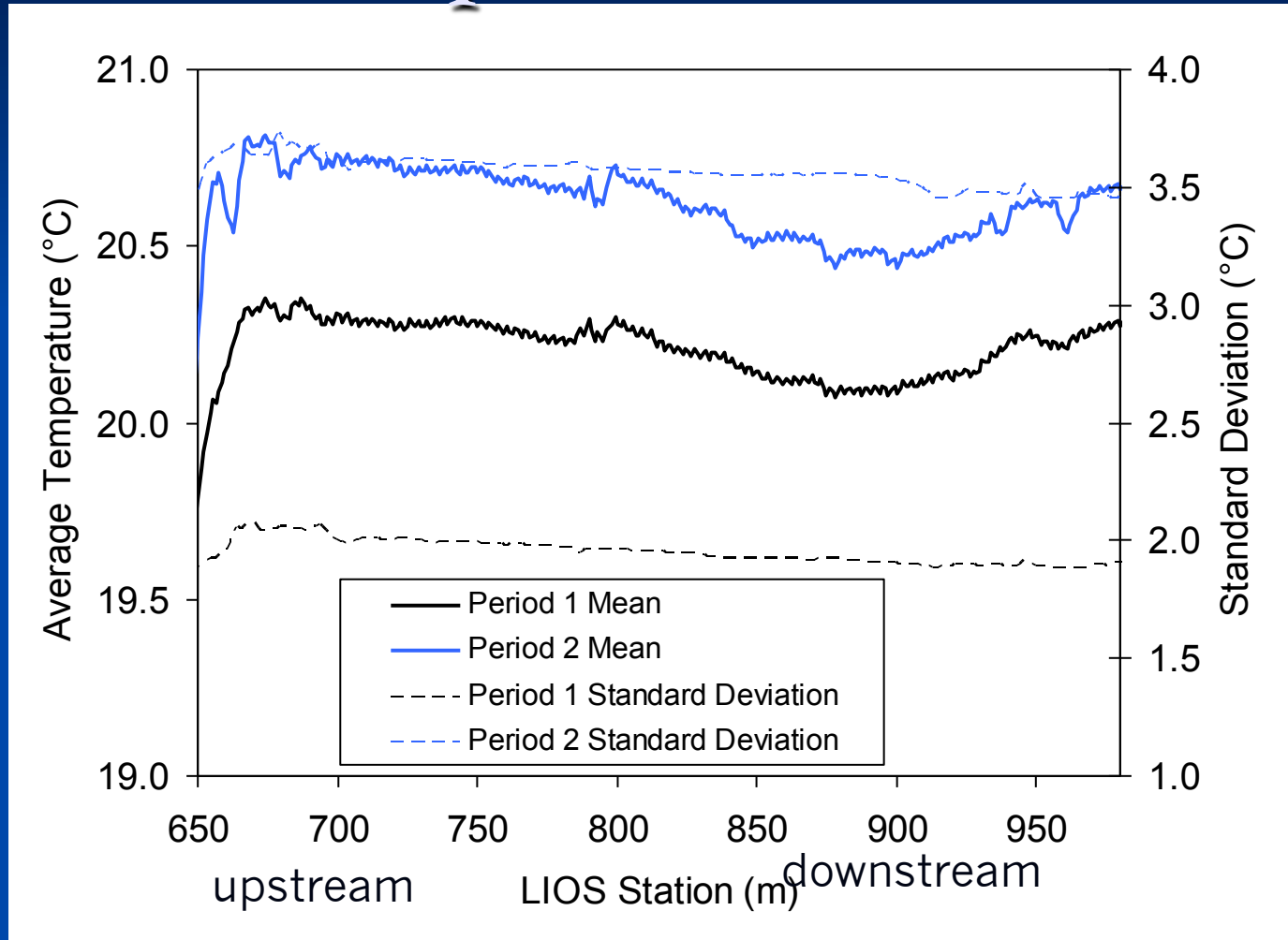
# Natural Stream Temperature Fiber Optic Measurements



Small tributaries, sand/gravel streambed and hill slope groundwater key to cool temps !!



# Urbanized Stream Temperature Fiber Optic Measurements



Period 1 was from 7/15/09 to 8/13/09. Period 2 was from 8/18/09 to 9/3/09

# Impacted Stream

## Storm Characteristics

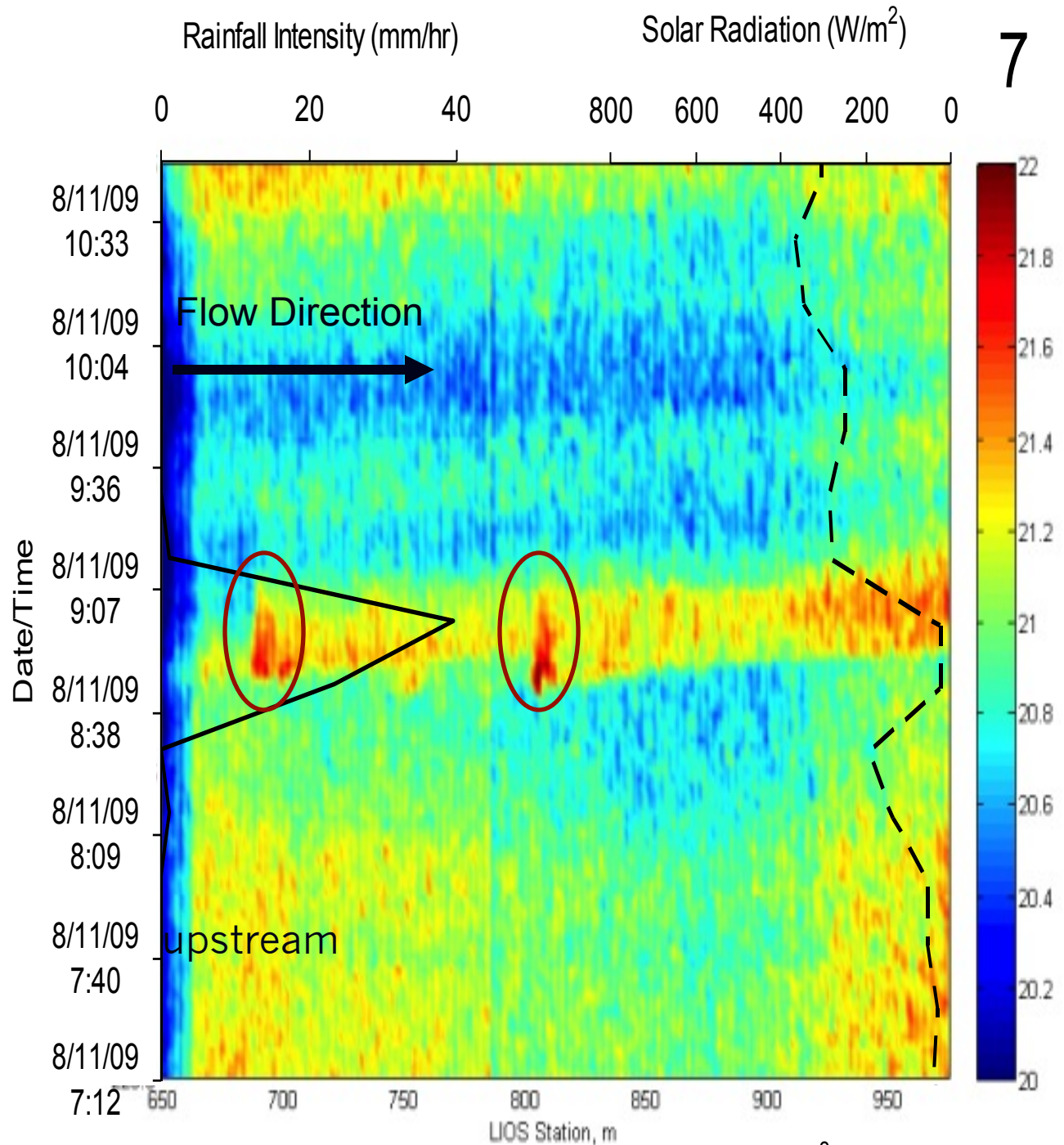
August 11, 2009

Time: 08:15 to 09:15

Air Temp: 21.3 °C

Water Temp: 21.0 °C

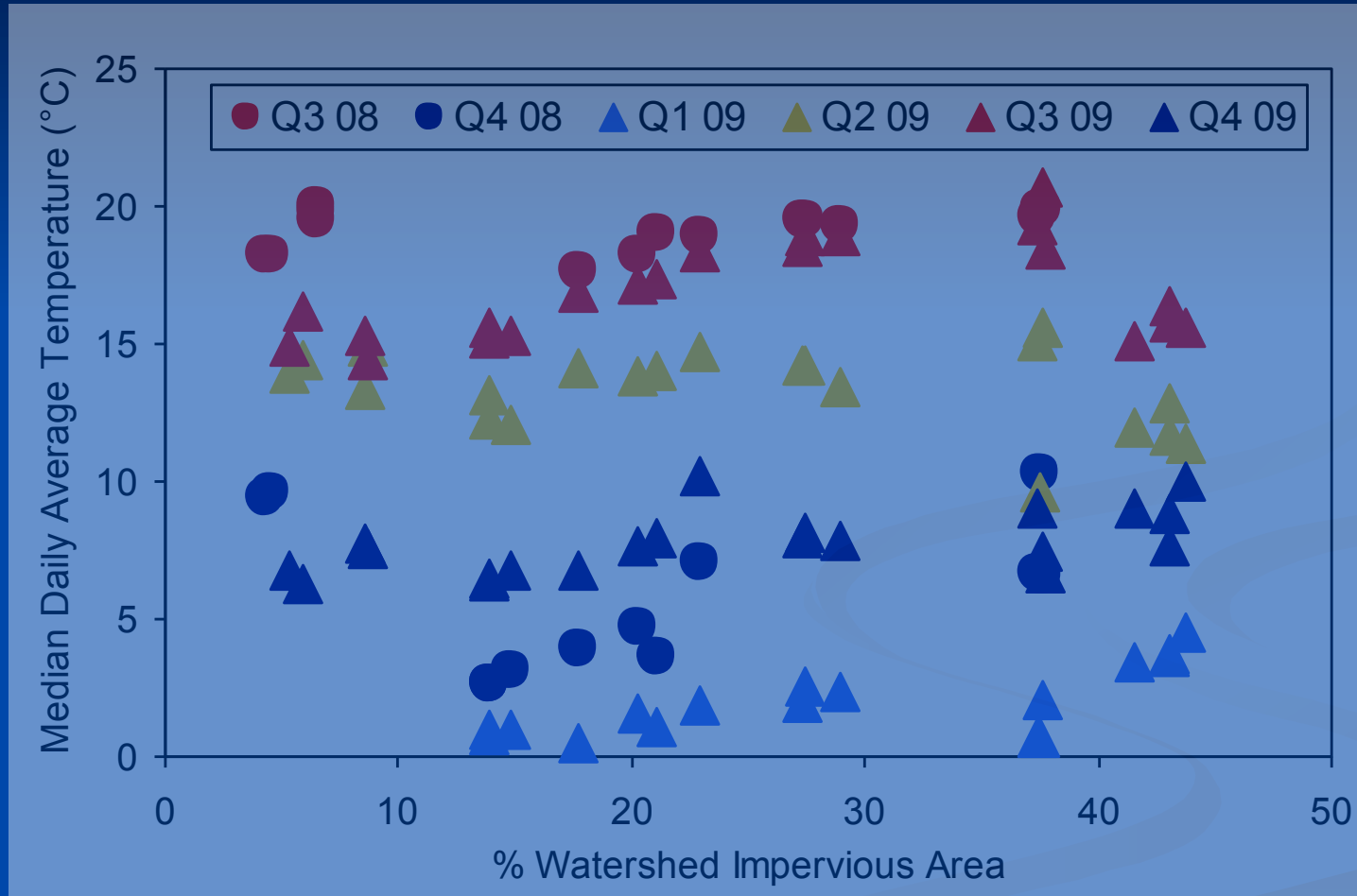
Rain: 1.6 cm





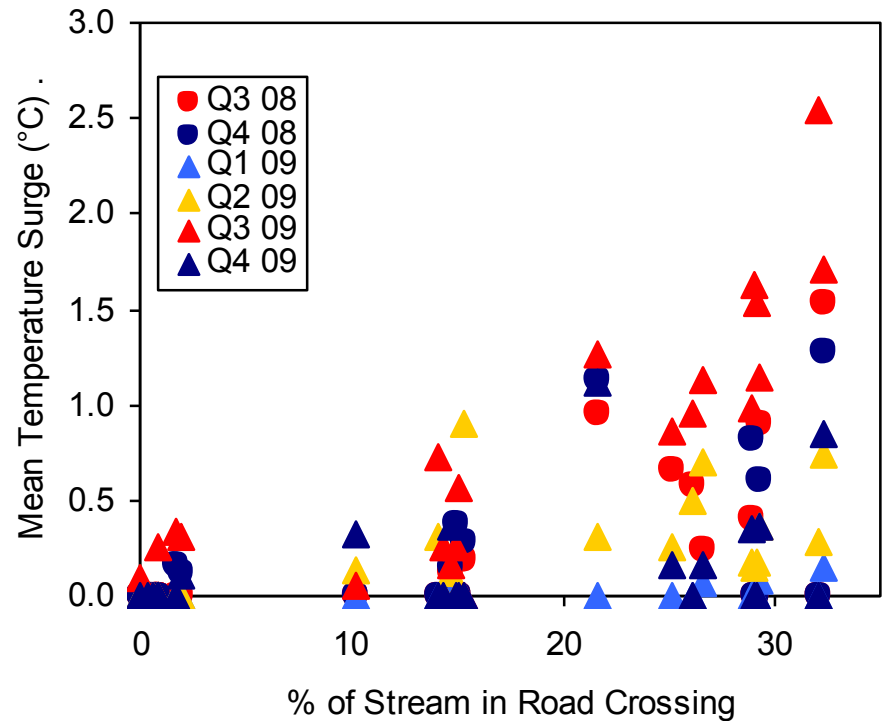
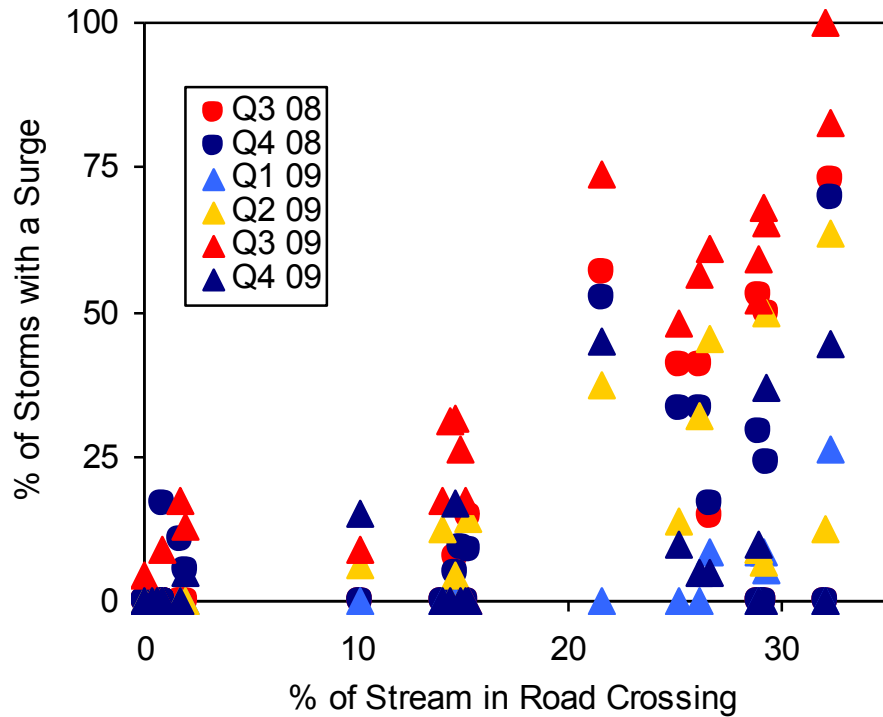
# Urbanization and Streamwater Temperature

## Impervious Area and Mean Temp

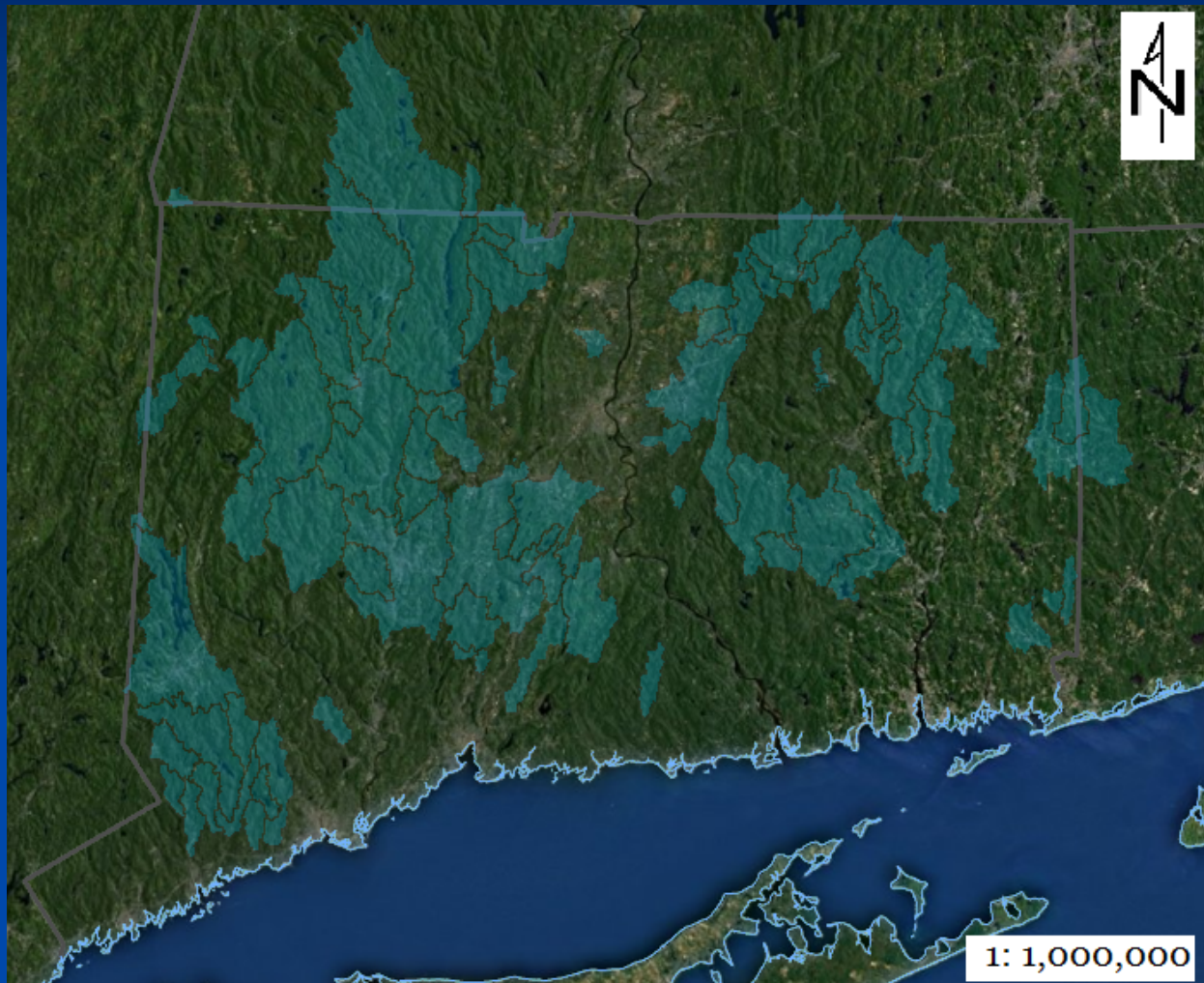


$$T_{Q3-2009} = 0.1813 Area + 0.1430\% Impervious - 0.0502\% Stratified + 14.33$$

# Urbanization and Streamwater Temperature Culverts and Storm Surges



# Estimating Connecticut Stream Temperatures Using Predictive Models

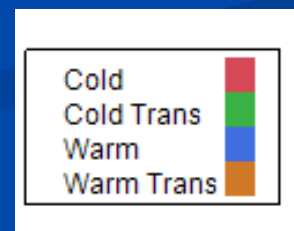
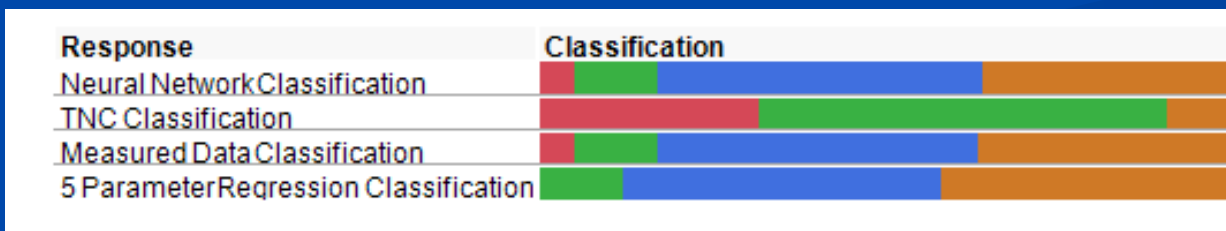


# Estimating Connecticut Stream Temperatures Using Regression and Neural Network Predictive Models

- Approach: Use Watershed Physical Parameters to best fit statistical models to Lyons et al. temperature statistics
- Results:
  - Regression Model best fits  $r^2$  values range from 0.40 to 0.472
  - Neural Network best fits  $r^2$  values typically 0.98 to 0.99

**Table 1: Significant Independent Variables**

Measured Parameters	Drainage Area	Stratified Drift	% per WS, Creek: $>=3.861 < 38.61$ sq.mi., Very Low Gradient: $<0.02\%$	% per WS, Headwater: $0 < 3.861$ sq.mi., High Gradient: $>=2 < 5\%$	% per WS, Medium Tributary River $>=200 < 1000$ sq.mi., High Gradient: $>=2 < 5\%$	% Forest
Maximum Daily Mean	+	-	+	-	-	-
Jun-Aug Mean	+	-	+	-	-	-
July	+	-	+	-	-	-



# Final Reflections

1. Lack of long-term measurements is challenging.
2. The differentiation between **potential** coldwater streams and warmwater needs to consider coolwater transition temperatures.
3. Existing models and literature thresholds don't broadly match observations. Urbanization matters.