

US EPA ARCHIVE DOCUMENT

Summer Water Temperatures in NH and MA Coldwater Streams

NEAEB: March 17-19, 2010

Jennifer M. Jacobs
Environmental Research Group
Department of Civil Engineering
University of New Hampshire

Todd Richards
Massachusetts Division of Fish and Wildlife

Ralph Abele
USEPA Region I

In Partnership With
M. Carpenter, NHFG, D. Neils, NHDES, and W. Kimball, MADEP
USEPA TMDL and USGS WRI Funding

Thermal Regime and Fish

■ Fish Species Preference

■ Coldwater

NH Examples: **Brook Trout**, **Slimy Sculpin**, Brown Trout, Lake Chub, Longnose Sucker, Northern Redbelly Dace, Rainbow Trout

■ Eurythermal (tolerating a wide range of temperature)

NH Examples: Common Shiner, Creek Chub, Eastern Blacknose Dace, Fallfish, Longnose dace, White Sucker



Pictures Credit:
NJ Freshwater Fish Identification

Thermal Regime and Water Quality

- Dissolved Oxygen
 - Inverse relationship between DO and temperature
 - Warm water may cause the fish's DO demand to increase.
- Photosynthesis
 - Cool waters slow the growth of bacteria and algae
 - Warm water enhances algal growth
- Water Chemistry
 - Increased plant growth can decrease DO
 - Increasing temperature decreases pH
- Water Turbidity and Sediment Loads
- Aquatic Organisms
 - Species abundance and diversity
Coldwater species include mayflies, caddisflies
 - Timing of reproduction, migration and aestivation



Pictures Credit: Bluegreen bloom,
Upper Saranac Lake, 10/90
(source: R. Handler, MD)

Why are coldwater streams cold?

Regional Scale

- Geographic Position or Ecoregions
 - Coldwater fisheries in the Northeastern Highlands
 - Warm-water fisheries Northeastern Coastal Zone
- Topography
 - Cold-water fisheries had a minimum mean basin elevation of 190 ft; the maximum mean monthly temperature of streams at this elevation typically did not exceed 20°C.

Regional Scale

Site Classification by Max. Average Monthly Temp

- Coldwater: 18°C (65°F)
- Cool (Mixed) Water
- Warm Water: 22°C (72°F)
- Upper Lethal Temp 25-30°C (77-86°F)

USGS
science for a changing world

NATIONAL WATER QUALITY ASSESSMENT PROGRAM

Water-Quality Assessment of the New England Coastal Basins in Maine, Massachusetts, New Hampshire, and Rhode Island: Environmental Settings and Implications for Water Quality and Aquatic Biota

Water Resources Investigations Report 96-429

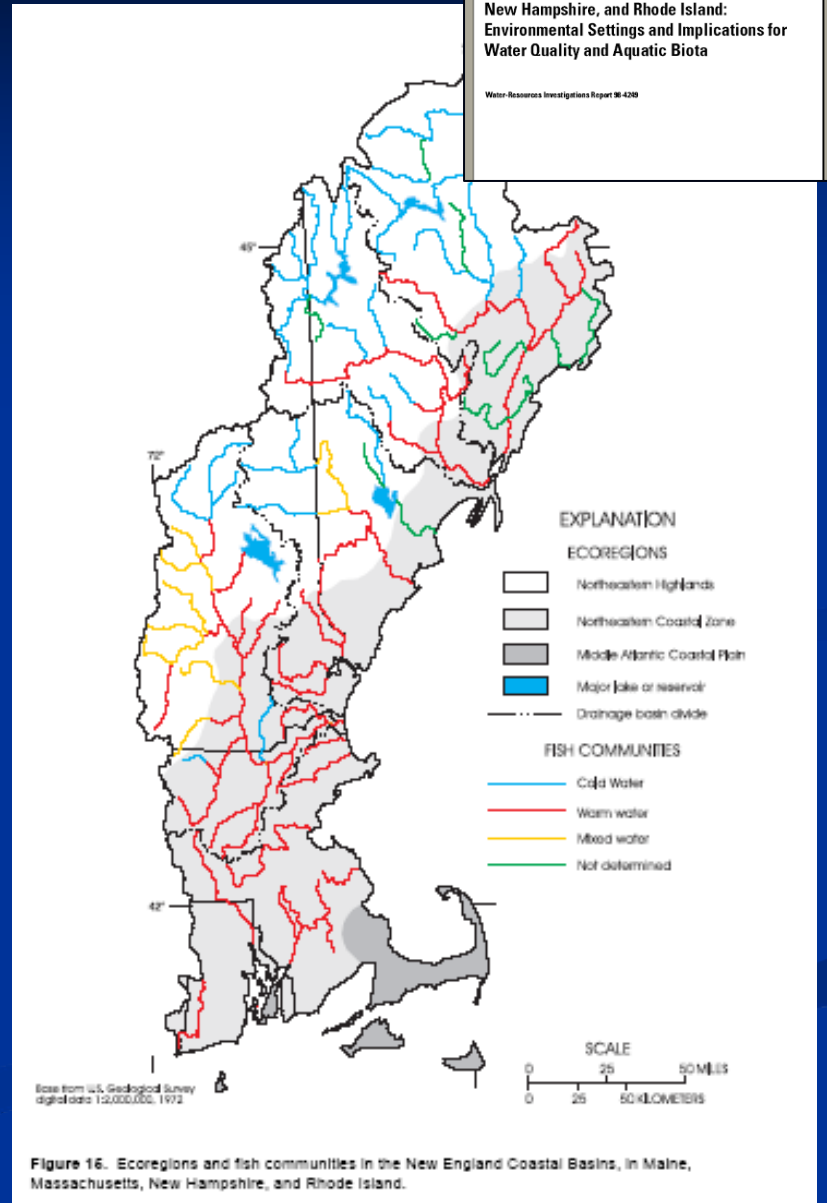
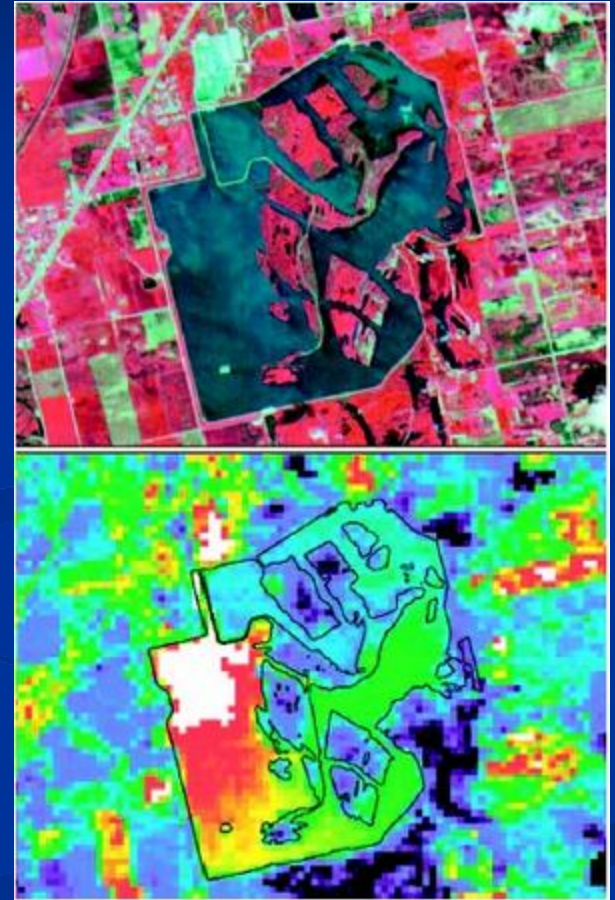


Figure 16. Ecoregions and fish communities in the New England Coastal Basins, in Maine, Massachusetts, New Hampshire, and Rhode Island.

Measurement and Monitoring

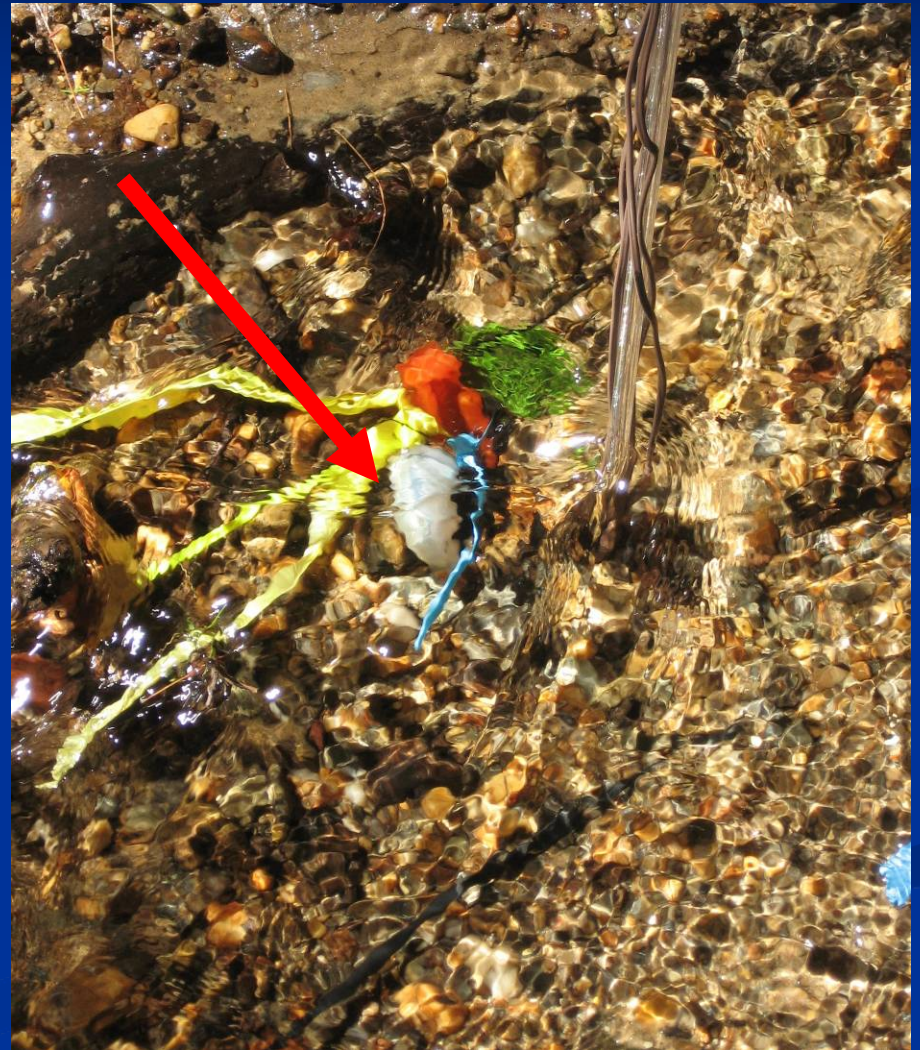
- Programmable digital data loggers
- Miniature temperature recorders
- Thermal infrared (TIR) imagery
- Fiber optic distributed temperature sensors (FO-DTS)



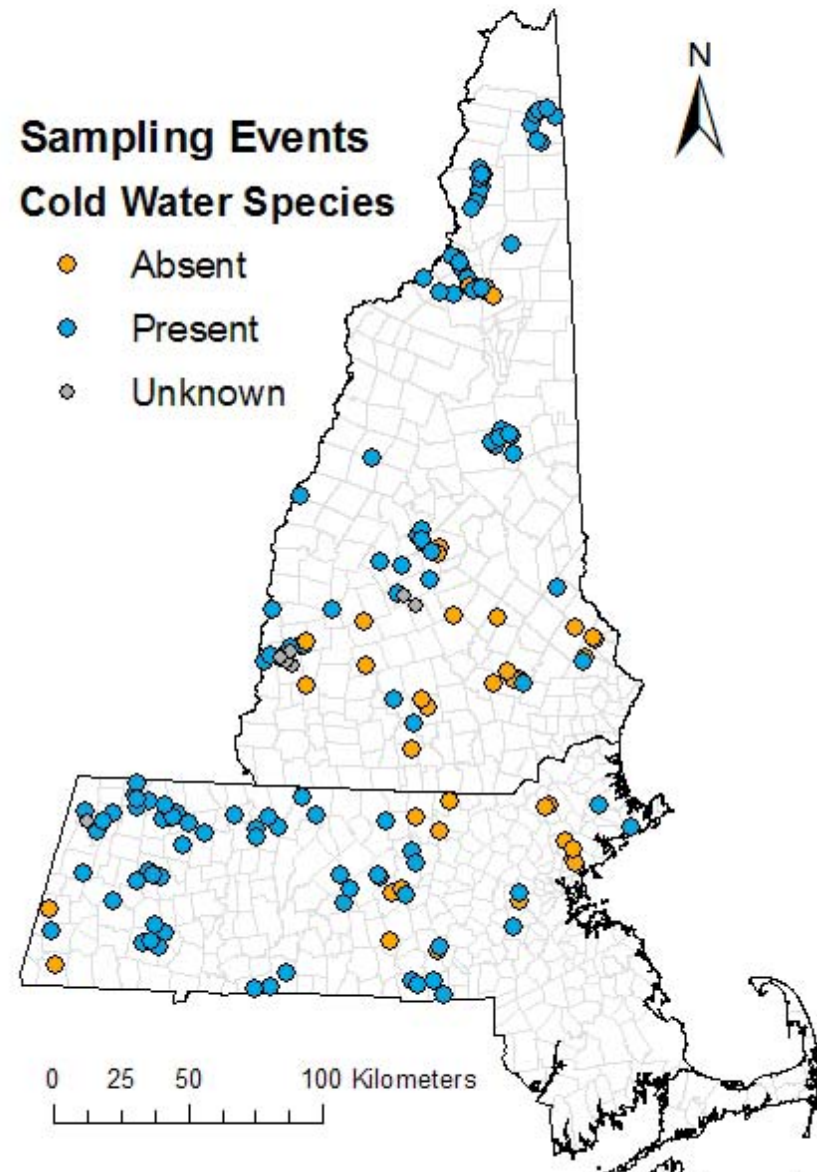
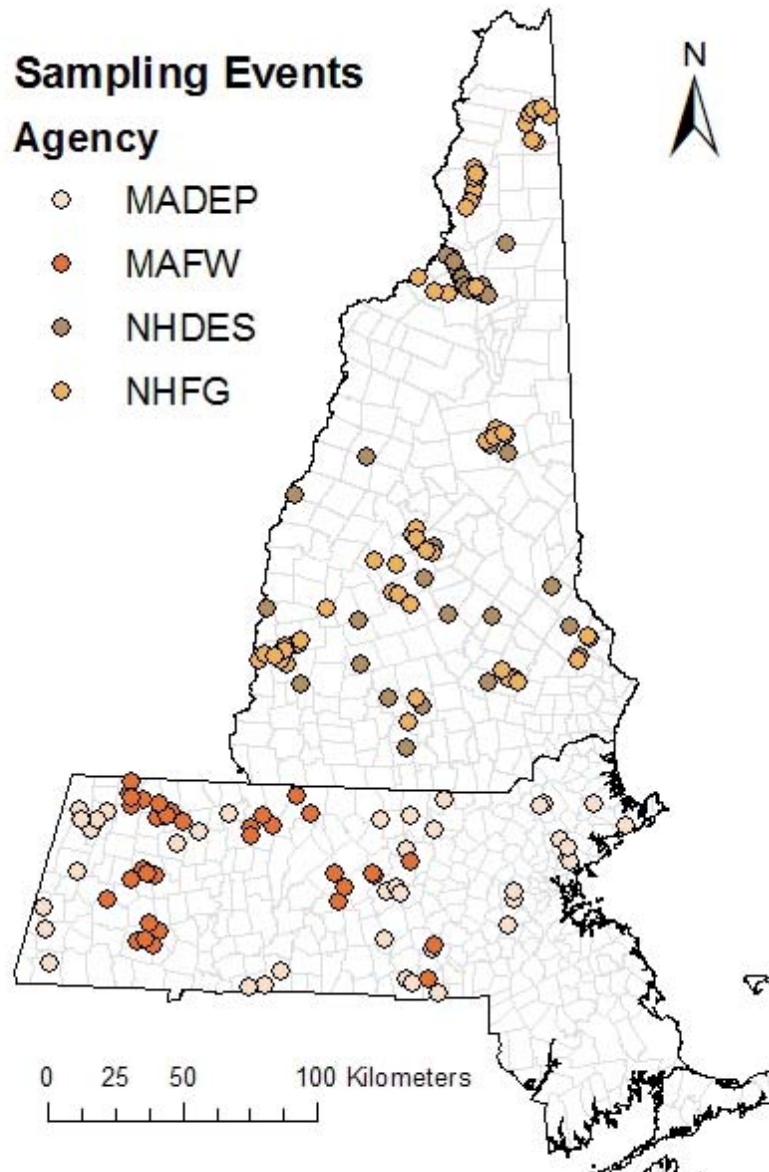
(Image: NASA/GSFC/MITI/ERSDAC/JAROS,
and U.S./Japan Aster Science Team.)

Digital Temperature Loggers

- Hobotm thermistor data loggers
- Tidbit temperature data loggers



185 Stream Temperature Sampling Sites 2005-2009



What's the temperature of a coldwater stream?

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

Magnitude
Frequency
Timing
Duration
Rate of Change

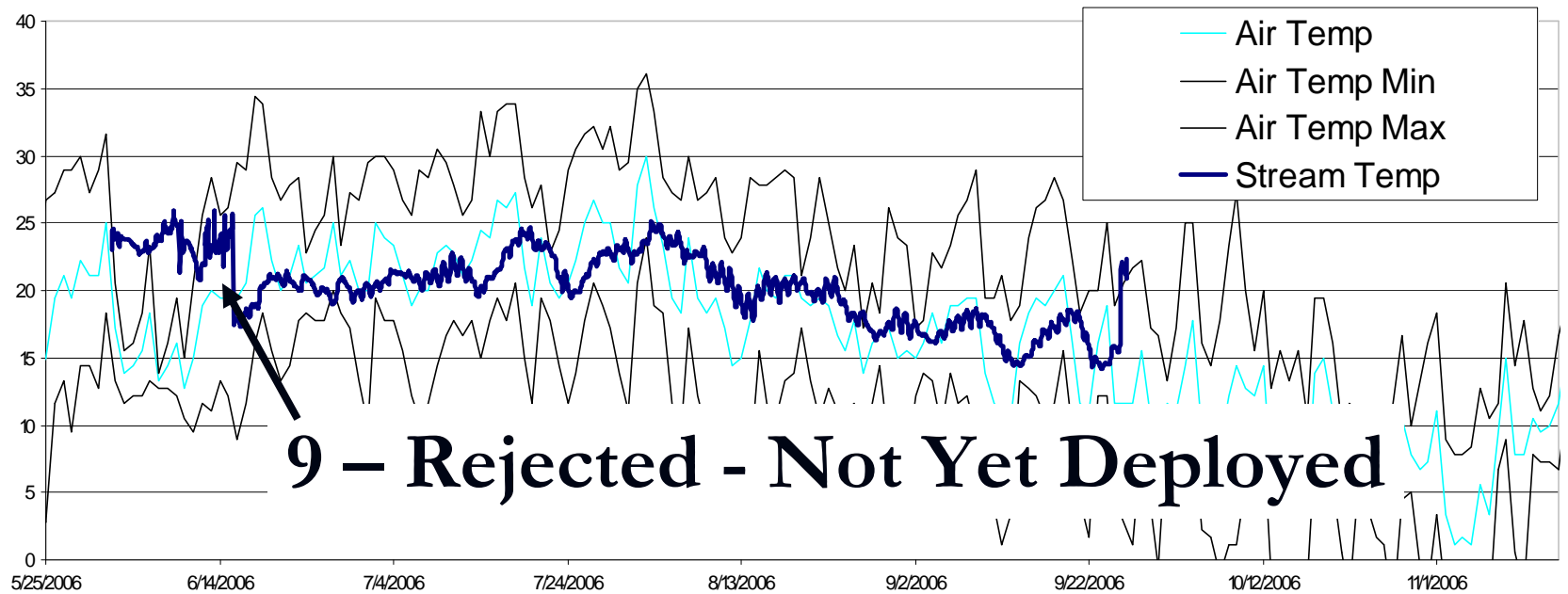
Step 1: Develop a stream temperature database

- Reformat existing datasets
- Develop and apply QA/QC protocols
- Design database
- Populate database
- Transfer protocols
- Link to GIS and webservers

Stream Temperature QAPP

Quality Assurance Project Plan

QAQC Code	Description
0	Not reviewed
1	Accented



Step 2: Quantify Temperature Regime

Magnitude

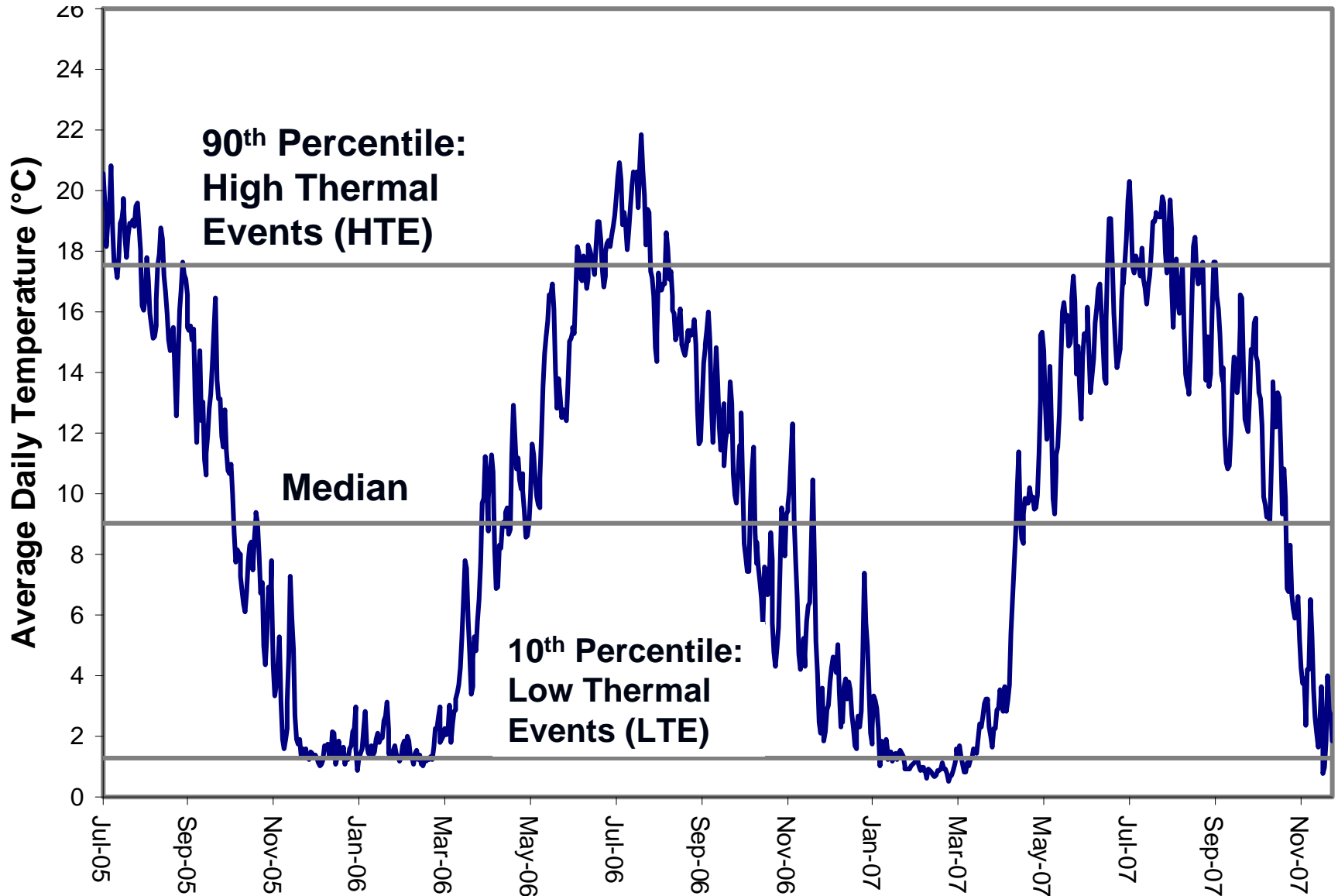
Frequency

Timing

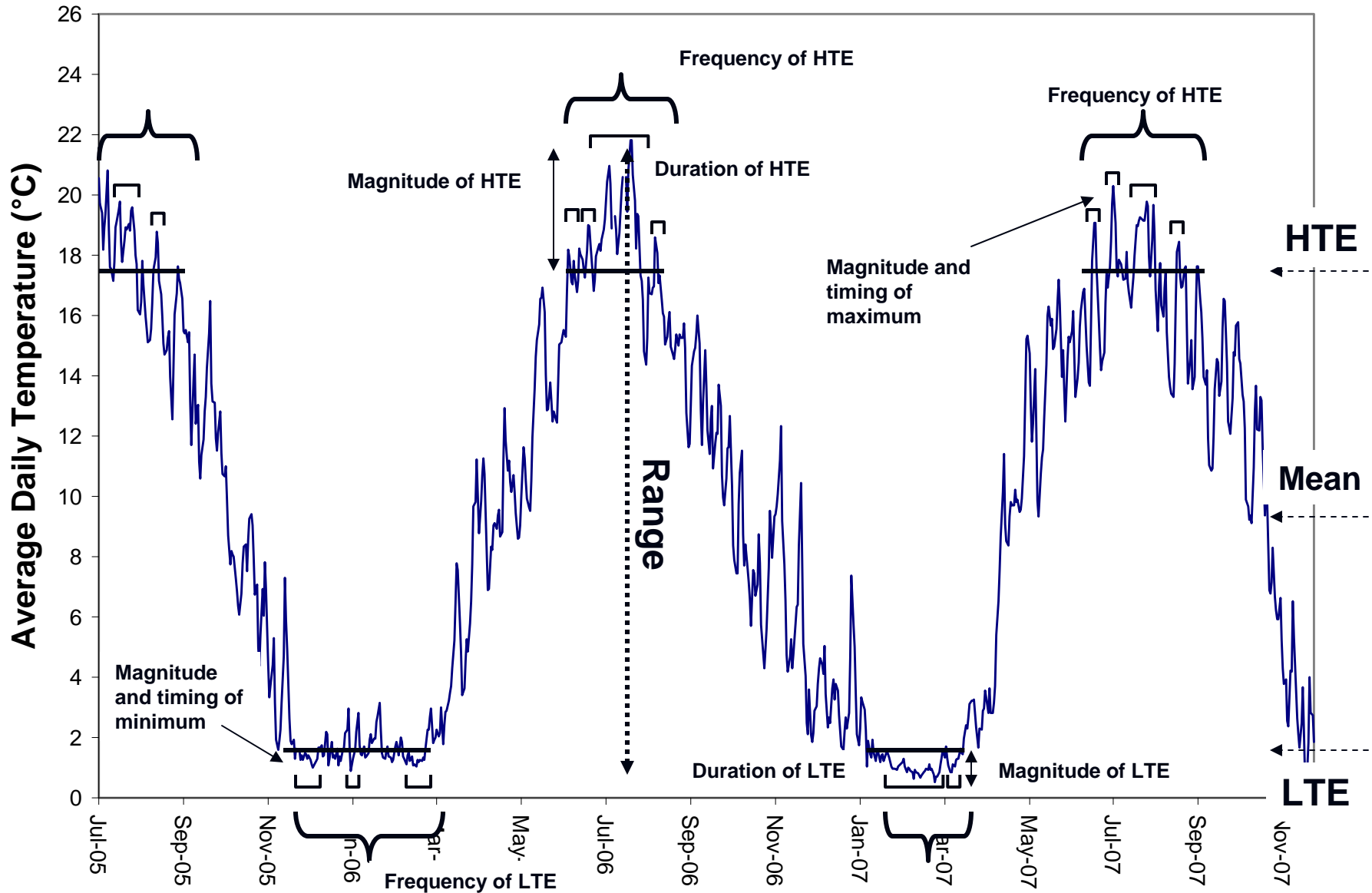
Duration

Rate of Change

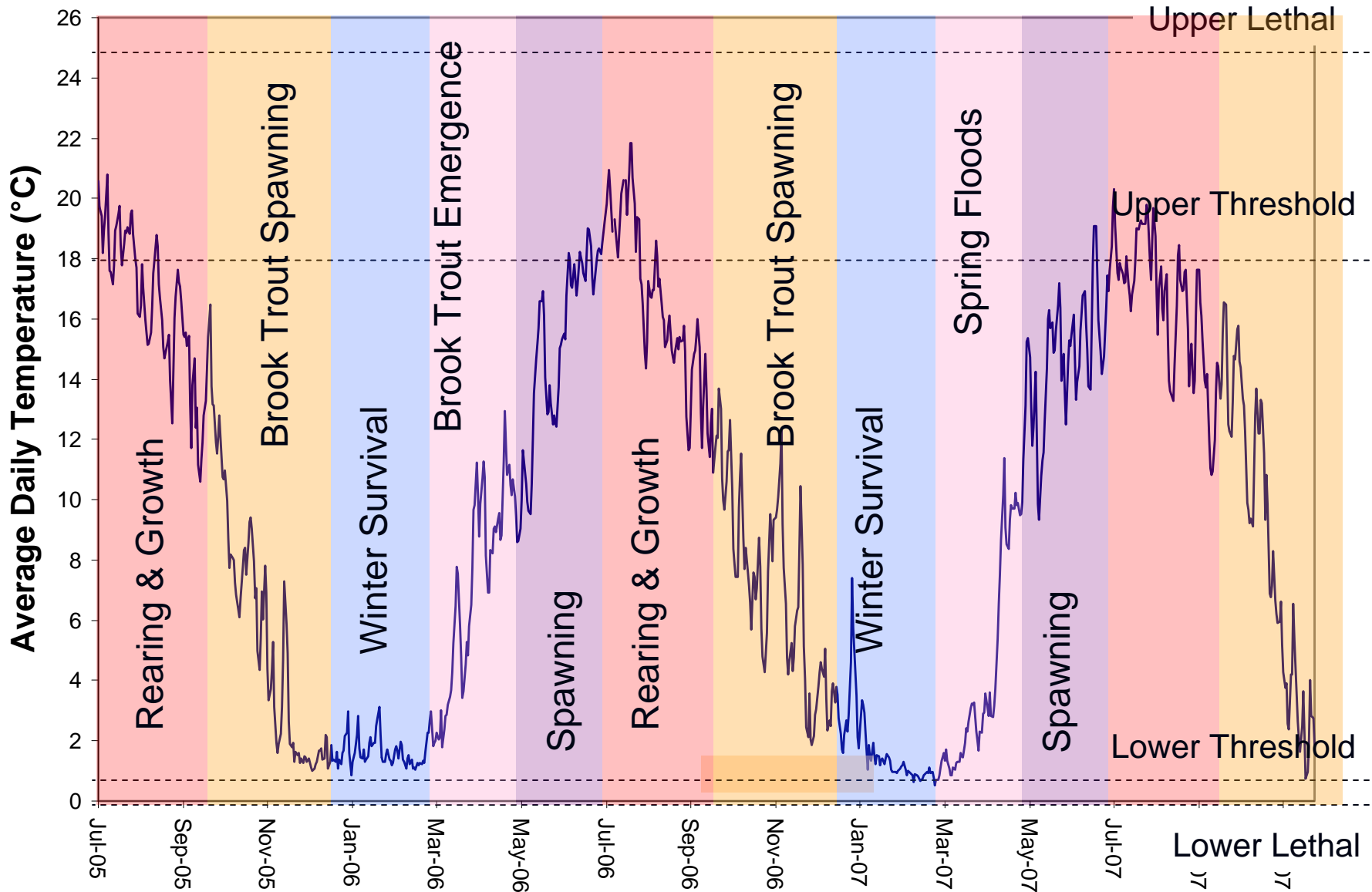
Massachusetts Fish and Wildlife Division Mean Daily Stream Average for 36 Coldwater Streams



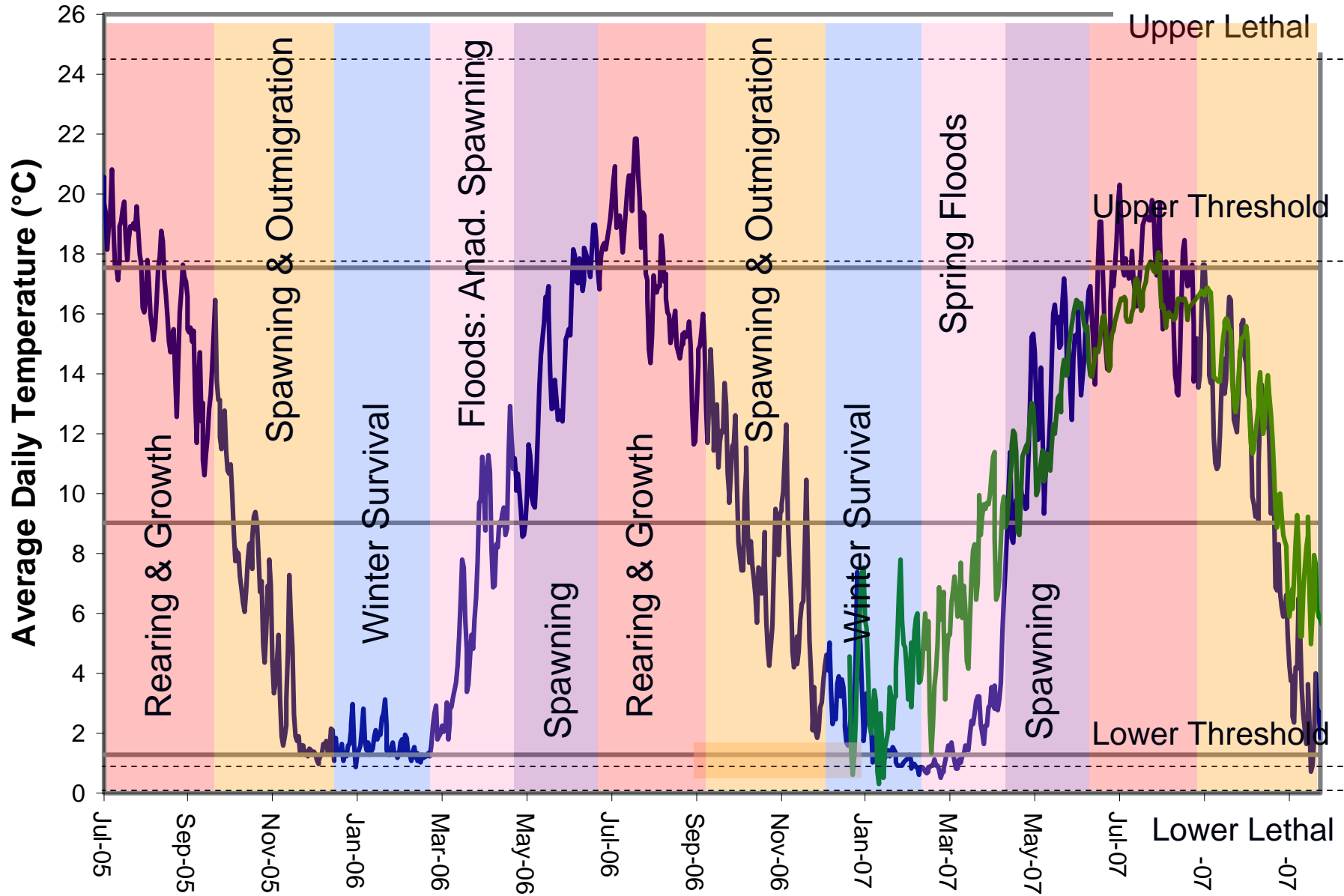
A Coldwater Stream's Thermal Regime



Typical Bioperiods for Fish



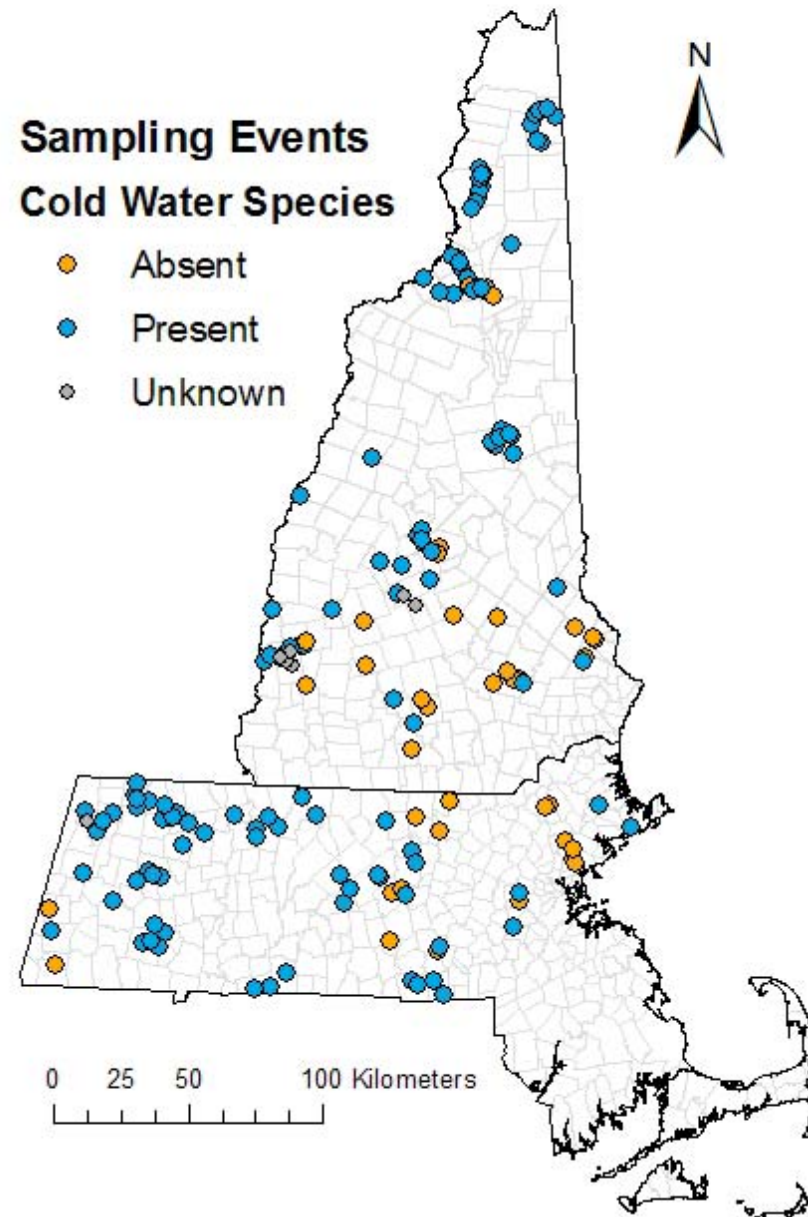
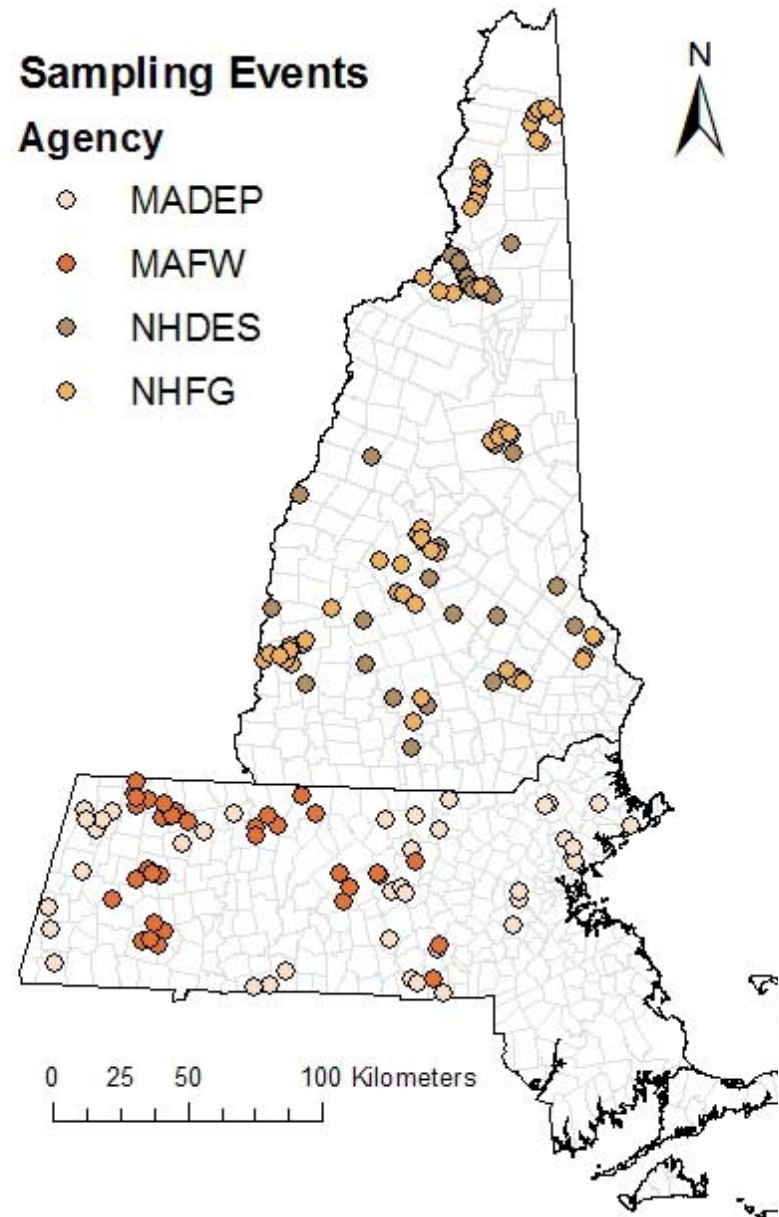
Typical Bioperiods for Fish + North Carolina Data



Stream Temperature Sampling Locations 2005-2009

Stream Temperature Sampling Locations

Stream Temperature Sampling Locations



MAGNITUDE: Mean Daily Temperatures

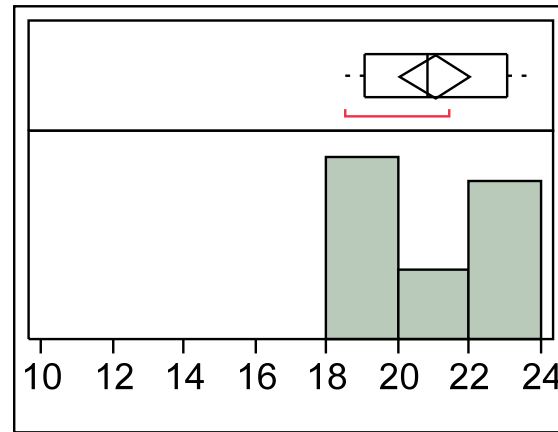
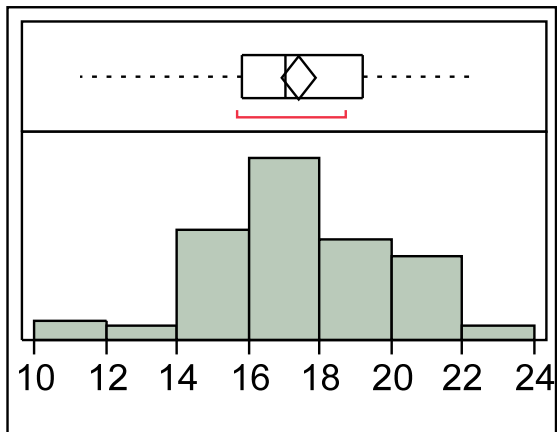
Coldwater Species

Present

Absent

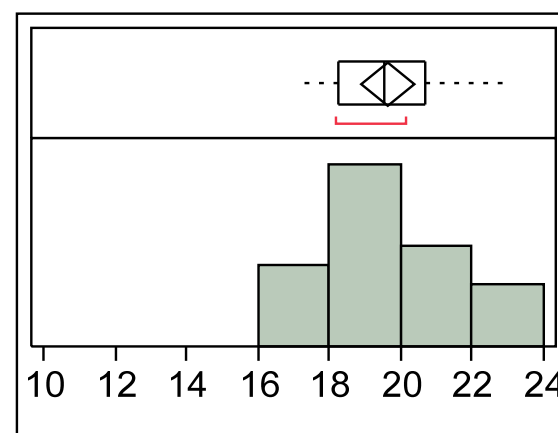
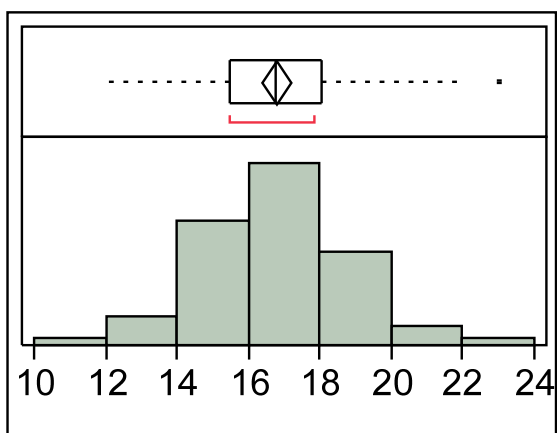
JULY

No. of Streams



AUGUST

No. of Streams



Temperature

Temperature

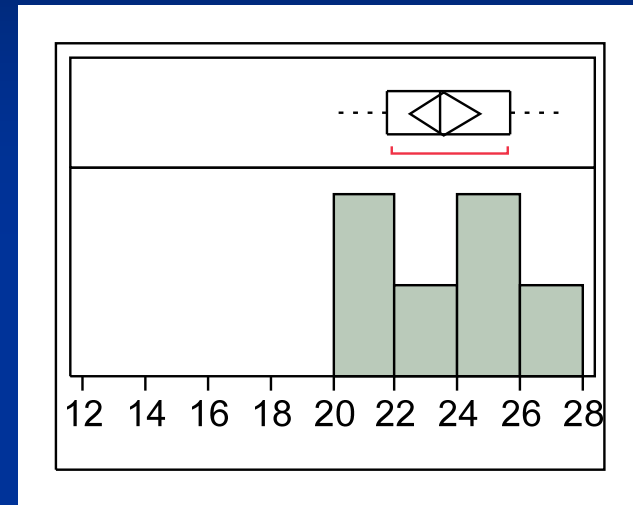
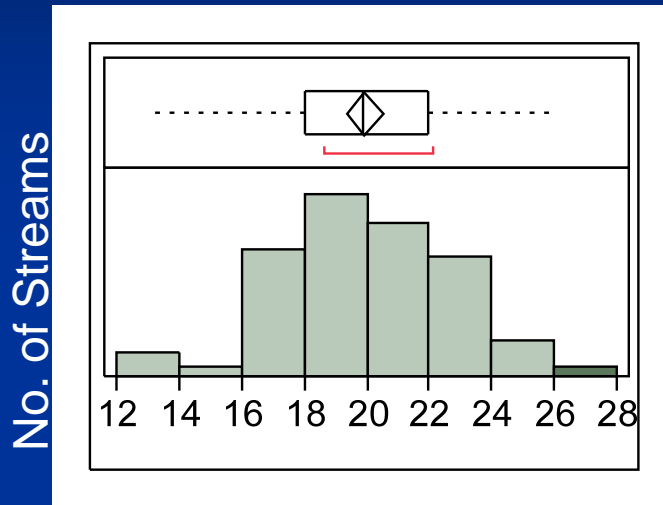
MAGNITUDE: Maximum Daily Temperatures

Coldwater Species

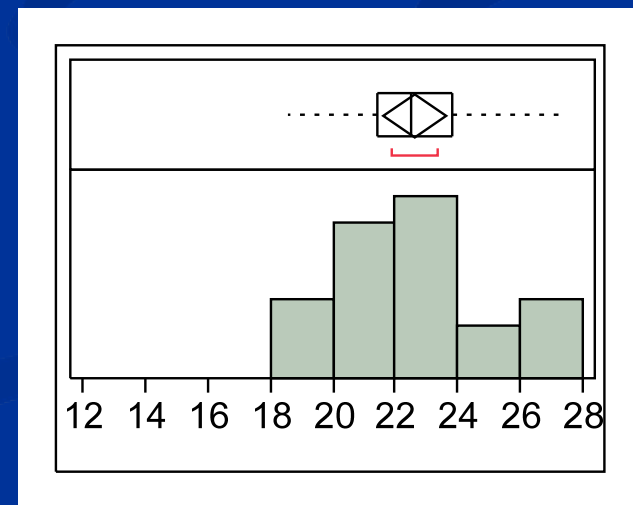
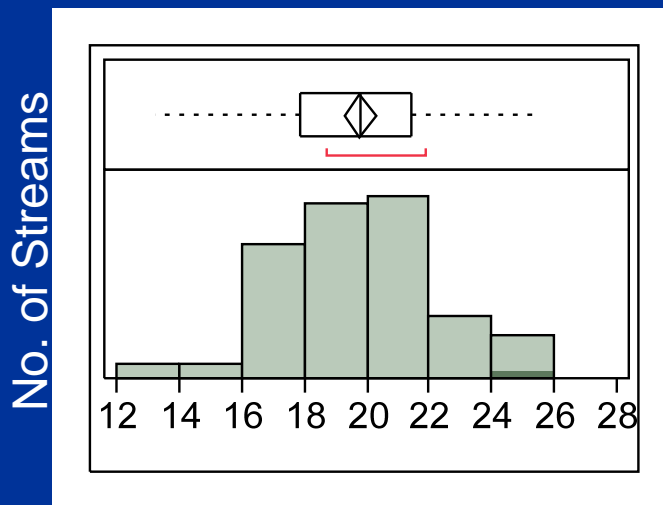
Present

Absent

JULY



AUGUST



Temperature

Temperature

FREQUENCY: % of Days $> 18^{\circ}\text{C}$

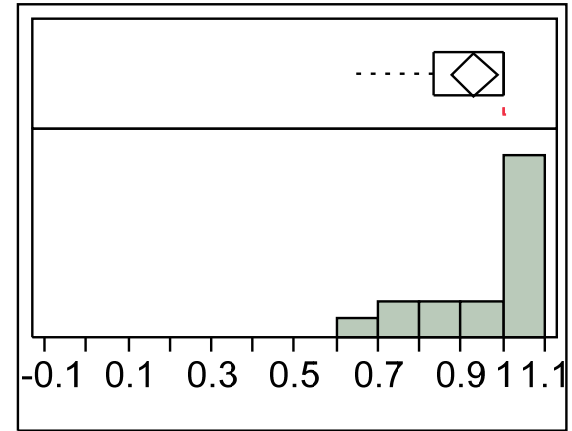
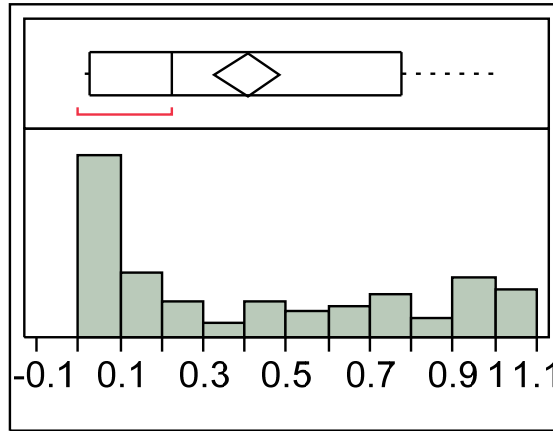
Coldwater Species

Present

Absent

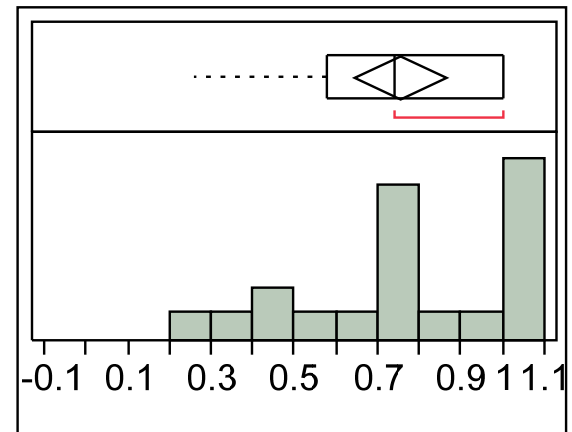
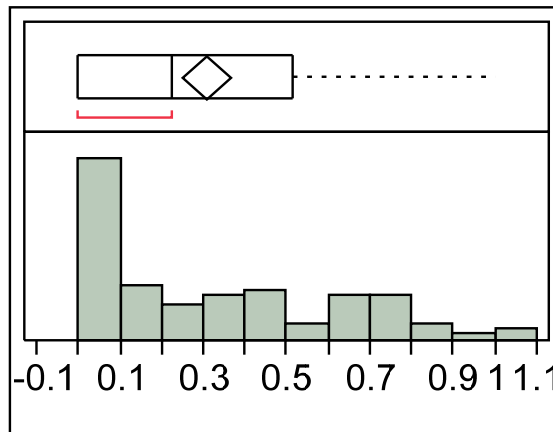
JULY

No. of Streams



AUGUST

No. of Streams



Percent

Percent

HTE Days Warmer Than 18°C

DURATION and FREQUENCY

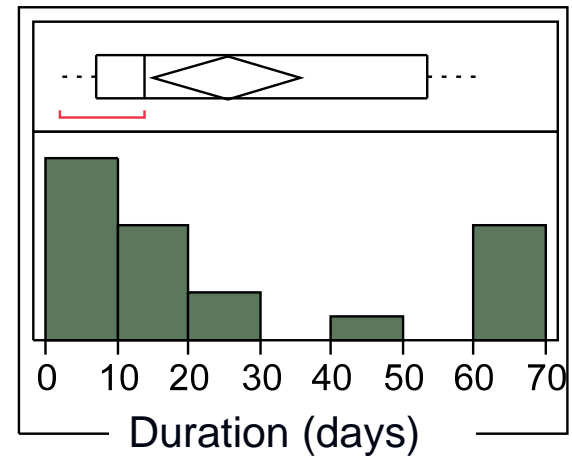
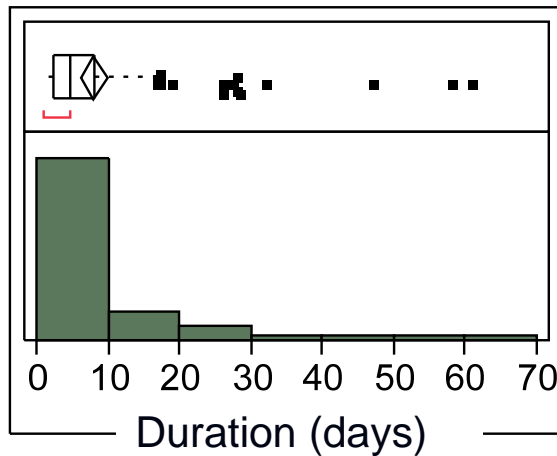
Coldwater Species

Present

Absent

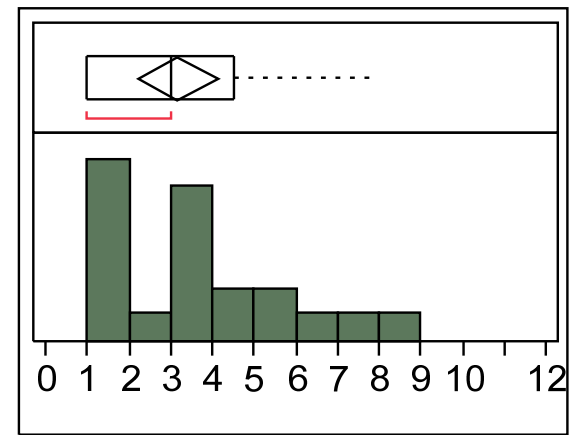
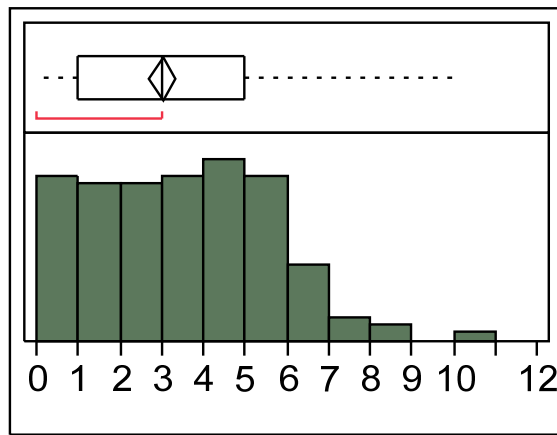
Duration
(days)

No. of Streams



Frequency
(# HTE pulses)

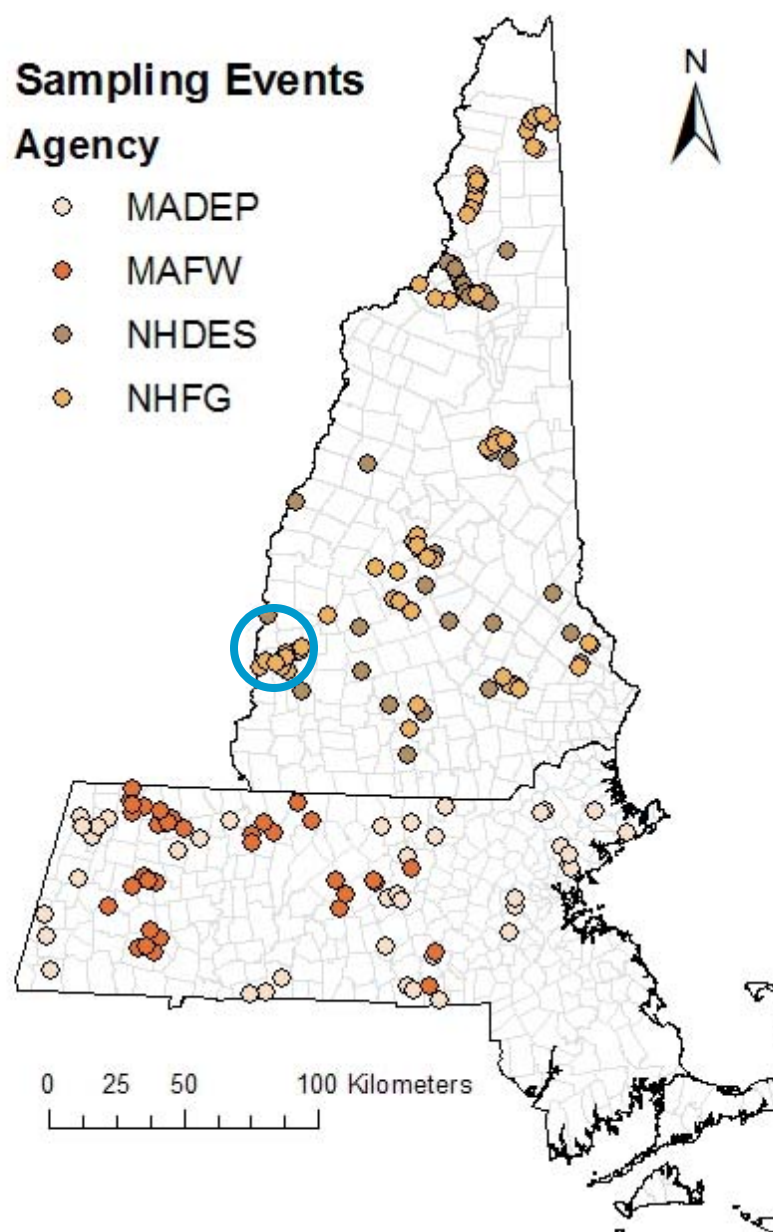
No. of Streams



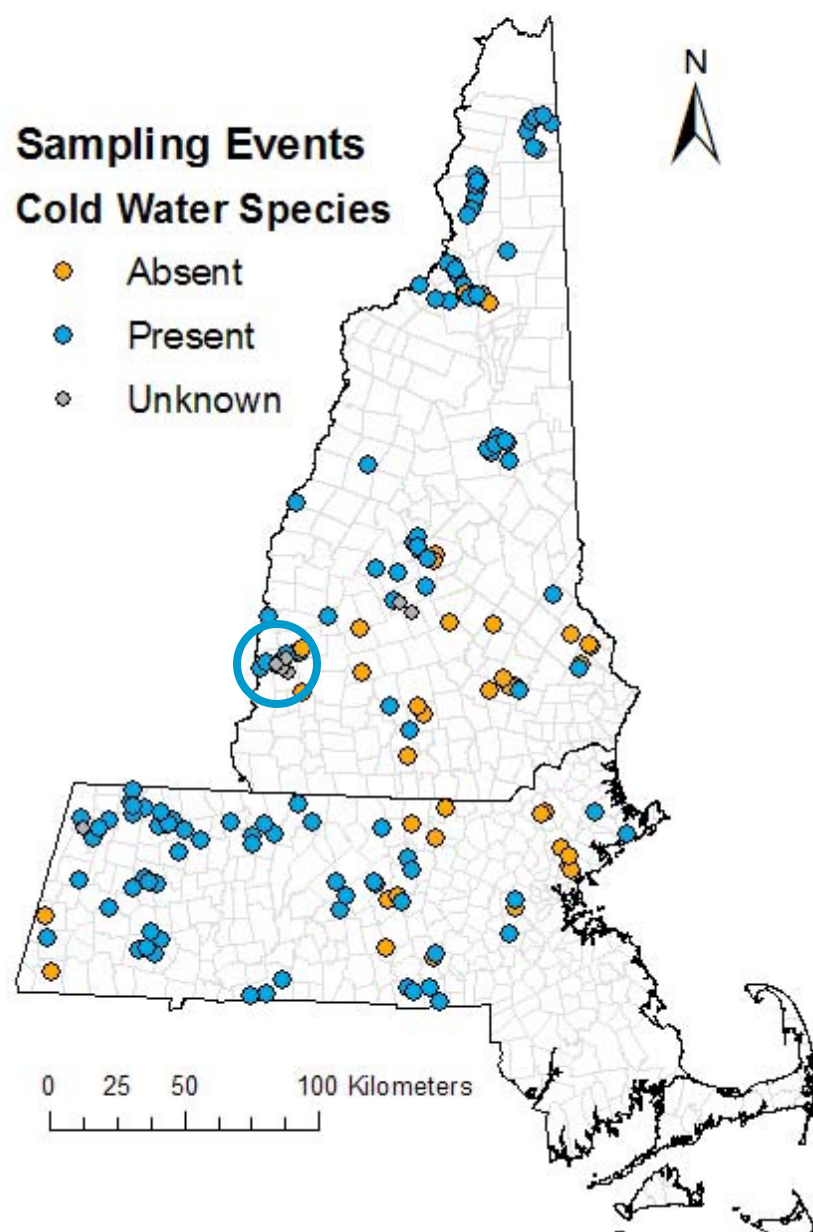
No. of Pulses

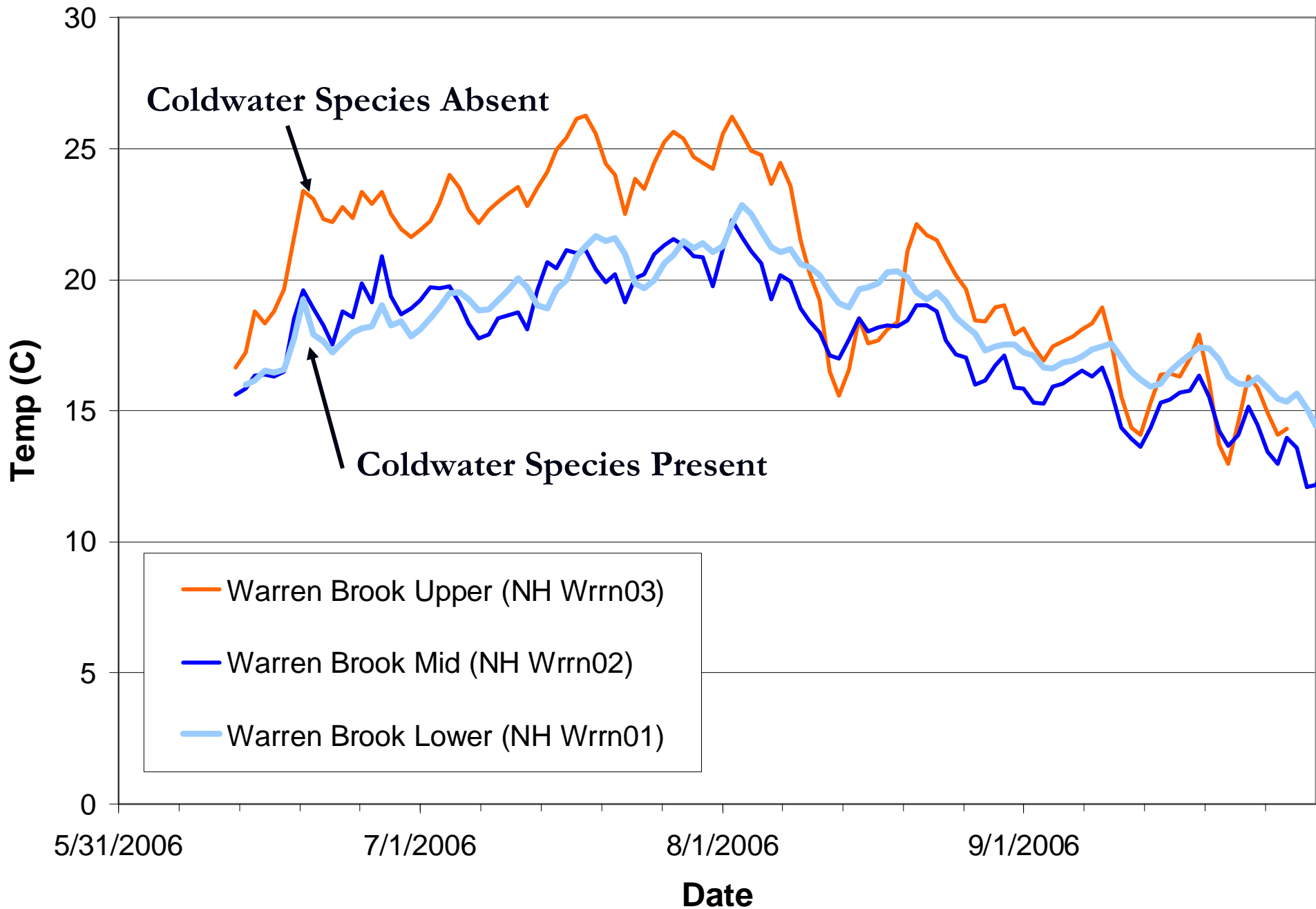
No. of Pulses

Stream Temperature Sampling Locations



Stream Temperature Sampling Locations

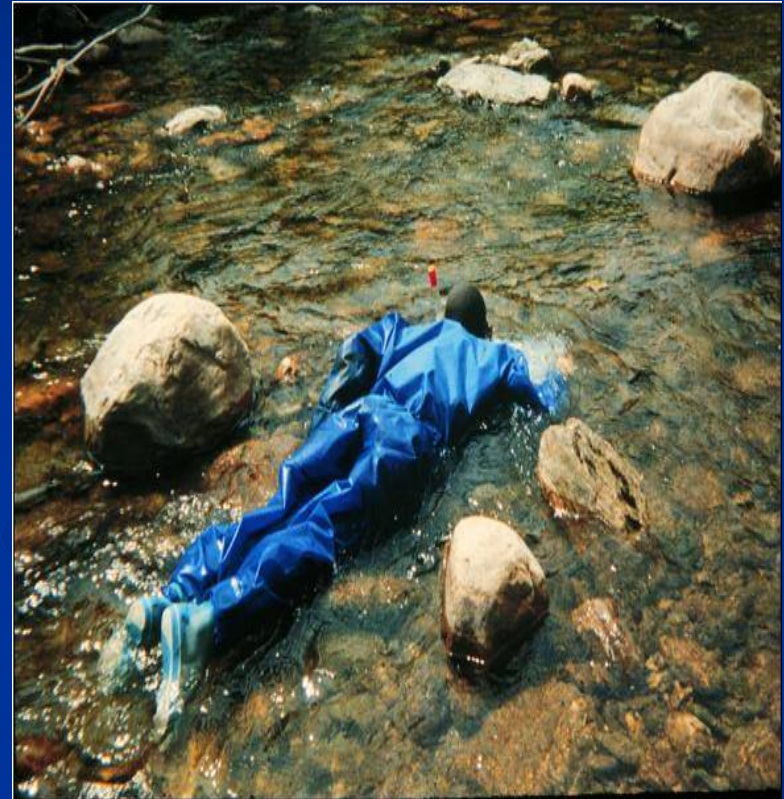




Why are coldwater streams cold?

A Closer Look

- Stream Order
 - Headwater streams often have low temperature and high dissolved oxygen
- Physical Features
 - Dense forest canopy reduces sunlight and warming
 - Groundwater flow cools



Why don't coldwater streams stay cold?

■ Natural Events

- Fires and floods

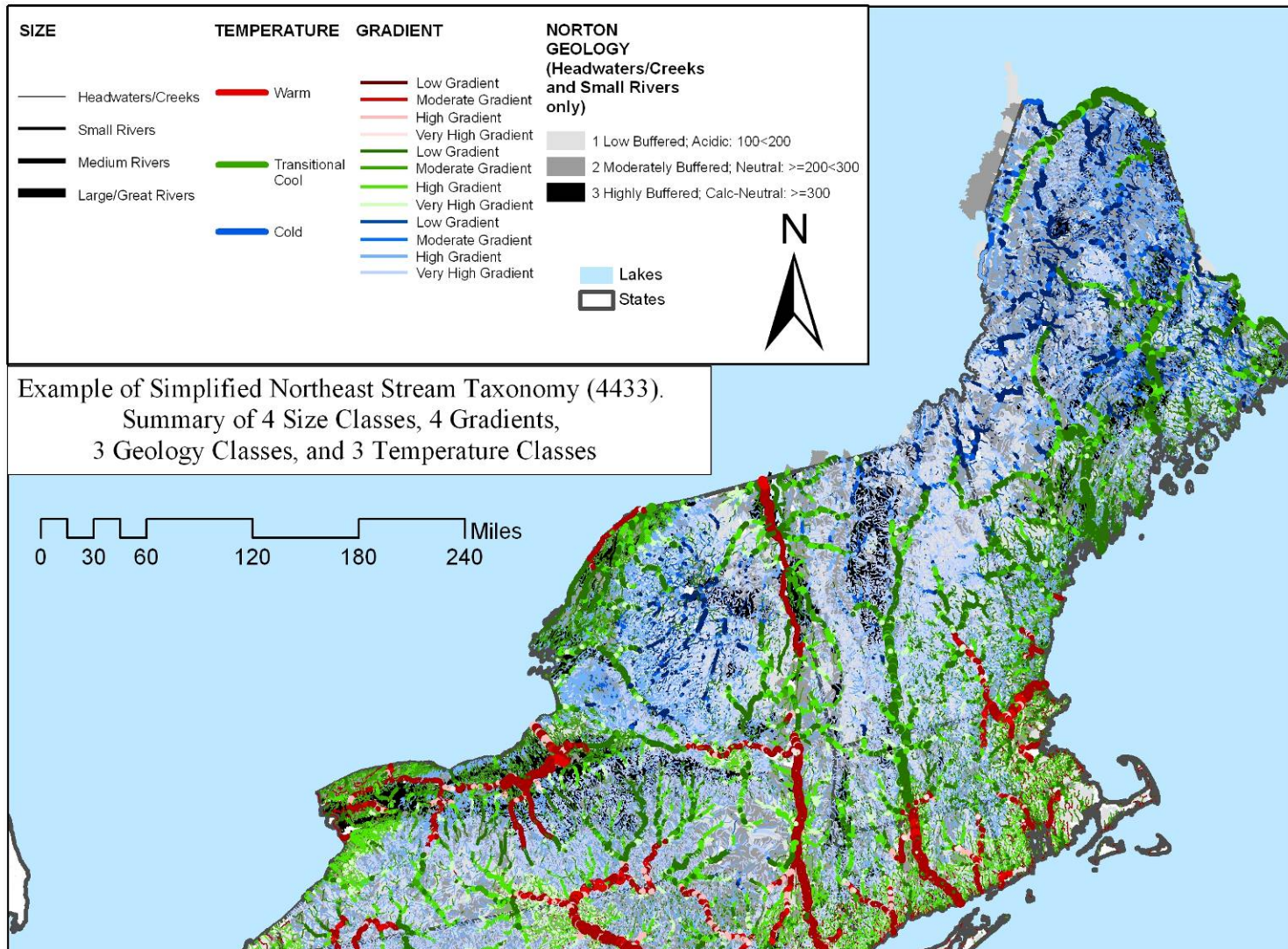
■ Land Management (human activity)

- Removing vegetation along the banks of streams
- Withdrawing water
- Contributing excessive sediment
- Increased impervious areas and storm runoff
- Storm runoff and scour
- Thermal loading (point source)
- Impoundments

Jennifer Jacobs
University of New
Hampshire

jennifer.jacobs@unh.edu
603 862-0635

NE Regional Scale Taxonomy



Source: Olivero and Anderson, NRC, Northeast Aquatic Habitat Classification System 2008

What About Climate Change?

2007 Union of Concerned Scientists Report

Coldwater: 65°F, Warm Water: 72°F, Upper Lethal Temp: 77-86°F

- By the end of the century, under the high-emissions scenario winter temperatures in the Northeast are projected to rise between 8°F to 12°F and summer temperatures anywhere from 6°F to 14°F.
- Under the low-emissions scenario, which requires significant reductions in atmospheric concentrations of CO₂ and other greenhouse gases, winter temperatures are projected to rise between 5°F to 8°F and summer between 3°F to 7°F.