Session 1
Water Temperature Monitoring Efforts by Individual Agencies

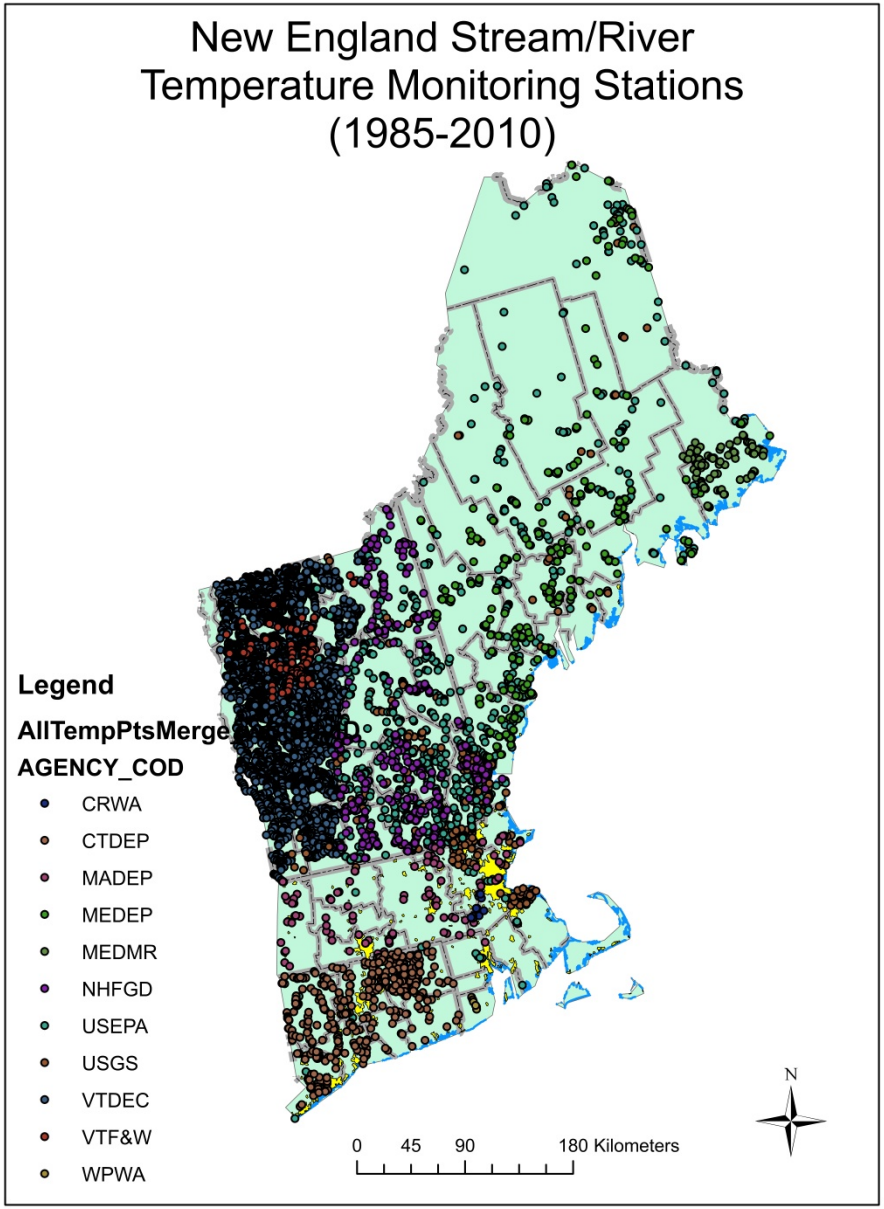
Overview & regional summary

Individual Case Studies:
1-Massachusetts
2-Vermont
3-New Hampshire
4-Connecticut
5-Maine
6-US Forest Service
7-USGS (CT Office)
8-National Park Service
9-USF&WS
10-Rhode Island

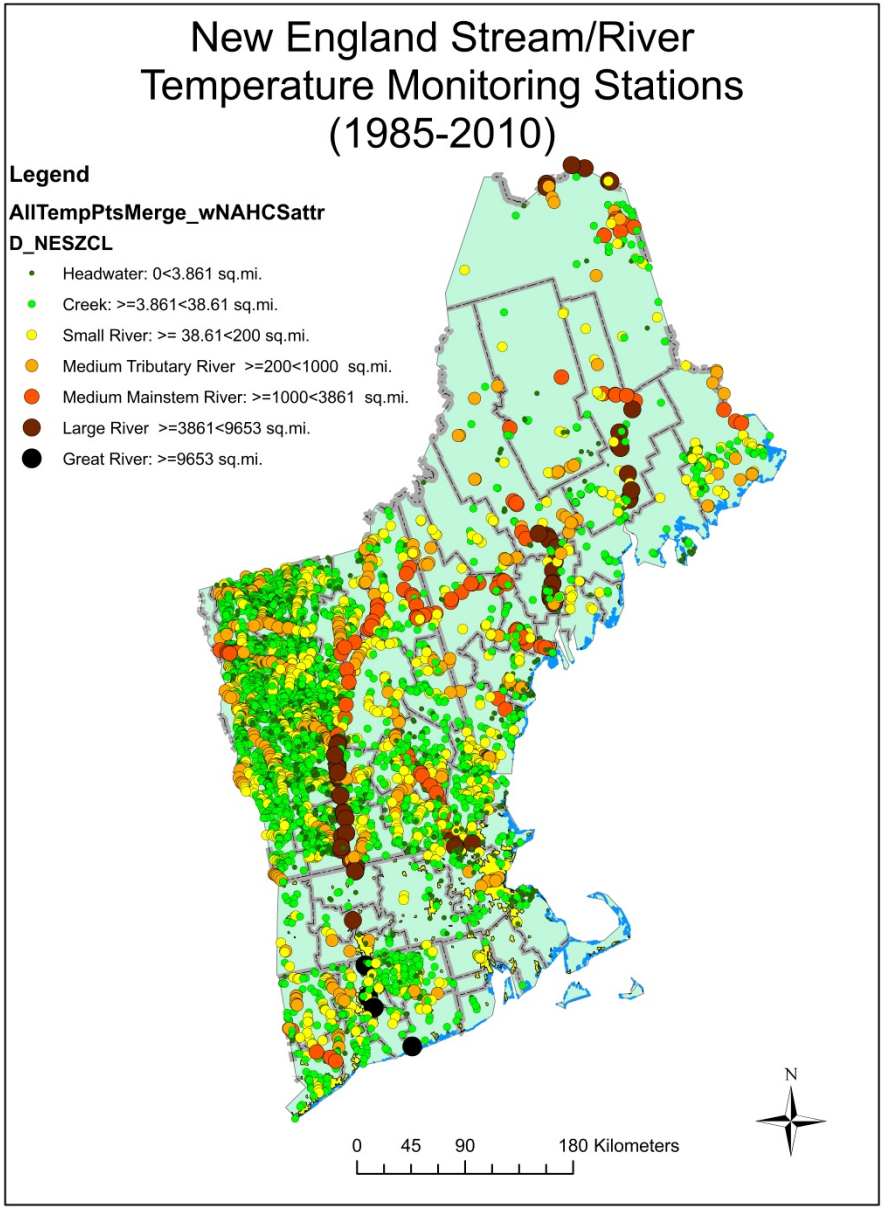
Break

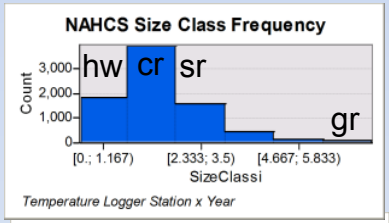
Moderated session
Questions & answers

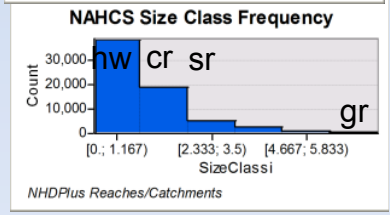
Topic	US EPA-Naomi Detenbeck, Ralph Abele
Why we collect	Develop predictive model of thermal regimes to help diagnose causes of fish community impairment along urbanization gradient
What else do we need	Good metadata (methods, location descriptions), Accurate georeferencing, More paired temperature and fish data, Balanced coverage of stream types, Consistent temporal window
Our coverage (space & time)	1985 – 2011 EPA Region 1 (New England states) compiled
Device & Frequency	Varies with collection agency
Calibration	Varies with collection agency
Data Management	Compiled in MSAccess relational database from multiple formats; Includes info on source, station id/location, error codes if available
Problems	Incomplete metadata, variable length and frequency of temperature monitoring, difficulty in matching time series files with sampling station descriptions, potentially biased sample distribution, Inconsistent record of error codes (pre- and post-deployment, out of water, buried, etc.)

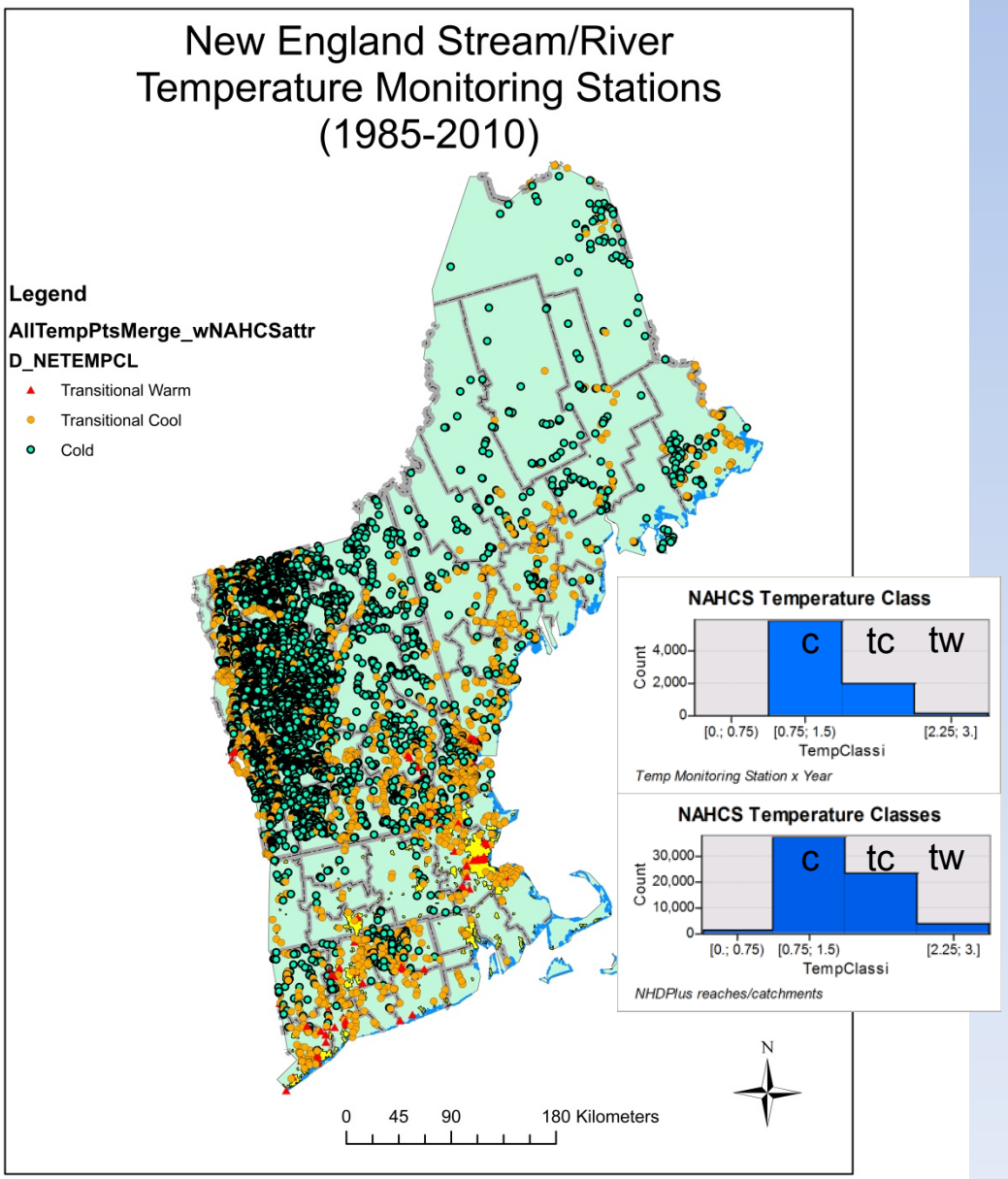

New England Stream/River
Temperature Monitoring Stations
(1985-2010)
Legend
AllTempPtsMerge
AGENCY_COD
CRWA
CTDEP
MADEP
MEDEP
MEDMR
NHFGD
USEPA
USGS
VTDEC
VTF&W
WPWA
0 45 90 180 Kilometers
N

New England Stream/River Temperature Monitoring Stations (1985-2010)





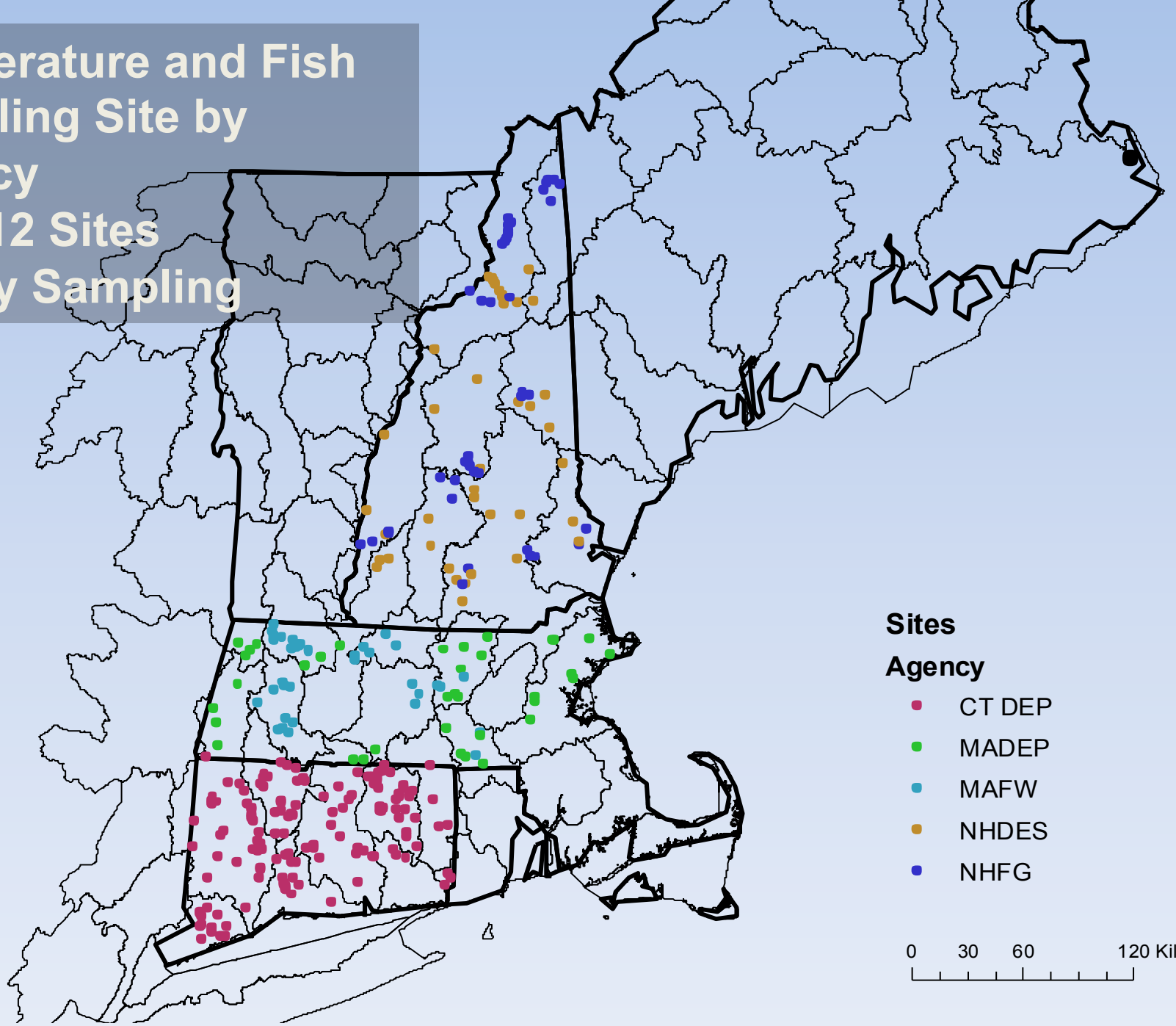



New England Stream/River
Temperature Monitoring Stations
(1985-2010)
Legend
AllTempPtsMerge_wNAHCSattr
D_NETEMPCL
Transitional Warm
Transitional Cool
Cold
NAHCS Temperature Class
Count
4,000
2,000
0
c
tc
tw
[0.; 0.75)
[0.75; 1.5)
[2.25; 3.]
TempClassi
Temp Monitoring Station x Year
NAHCS Temperature Classes
Count
30,000
20,000
10,000
0
c
tc
tw
[0.; 0.75)
[0.75; 1.5)
[2.25; 3.]
TempClassi
NHDPlus reaches/catchments
N
0
45
90
180 Kilometers

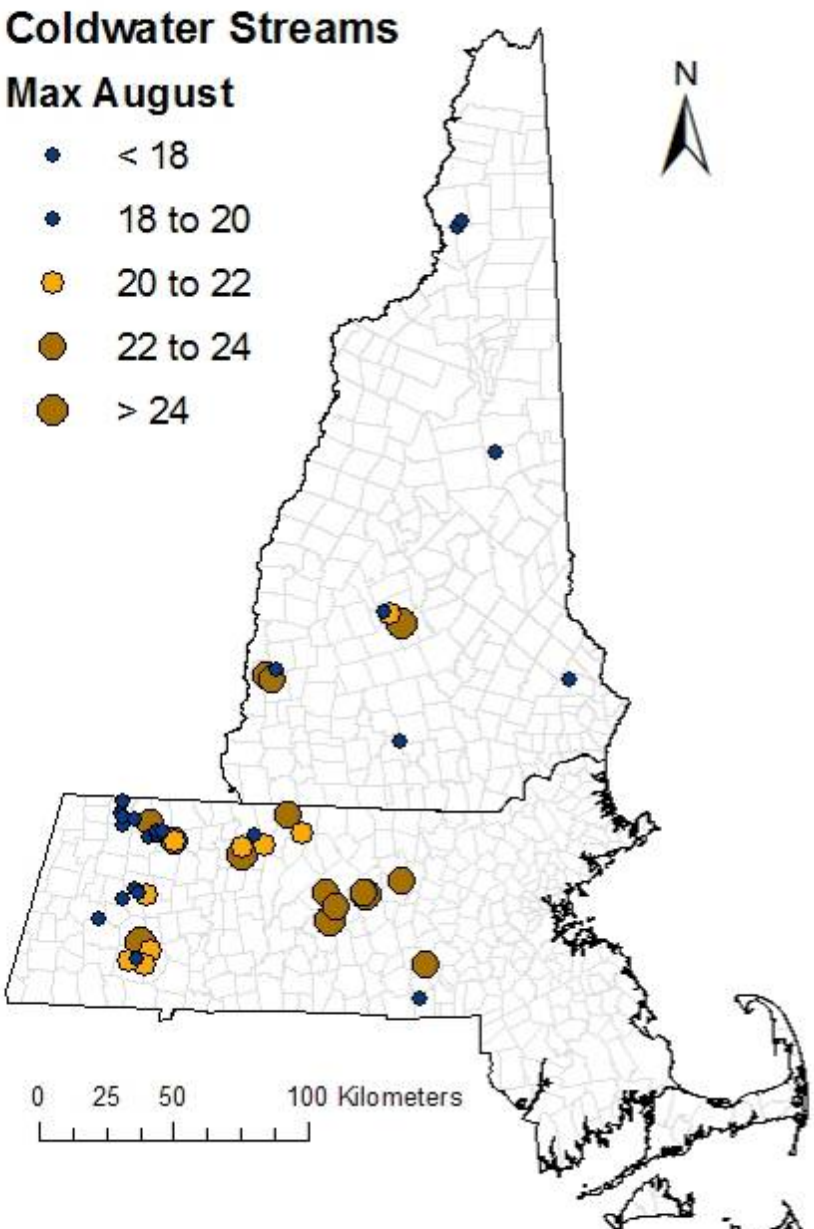

GREETINGS
from
MASSACHUSETTS
State Capitol in Boston
State Flower
the Mayflower or Arbutus
© RetroAmerica.com

Topic	Mass DEP-DWM-Watershed Planning (Gerry Szal and Todd Richards)
Why we collect	ID approx. thermal category; D.O. saturation; thermal discharges; figure out how to use temperature information for characterizing/identifying thermal stream type
What else do we need	More cold water, multi-year reference sites ; more deployable units for greater coverage (current inventory= approx. 80 loggers); better strategy for Assessing Use Support
Our coverage (space & time)	2005 - 3 stations,2006 - 0 stations,2007 - 17 stations,2008 - 12 stations,2009 - 17 stations, 2010 - 26 stations,2011 - 43 stations 9 of which were reference stations
Device & Frequency	Onset HOBO Pro V2 @ 30 minute interval (typ. 2-4 month deployments in the summer); also Hydrolab optic DO/temperature sondes @ 30 minute interval (typ. 3-5 day deployments each month for three months in the summer). All deployed loggers/sondes are placed in rigid PVC tubes (drilled with holes) which are anchored in place in the water column.
Calibration	Units are factory calibrated. Prior to use, all loggers are checked vs. a NIST-traceable thermometer in a completely mixed (aerated), room temperature water tank prior to use; these QC data are evaluated for accuracy (any loggers showing > 0.3 C difference to NIST are re-evaluated/not used). Once launched and deployed, the quality of "unattended" temperature data are assessed by taking side-by-side field measurements with a NIST-traceable thermometer---at deployment, pickup and one or more intermediate checks.
Data Management	Loggers are uploaded to PC as raw data files, which then undergo formal data validation using standardized procedures involving VB code and Excel. This validation includes trimming, outlier identification, comparison to data quality objectives, censoring and qualification as needed, standard statistical output and graphs, and linking to metadata. Data go from raw to preliminary to final within 6 months (goal).
Problems	MassDEP fish data since 2007 not yet in our WQ database. Questions: 1) How do we match water temp. data with those that fish use/avoid/need. 2) How do we characterize a thermal regime appropriate for a robust cold-water community; and 3) what temperture metrics do we use to identify use-support/non-support/degree of support.

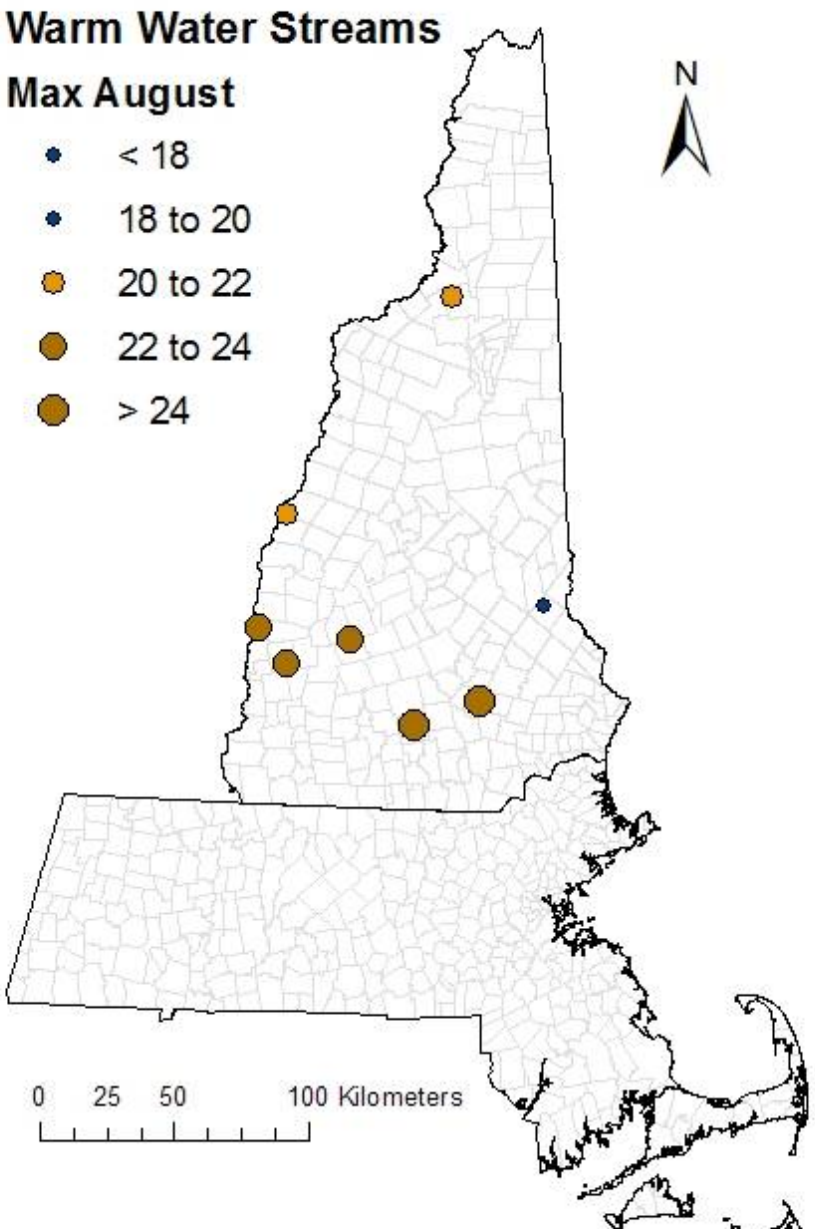
Temperature and Fish Sampling Site by Agency
N = 312 Sites
Hourly Sampling



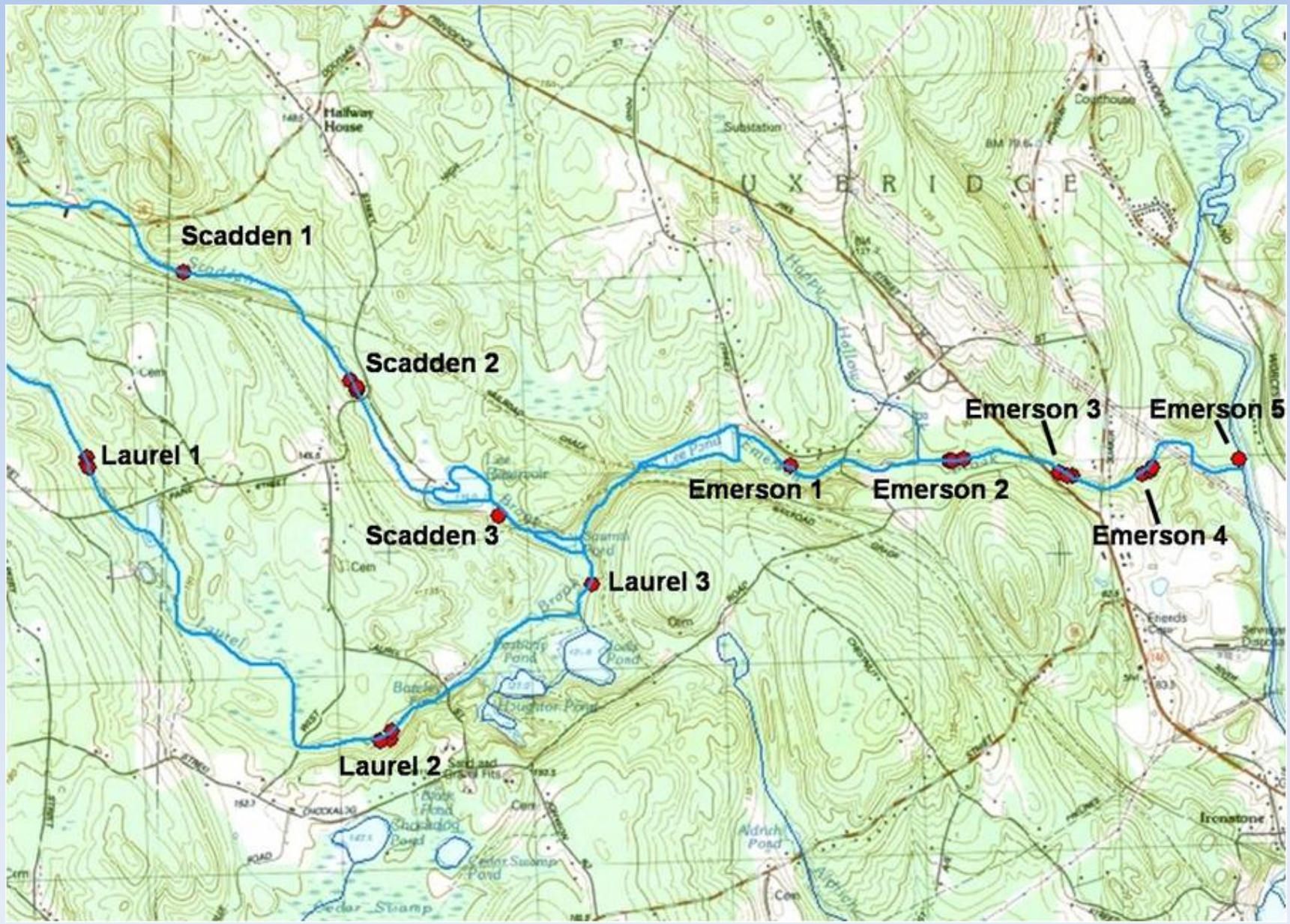
Stream Temperature for 2006



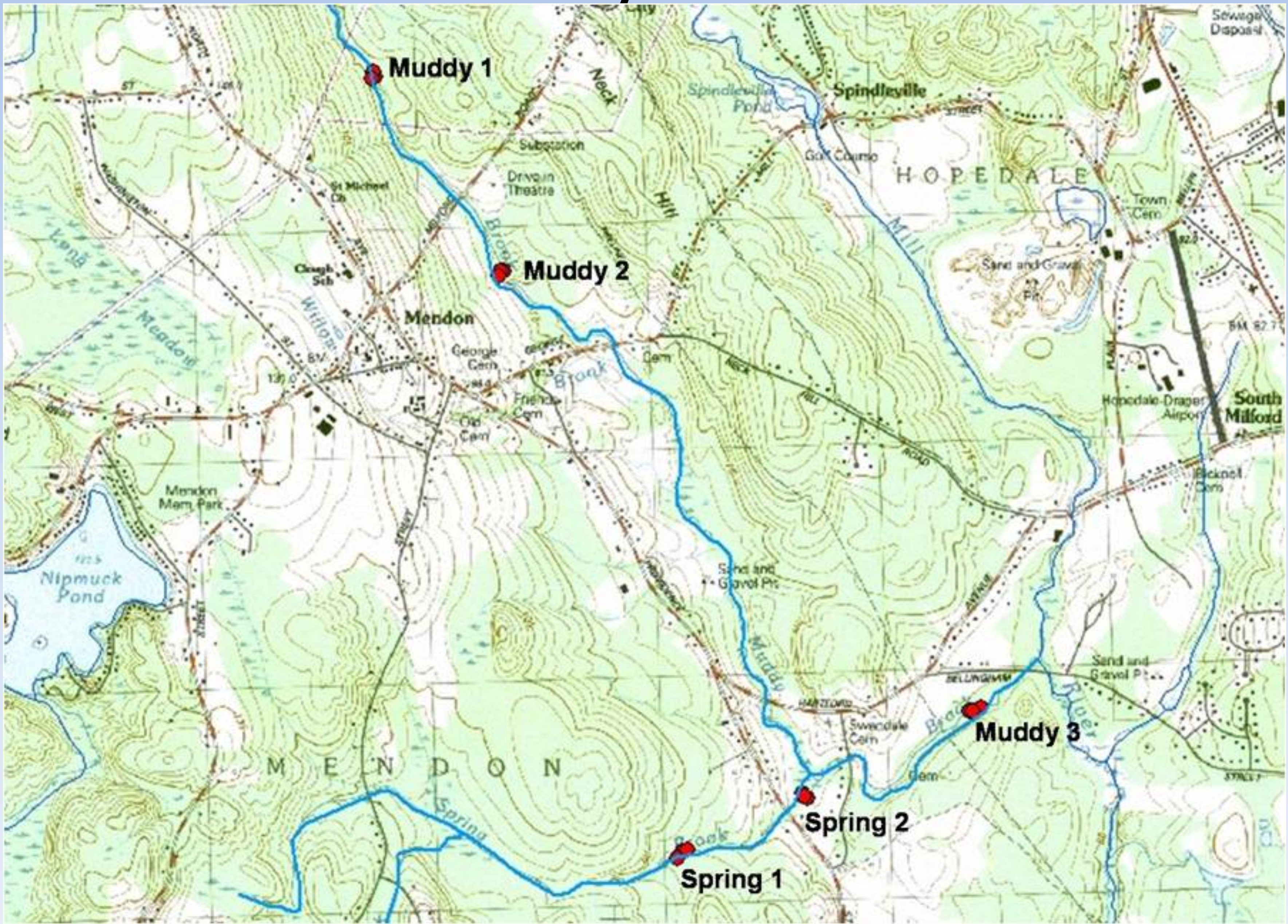
Stream Temperature for 2006



Emerson Brook



Muddy Brook

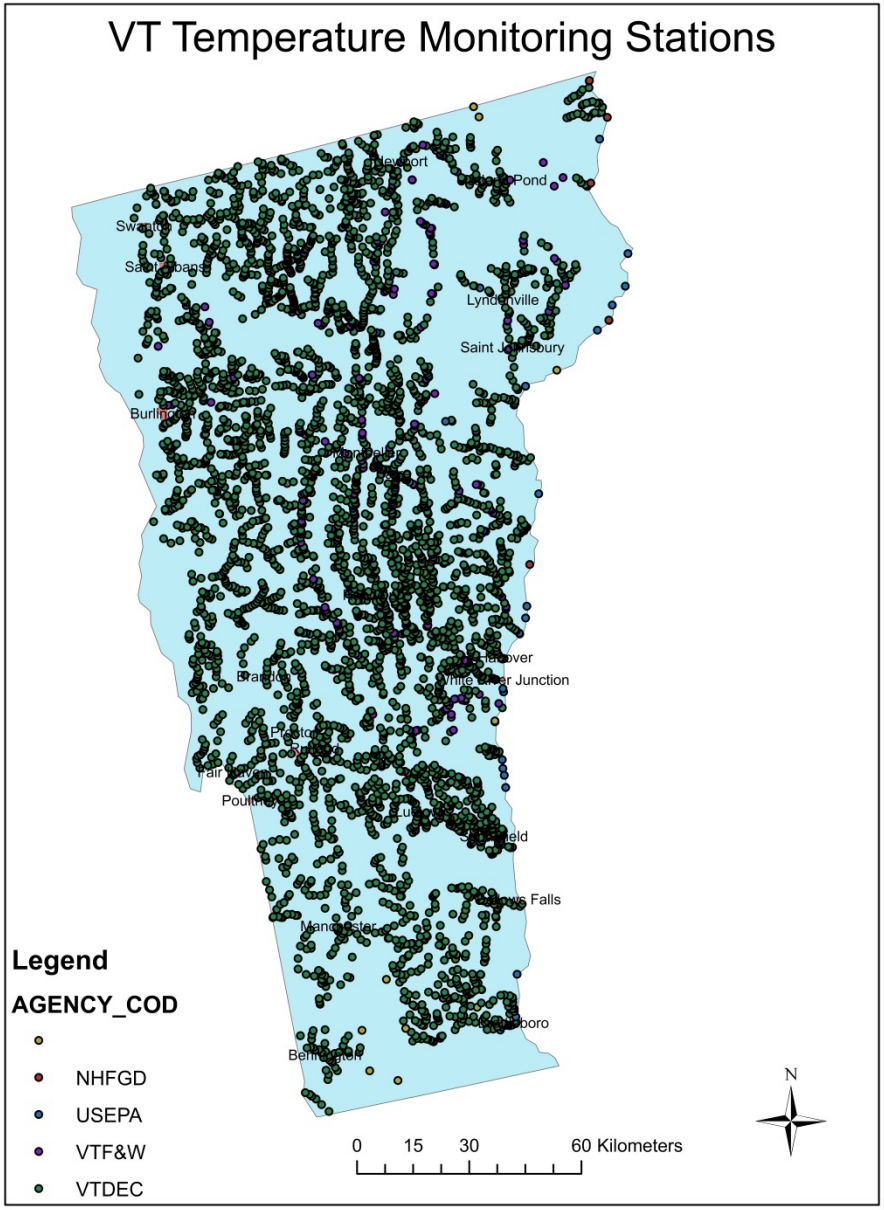

Muddy 1
Muddy 2
Muddy 3
Spring 1
Spring 2
Spindleville
Spindleville Pond
Substation
Drive-in Theatre
St Michael Ch
Clough Sch
Mendon
George Cem
Friends Cem
Old Cem
Cem
Neck Hill
Mill
Brook
Muddy
Spring
HOPEDALE
Town Cem
Sand and Gravel Pit
Hopedale-Draper Airport
South Milford
Bicknell Cem
Mendon Mem Park
Nipmuck Pond
Long Meadow
Willow
Sand and Gravel Pit
Swedeville Cem
Sand and Gravel Pit
M E N D O N
Sewage Disposal
Golf Course

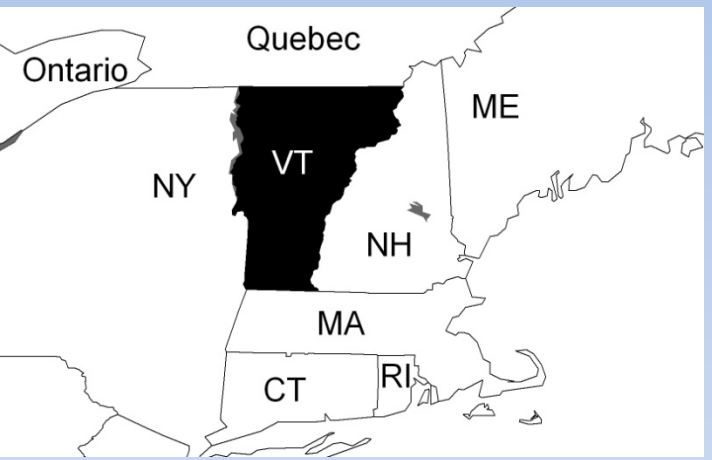
Center Brook

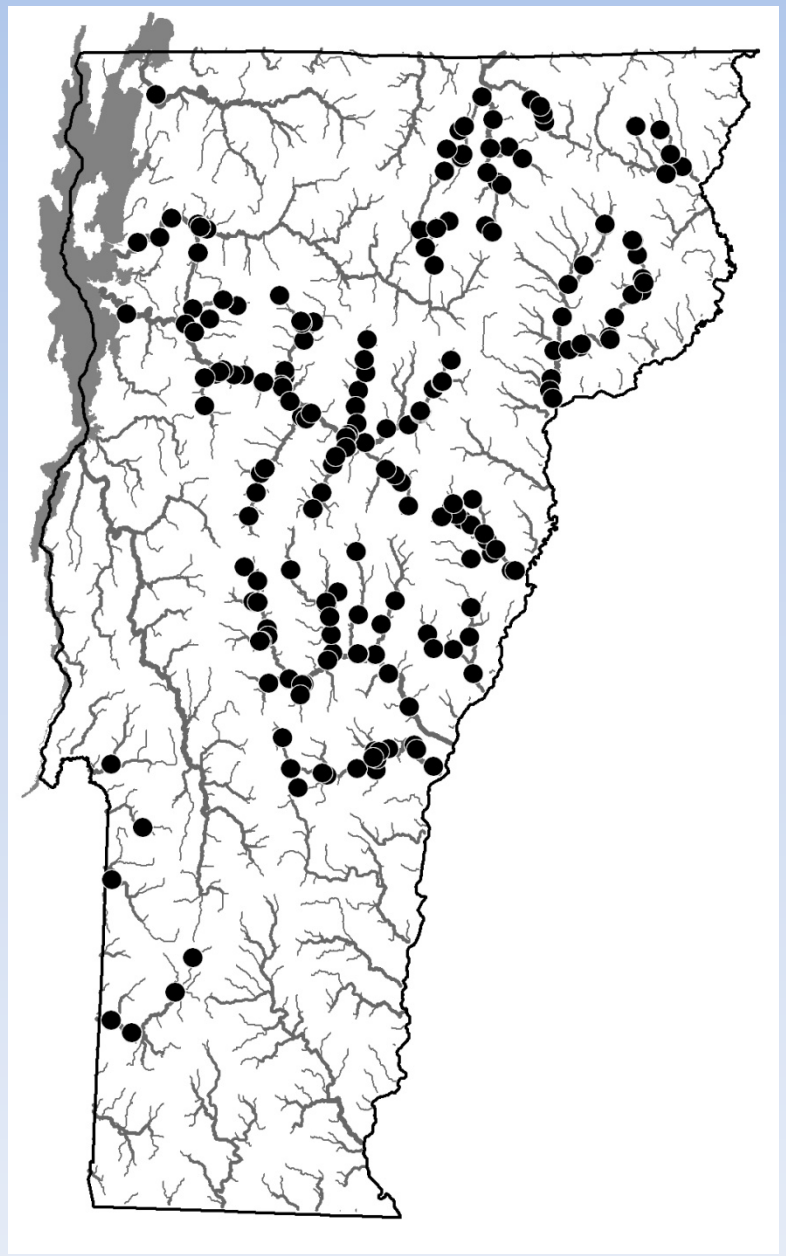

Greetings
FROM
VERMONT
State Capitol in
Montpelier
State Flower
the Red Clover
© RetroAmerica.com

Topic	Vermont Dept Fish and Wildlife Water Temperature Logger Data
Why we collect	Coldwater stream thermal regime & fisheries implications. Fish spawning, migration. Hydropower & reservoir impacts. Case study of SNTEMP and opportunities on a stressed river.
What else do we need	Address problem areas (below). Map stations. Coordination at broad geographic scale.
Our coverage (space & time)	Began in 1998; more widespread 2000 on. About 40 separate streams, with multiple locations. Mostly summer period; some during spring & fall.
Device & Frequency	Onset StowAway Onset HOBO Water Temperature Pro v2 Logger Frequency 30-120 minutes.
Calibration	Check against certified thermometer; ice water bath.
Data Management	Excel: temperature data files, metadata information.
Problems	▪ Inconsistencies by state region: QA/QC, metadata, summer period and data recording interval. ▪ Lack of plan for long term monitoring. ▪ Inadequate communication between agencies/groups with data. ▪ Data metrics and interpretation.

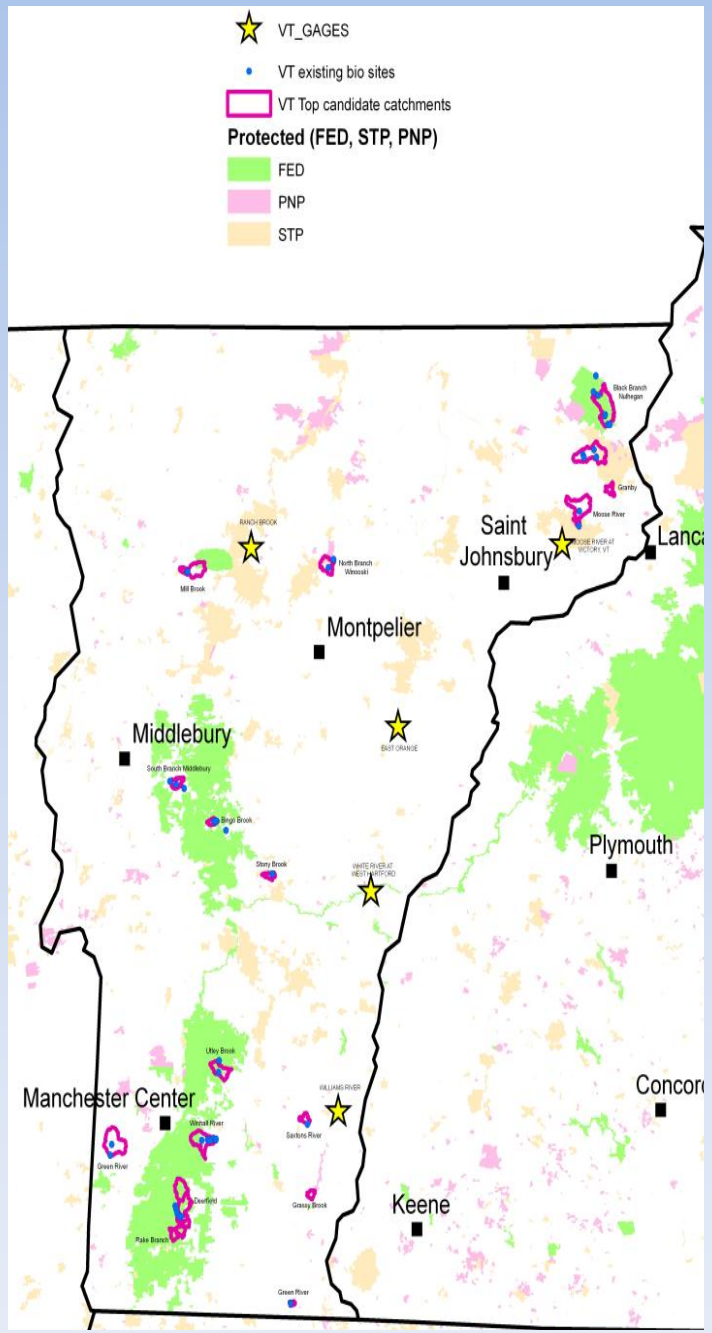
Topic	Vermont Dept Environmental Conservation
Why we collect	Measure long term water temperature trends. (Fish, macroinvertebrates, basic chemistry sampled annually)
What else do we need	Coordination with other climate change monitoring efforts
Our coverage (space & time)	Wide range of stream types from small cold to large cool
Device & Frequency	Onset HOBO units
Calibration	
Data Management	DEC- Access Database
Problems	Resource support so that we can continue long term


VT Temperature Monitoring Stations
Newport
Pond
Swanton
Saint Albans
Lyndonville
Saint Johnsbury
Burlington
Montpelier
Hanover
Bradford
White River Junction
Poultney
Rutland
Springfield
Bellows Falls
Manchester
Bennington
Legend
AGENCY_COD
NHFGD
USEPA
VTF&W
VTDEC
0 15 30 60 Kilometers
N





- Stream Temperature
  n=207

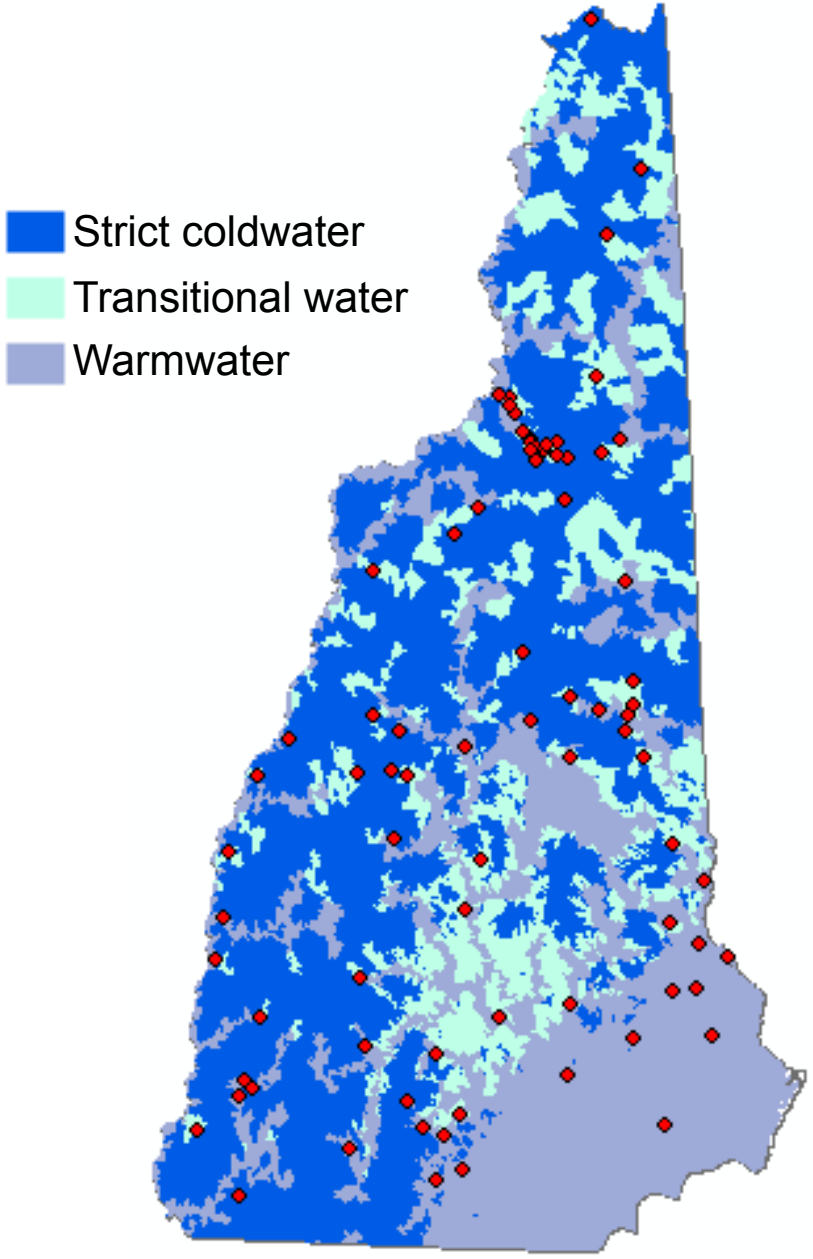

VT_GAGES
VT existing bio sites
VT Top candidate catchments
Protected (FED, STP, PNP)
FED
PNP
STP
Saint Johnsbury
Montpelier
Middlebury
Plymouth
Manchester Center
Keene
Concord
RANCH BROOK
WILLIAMS RIVER
WHITE RIVER AT WEST HARTFORD
EAST ORANGE
Mill Brook
North Branch Winooski
South Branch Middlebury
Stony Brook
Sarstons River
Grassy Brook
Green River
Moose River
Granby
Black Branch Nulhegan

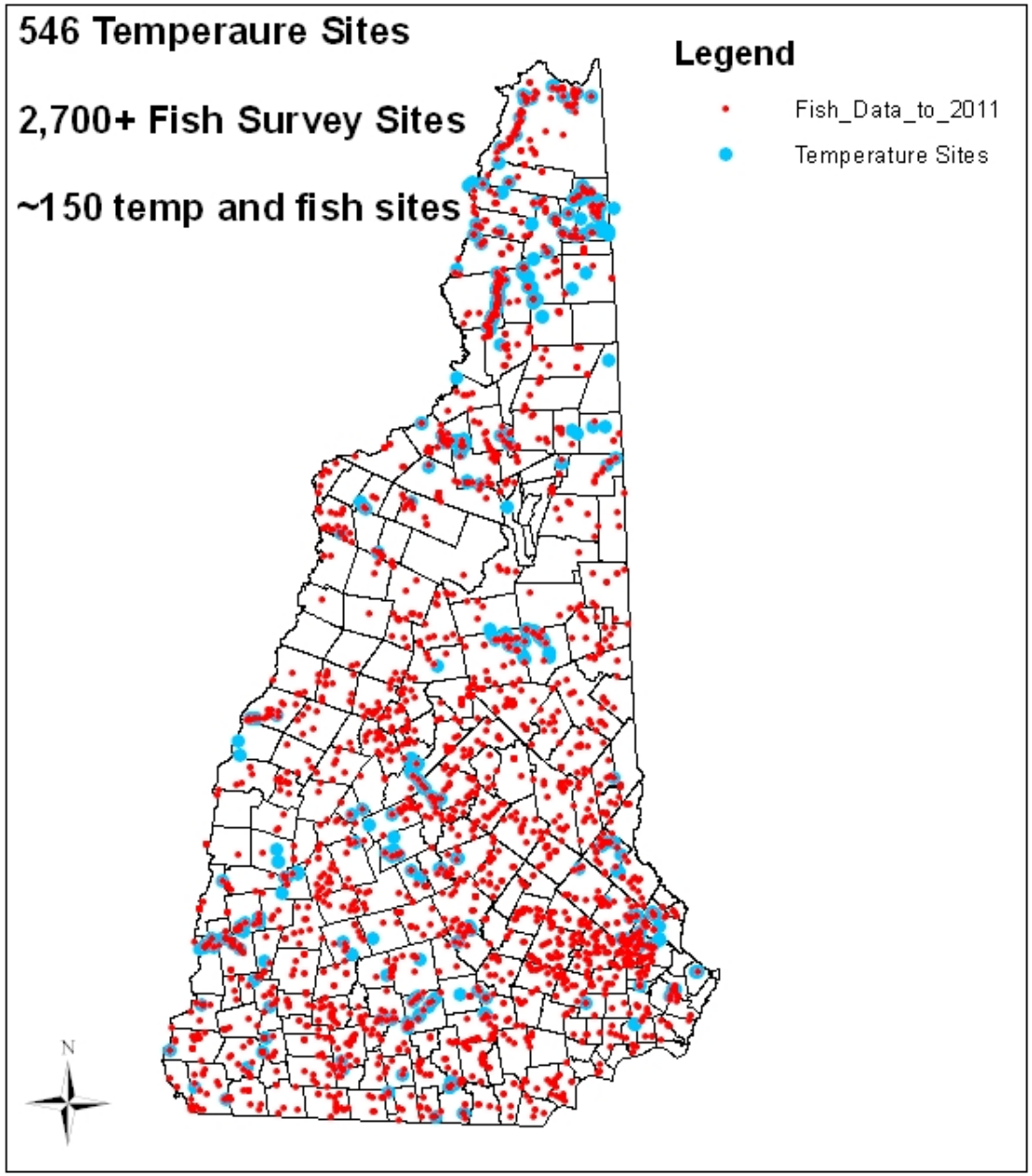

Greetings from
NEW
HAMPSHIRE

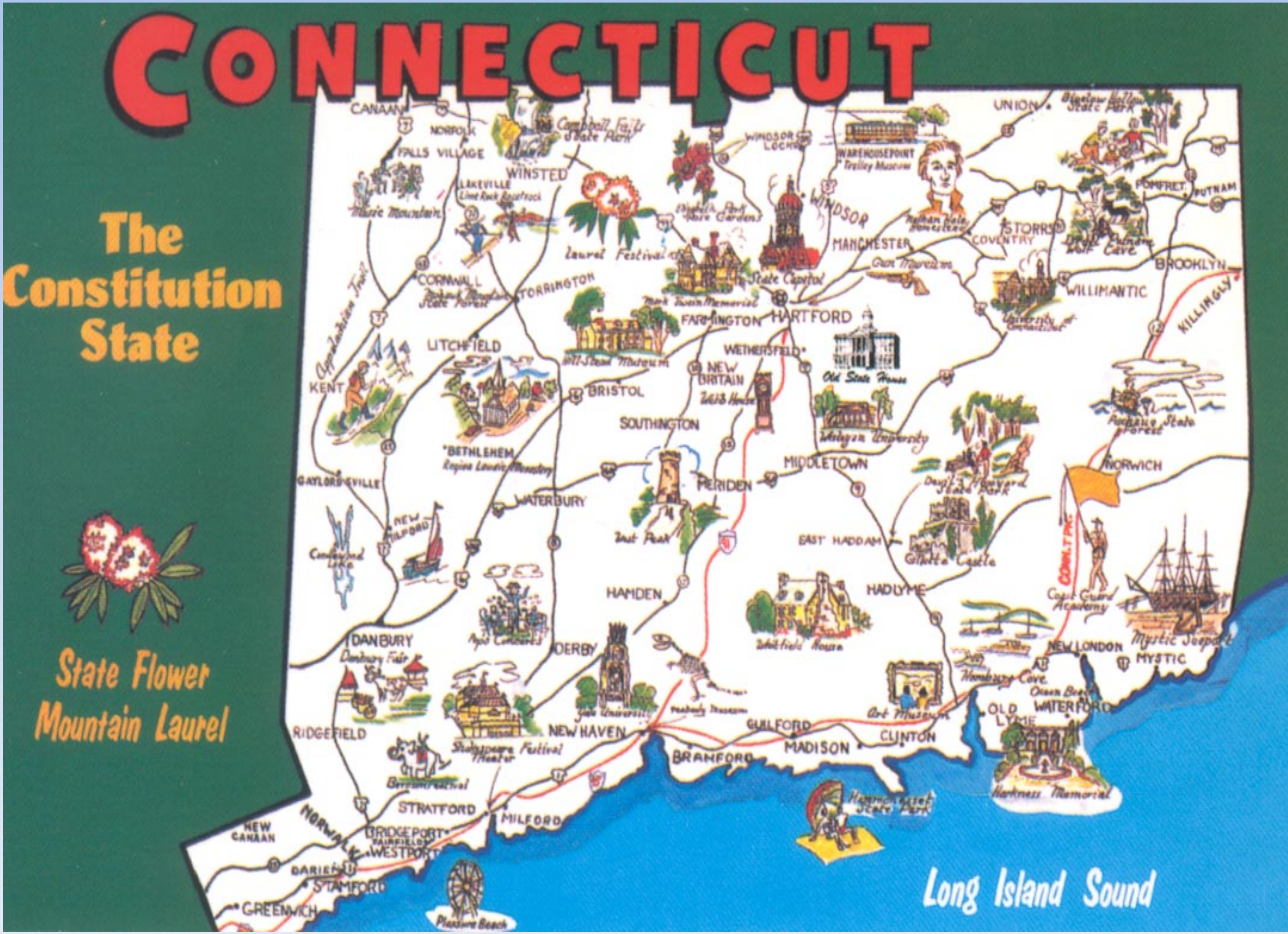
Topic	NH DES, Dave Neils	NH Fish & Game, John Magee
Why we collect	Towards establishment of numeric temperature criteria	Evaluate thermal regimes for long-term conservation of aquatic species
What else do we need	Greater spatial coverage, more intensive "watershed-based studies" such as Israel River	A solid, comprehensive database
Our coverage (space & time)	June – mid-October, ~45 sites / year; 15 sites are fixed, 30 sites rotate	June 1 – Sept 15 generally, with some data for all year in some sites
Device & Frequency	Onset HOBO, 1-hour increments	Onset WT Prov2, Tidbits, Stowaways till 2010
Calibration	Water bath, prior to installation	Generally ice water bath and checks with calibrated digital thermometer
Data Management	NH DES environmental monitoring database (EMD); Excel files for metric computation	Master deployment spreadsheet with some data metrics, all individual files organized by year
Problems	Occasional loss of instrumentation	We don't have a solid database yet

Data Collection

- 2007 - 2010
- 110 installations; 83 sites
- Coldwater = 31 sites
- Transitional water = 24 sites
- Warmwater = 28 sites
- Loggers placed in stream in June; retrieved in October
- Temperature recorded hourly

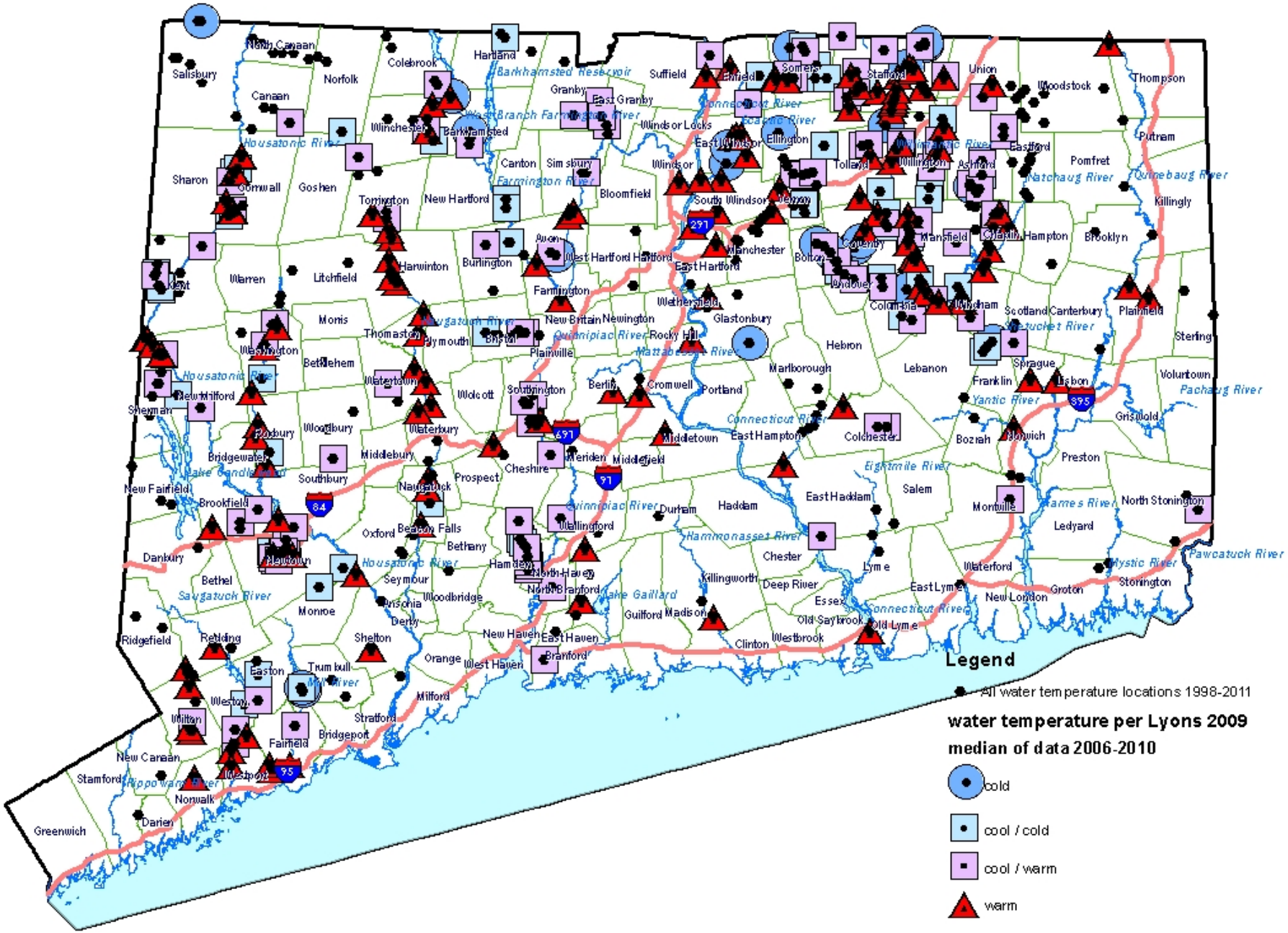



546 Temperaure Sites
2,700+ Fish Survey Sites
~150 temp and fish sites
Legend
Fish_Data_to_2011
Temperature Sites
N
0
12.5
25
50 Miles
N

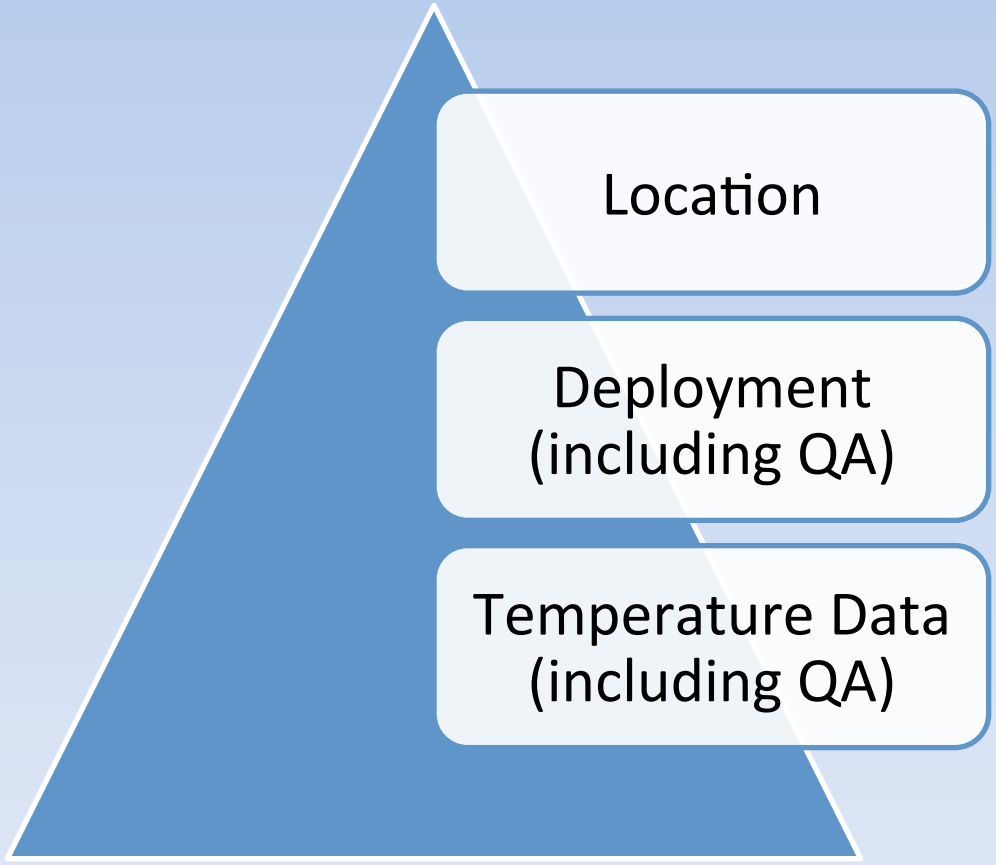


CONNECTICUT
The Constitution State
State Flower
Mountain Laurel
CANAAN
NORFOLK
FALLS VILLAGE
WINSTED
LAKEVILLE
Music Mountain
CORNWALL
TORRINGTON
LITCHFIELD
KENT
BETHLEHEM
GAYLORDSVILLE
NEW MILFORD
WATERBURY
DANBURY
RIDGEFIELD
NEW CANAAN
NORWALK
DARIEN
STAMFORD
GREENWICH
WESTPORT
BRIDGEPORT
STRATFORD
MILFORD
DERBY
NEW HAVEN
HAMDEN
Yale University
Shakespeare Festival Theater
Laurel Festival
Campbell Falls State Park
WINDSOR LOCKS
WINDSOR
State Capitol
HARTFORD
FARMINGTON
WETHERSFIELD
NEW BRITAIN
BRISTOL
SOUTHINGTON
MERIDEN
MIDDLETOWN
Old State House
Wesleyan University
EAST HADDAM
Gillette Castle
HADLYME
GUILFORD
MADISON
CLINTON
BRANFORD
Art Museum
Hammonasset State Park
Harkness Memorial
OLD LYME
WATERFORD
NEW LONDON
Coast Guard Academy
MYSTIC
Mystic Seaport
NORWICH
WILLIMANTIC
University of Connecticut
STORRS
COVENTRY
MANCHESTER
Nathan Hale Homestead
WAREHOUSE POINT Trolley Museum
UNION
Bigelow Hollow State Park
POMFRET
PUTNAM
BROOKLYN
KILLINGLY
Pleasure Beach
Long Island Sound

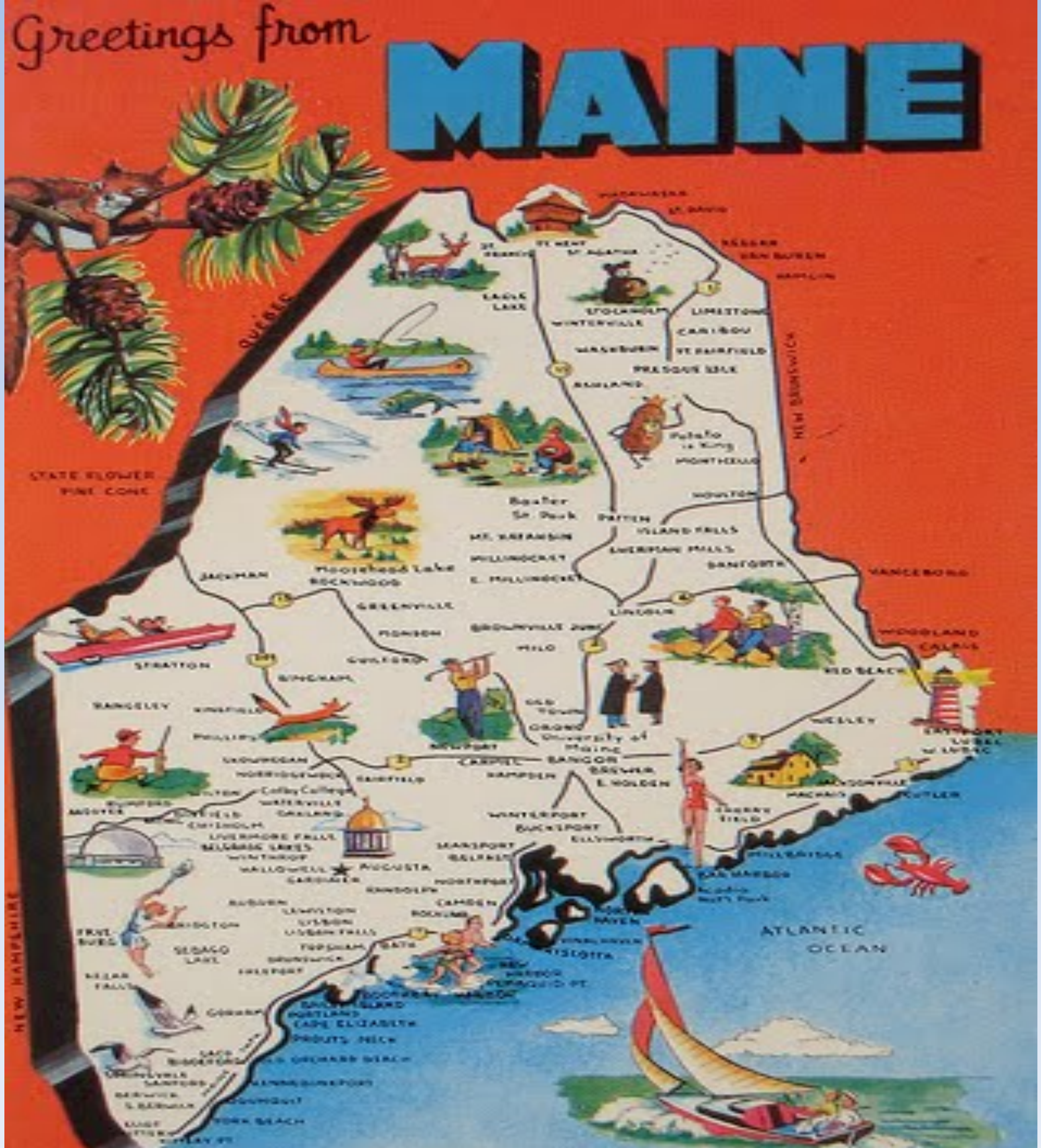
Topic	CT DEEP Inland Fisheries (Neal Hagstrom)	CT DEEP Water Management (Mike Beauchene)
Why we collect	Evaluate trout habitat	Baseline data variety of uses, water quality criteria, identify temperature regeime
What else do we need	More spatial coverage	More cold water year round data (sites)
Our coverage (space & time)	Summer time in trout or potential trout waters	Statewide year round all waters
Device & Frequency	Onset HOBO water temp pro @ 1 hour	Onset HOBO water temp pro or tidbit @ 1 hour
Calibration		Ice water bath pre and post deployment, evaluate any outside of 0.2 C again.
Data Management	Individual .dtf files organized in folders on network, master deployment spreadsheet	HOBO Central Microsoft access relational database, (location, deployment metadata, and values)
Problems	Large scale data evaluation	Better predictive model for cold, cool, warm. Identify key metrics for evaluation of temperature data. Define cold, cool and warm for CT.


Legend
All water temperature locations 1998-2011
water temperature per Lyons 2009
median of data 2006-2010
cold
cool / cold
cool / warm
warm

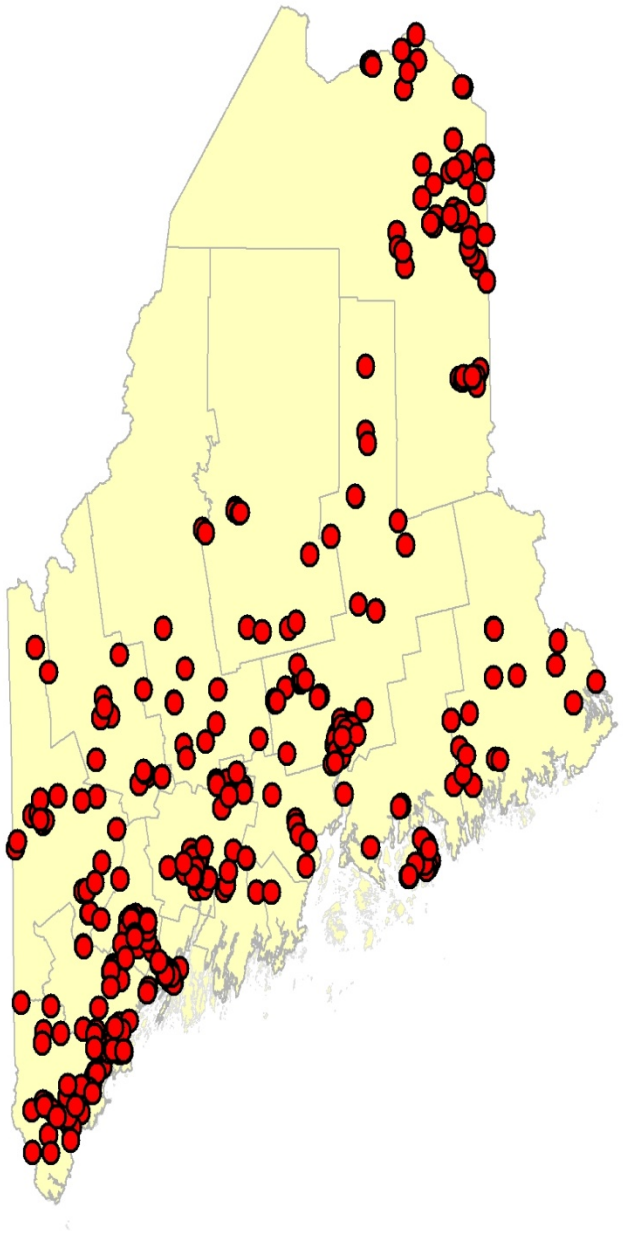
Simple Data Management

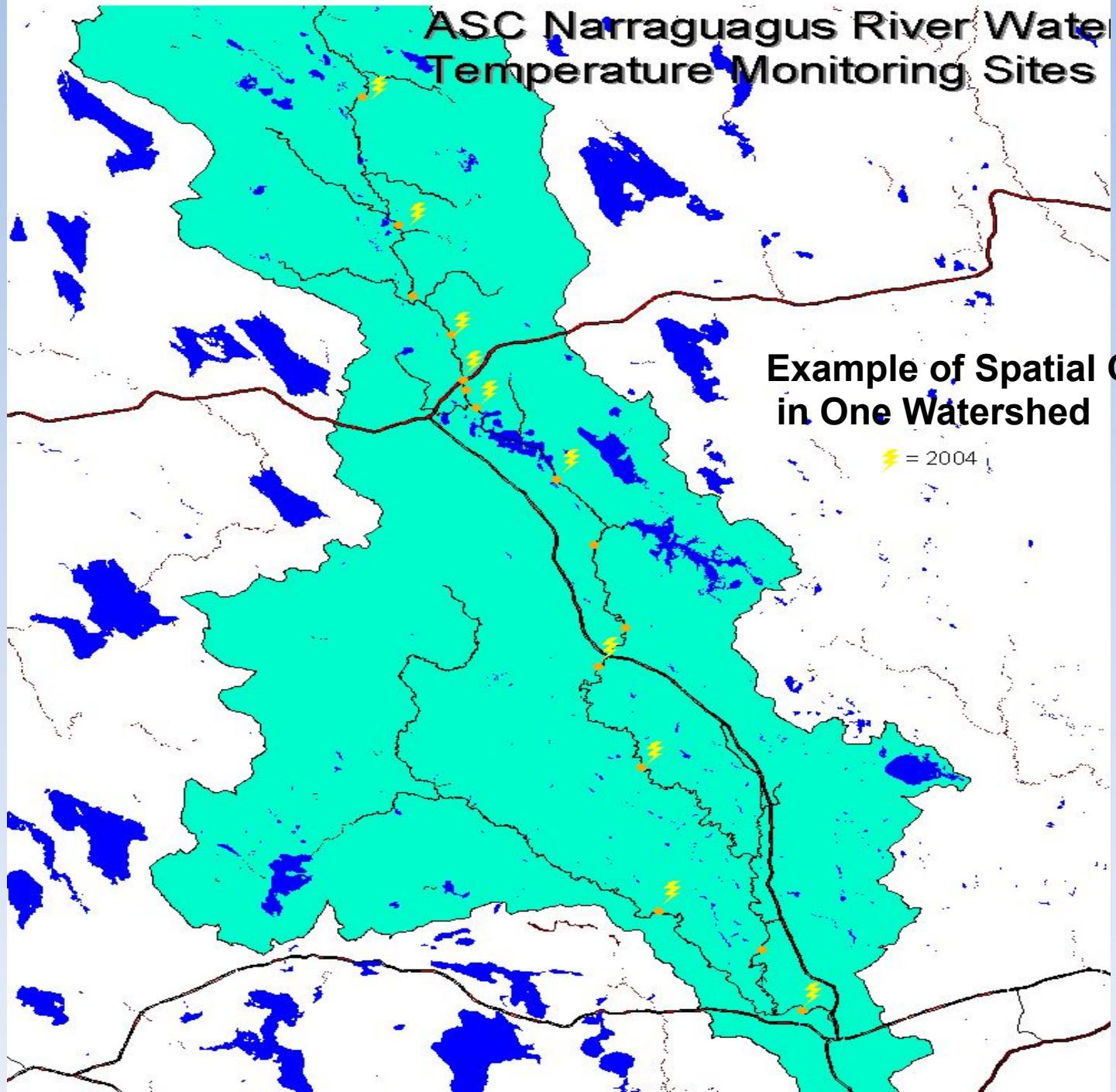


StationID	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Median of years	Average of all years
1								4	3	4	4	4	3.8
4						2						2	2.0
22										4	4	4	4.0
27							2					2	2.0
28										4	4	4	4.0
31						4						4	4.0
33	3											3	3.0
43			3					3				3	3.0
44								3				3	3.0
47			2			3		3	2		3	3	2.6
49											4	4	4.0
50	2											2	2.0
51				3	3	3	3	3	2	3		3	2.9
54	3					3				4		3	3.3
63		3										3	3.0
68			1								2	1.5	1.5
69			2									2	2.0
75								3				3	3.0
77											4	4	4.0
81											4	4	4.0
89						4	4	4	4	4		4	4.0
90									4			4	4.0
98						4						4	4.0
101				4							4	4	4.0
102		2										2	2.0
110				4	4	4	4	4		4		4	4.0
112	4		4	4								4	4.0
113											3	3	3.0
116				4	4	4	4	4		4		4	4.0


Greetings from
MAINE
QUEBEC
STATE FLOWER
PINE CONE
NEW BRUNSWICK
NEW HAMPSHIRE
EAGLE LAKE
VAN BUREN
STOCKHOLM
LIMESTONE
CARIBOU
WASHBURN
PRESQUE ISLE
Potato is King
MONTICELLO
HOULTON
Baxter St. Park
PATTEN
ISLAND FALLS
MT. KATAHDIN
MILLINOCKET
E. MILLINOCKET
JACKMAN
Moosehead Lake
ROCKWOOD
GREENVILLE
MONSON
LINCOLN
VANCEBORO
MILO
WOODLAND
CALAIS
RED BEACH
STRATTON
BINGHAM
RANGELEY
PHILLIPS
ORONO
University of Maine
NEWPORT
CARMEL
BANGOR
BREWER
HAMPDEN
SKOWHEGAN
NORRIDGEWOCK
FAIRFIELD
Colby College
WATERVILLE
OAKLAND
WINTERPORT
BUCKSPORT
ELLSWORTH
MACHIAS
CUTLER
SEARSPORT
BELFAST
HALLOWELL
AUGUSTA
GARDINER
CAMDEN
ROCKLAND
LEWISTON
LISBON
BATH
BRUNSWICK
FREEPORT
SEBAGO LAKE
BAR HARBOR
ATLANTIC
OCEAN
PORTLAND
CAPE ELIZABETH
PROUTS NECK
OLD ORCHARD BEACH
KENNEBUNKPORT
YORK BEACH

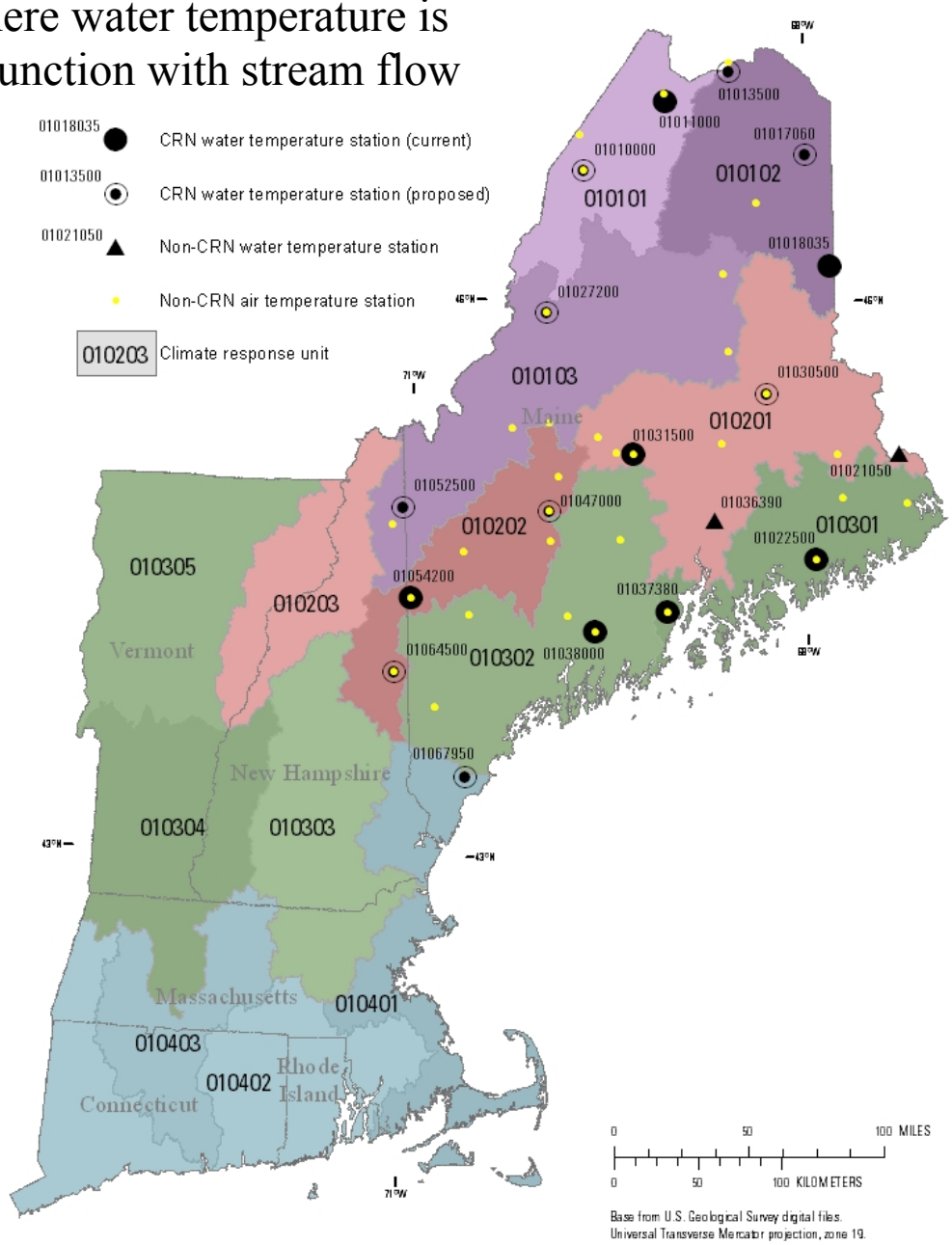
Topic	ME Department of Marine Resources, Sea Run Fisheries and Habitat -Joan Trial	ME Department of Environmental Protection-Rob Mohlar
Why we collect	Evaluate quality of Atlantic salmon habitat, thermal regime, limiting high temperatures, watershed modeling, growth modeling, cold water refugia, egg incubation,	Assess effect of discharges with Maine's Water Quality Standards percent saturation dissolved oxygen criteria and temperature rule
What else do we need	More time and expertise to analyze and use the data	Long term monitoring stations
Our coverage (space & time)	Narraguagus 1960-1969, Most other salmon rivers data 1991–2012. Annual average 8 units/watershed (range 1 to 40)	Miscellaneous discrete, monthly and hourly time series measurements from 1970s to present in large rivers and some small streams mostly in southern half of state. No long term program. Some Biomonitoring data in summer every 5 years since 1997
Device & Frequency	Onset, variety of units, frequency varies with objective (gen 1 hr)	Hand thermometers, Onset Hobo temperature loggers, data sondes variable frequency
Calibration	Annually before units are deployed	before units are deployed
Data Management	Access database with daily summary data, dtf files stored on server	most data since 2000 in EGAD database
Problems	Keeping database up to date	Capturing all data




ASC Narraguagus River Wate
Temperature Monitoring Sites
Example of Spatial Coverage
in One Watershed
= 2004

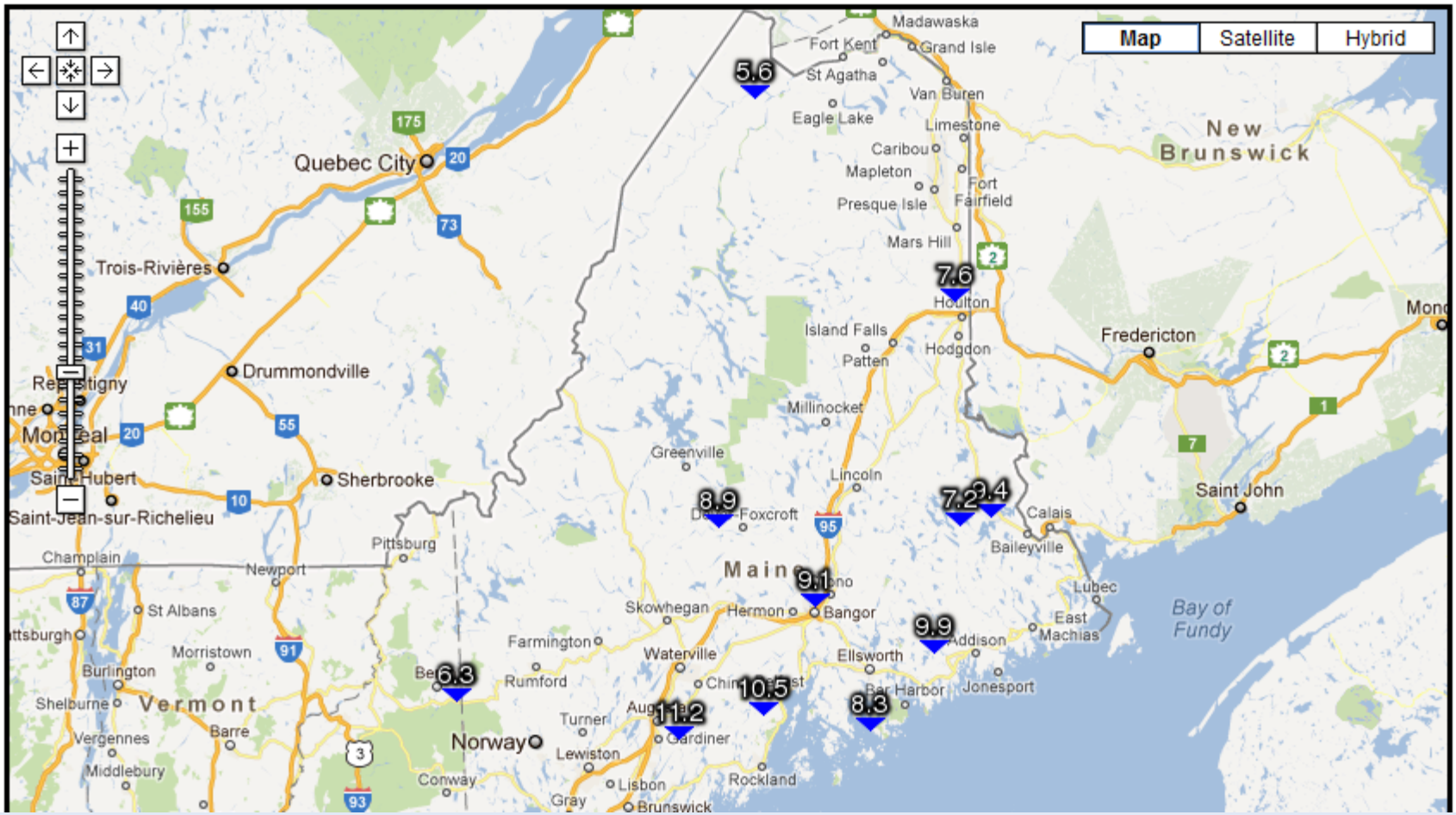
Topic	Maine USGS -Robert Lent or Tom Huntington
Why we collect	Climate Response Network (CRN), Trend Detection, Habitat models
What else do we need	Collaboration/coordination with Maine State DEP, DIFW, DMR
Our coverage (space & time)	Continuous Year Round: Currently 7 Sites in CRN, up to 8 sites proposed to add in 2012; 1 non-CRN site; 1 IJC summer only site
Device & Frequency	WATERLOG H-377 SDI-12 Thermistors, +/- 0.1 °C, 15-minute data, realtime telemetry
Calibration	NIST Traceable digital thermometers before deployment and field checked periodically
Data Management	National Water Information System (NWIS) USGS database
Problems	Need for quality assurance of historical data in Maine

Sites in Maine where water temperature is monitored in conjunction with stream flow



Maine Real-Time Water Temperature Sites

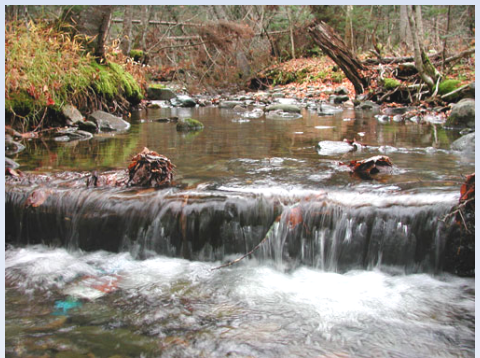
This map shows the real-time water temperature monitoring sites in Maine. You can click on a site and see a popup window containing the site name and USGS site number, a link to USGS's NWIS Web home page for site, and links to view the water temperature charts for the last seven days. Note that these linked pages will open up in a new browser window. This map is also zoomable and scrollable.



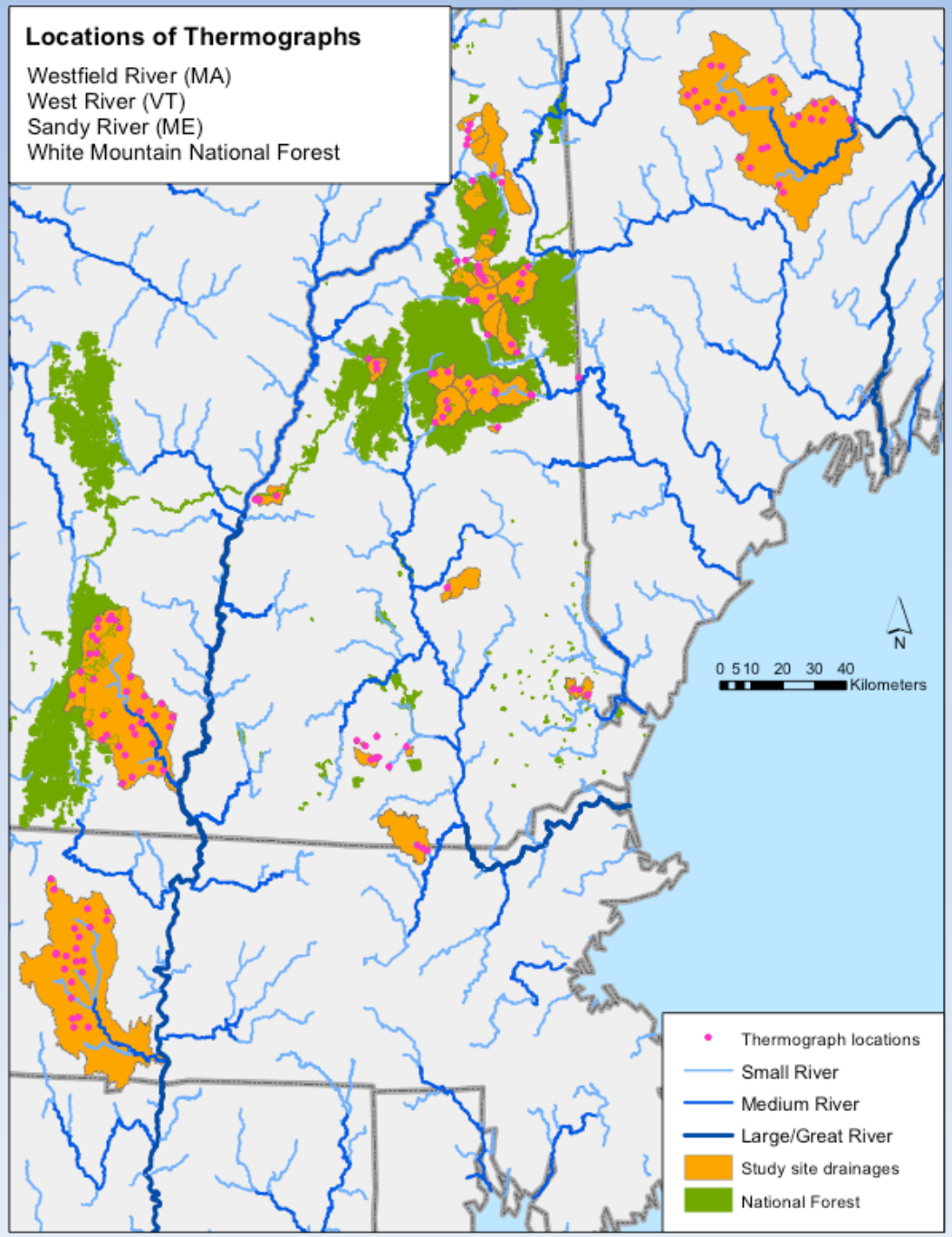
Data for 5/1/2012 10:45

USDA Forest Service Stream Temperature Monitoring in New England

Keith H. Nislow
Northern Research Station
Amherst, MA
Mark Prout
White Mountain National Forest
Compton, NH

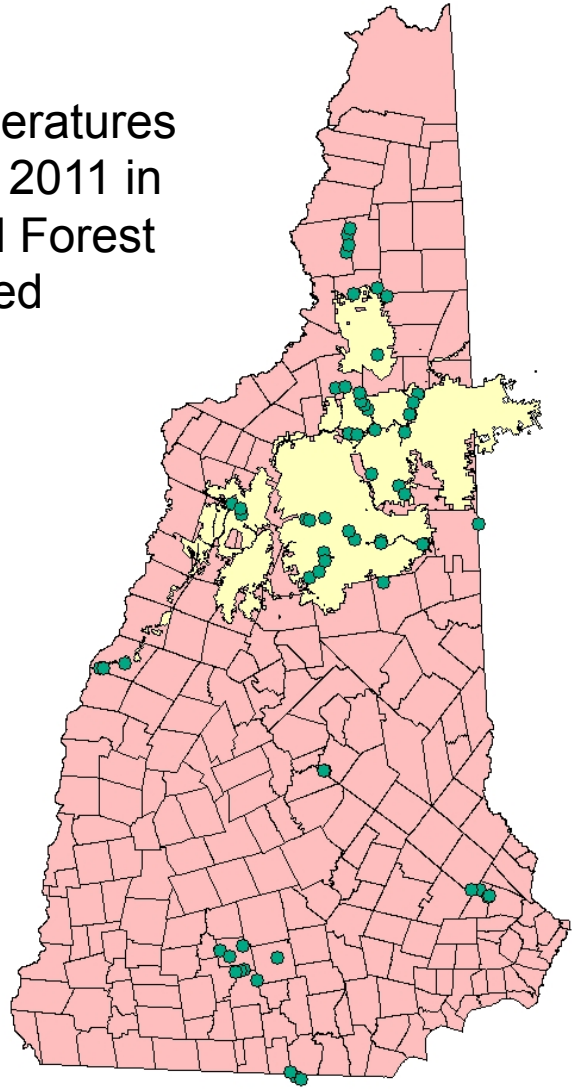


Topic	USDA Forest Service Green Mountain National Forest White Mountain National Forest Northern Research Station (Keith H. Nislow)
Why we collect	Monitor coldwater habitat; Evaluate effects of forest management; Identify and prioritize opportunities for habitat restoration (riparian restoration and barrier removal)
What else do we need	More spatial coverage; longer periods of record; more all-year monitoring
Our coverage (space & time)	Pre- 2010 adhoc placement in on the NFs Paired air and water temperature measurements in summer 2011 (WMNF); year-round in the GMNF and two other high-priority NALCC watersheds
Device & Frequency	HOBO's
Calibration	Not consistent
Data Management	Paired air-water: Access databases; others excel spreadsheets
Problems	Consistent calibration protocols; integration/w others


Locations of Thermographs
Westfield River (MA)
West River (VT)
Sandy River (ME)
White Mountain National Forest
N
0 5 10 20 30 40
Kilometers
Thermograph locations
Small River
Medium River
Large/Great River
Study site drainages
National Forest

Topic	USDA White Mountain National Forest -Mark Prout
Why we collect	Identify temperature regime, sensitivity, and vulnerablity of coldwater stream habitat
What else do we need	More spatial coverage in lower elevation sites near coldwater and coolwater thresholds.
Our coverage (space & time)	Summer time in coldwater and coolwater stream reaches
Device & Frequency	Onset HOBO water temp pro @ 1 hour (half hour in 2012)
Calibration	
Data Management	Microsoft Excel and Forest Service “Aquatic Survey” database
Problems	Locating approximate thresholds of coolwater and coldwater

Paired Air – Water Temperatures Sites in New Hampshire 2011 in White Mountain National Forest and other partner selected watersheds.




U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
USGS
science for a changing world

Topic	USGS CT WSC-Jon Morrison
Why we collect	Develop and maintain a long term data base of water temperature in a network of streams that is suitable for characterizing 1) the natural temperature fluctuation in individual streams, 2) for statistics of regional and temporal variation and trends (daily, seasonal, and annual).
What else do we need	Defined methods for data collection, verification, and quality control including documentation.
Our coverage (space & time)	Statewide coverage in Connecticut year-round, including the Connecticut, Housatonic, and Thames River watershed and smaller coastal watersheds draining to Long Island Sound.
Device & Frequency	Many types including continuous measurement 15 minute to hourly time step and periodic measurements.
Calibration	3-point calibration/verification – periodic inspection and concurrent independent measurement.
Data Management	NWIS and NWIS-web.
Problems	Network analysis and sufficiency assessment, data access (see on-going development of web-based hosting of data), quality control of data from other sources.

Web Site and Data Map

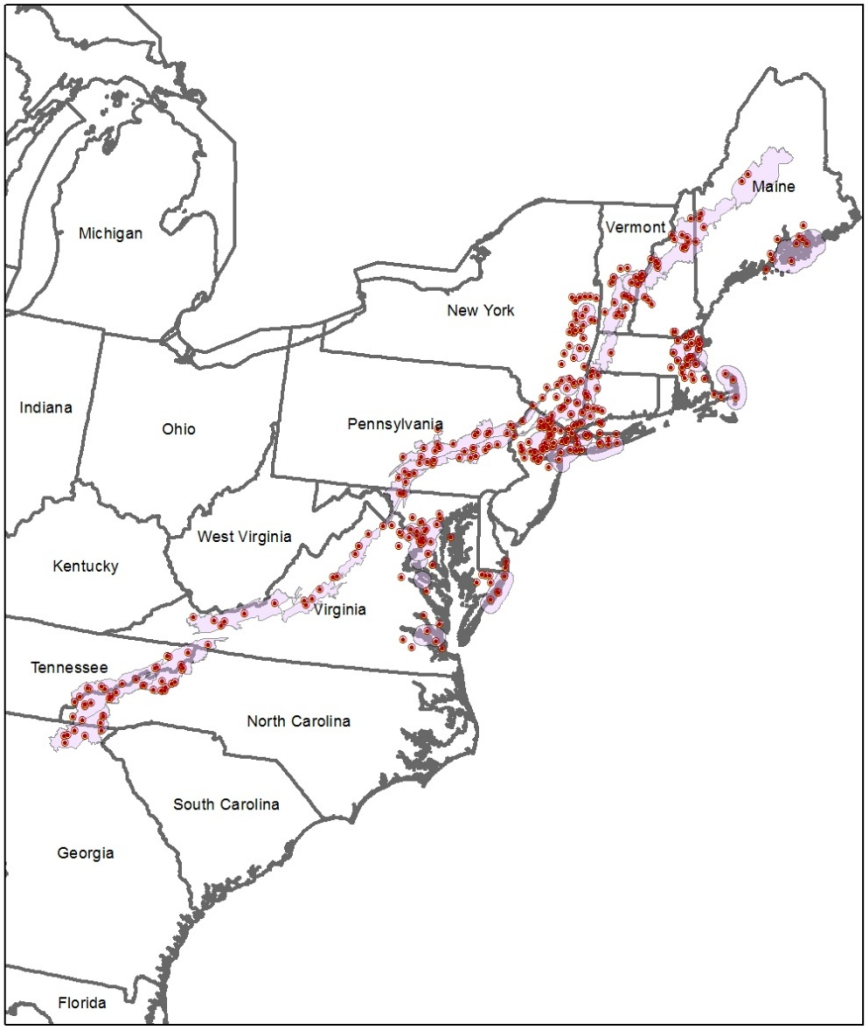
USGS Connecticut Water
Science Center

http://ct.water.usgs.gov/tt/ConnTemp.html


NATIONAL
PARK
SERVICE

Topic	Northeast Temperate Network (Kevin Morris)
Why we collect	Provide weather and climate data to biologists, ecologists, facility and park management.
What else do we need	Refine software interfaces and reporting environment
Our coverage (space & time)	Year around – long term
Device & Frequency	Daily
Calibration	n/a
Data Management	• SQL Server 2008 R2 • Access
Problems	• Data gaps • Refine software interfaces and reporting environment

Northeast Temperate Network



0 85 170 340 Miles

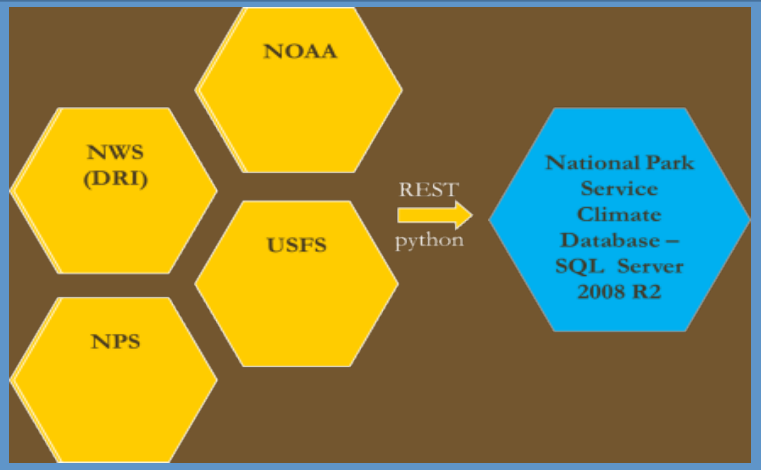
0 115 230 460 Kilometers

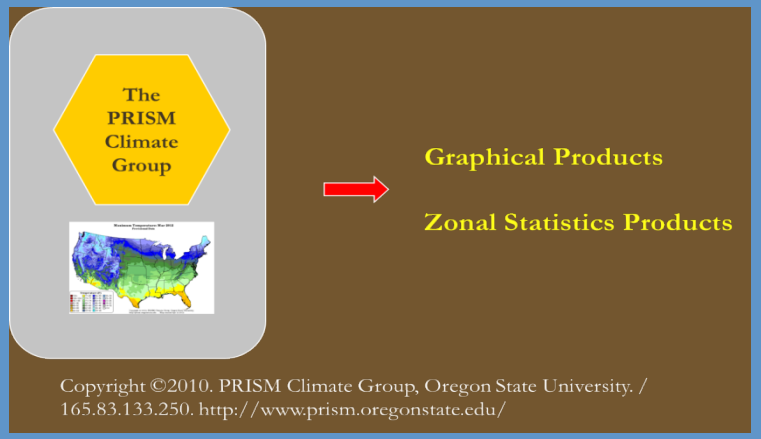
N

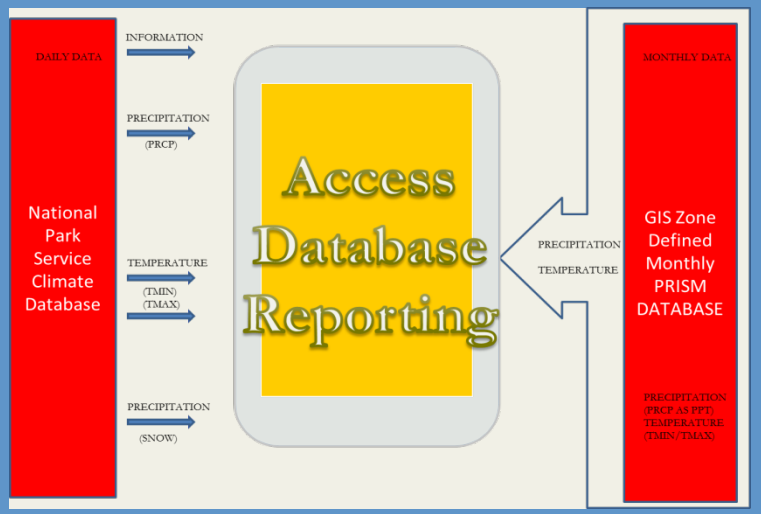
Weather Stations
- Selected

Map produced by the National Park Service (NPS) Northeast Temperate Network. Geographic coordinate system North American Datum - NAD 83. Scale 1:10,000,000

EXPERIENCE YOUR AMERICA



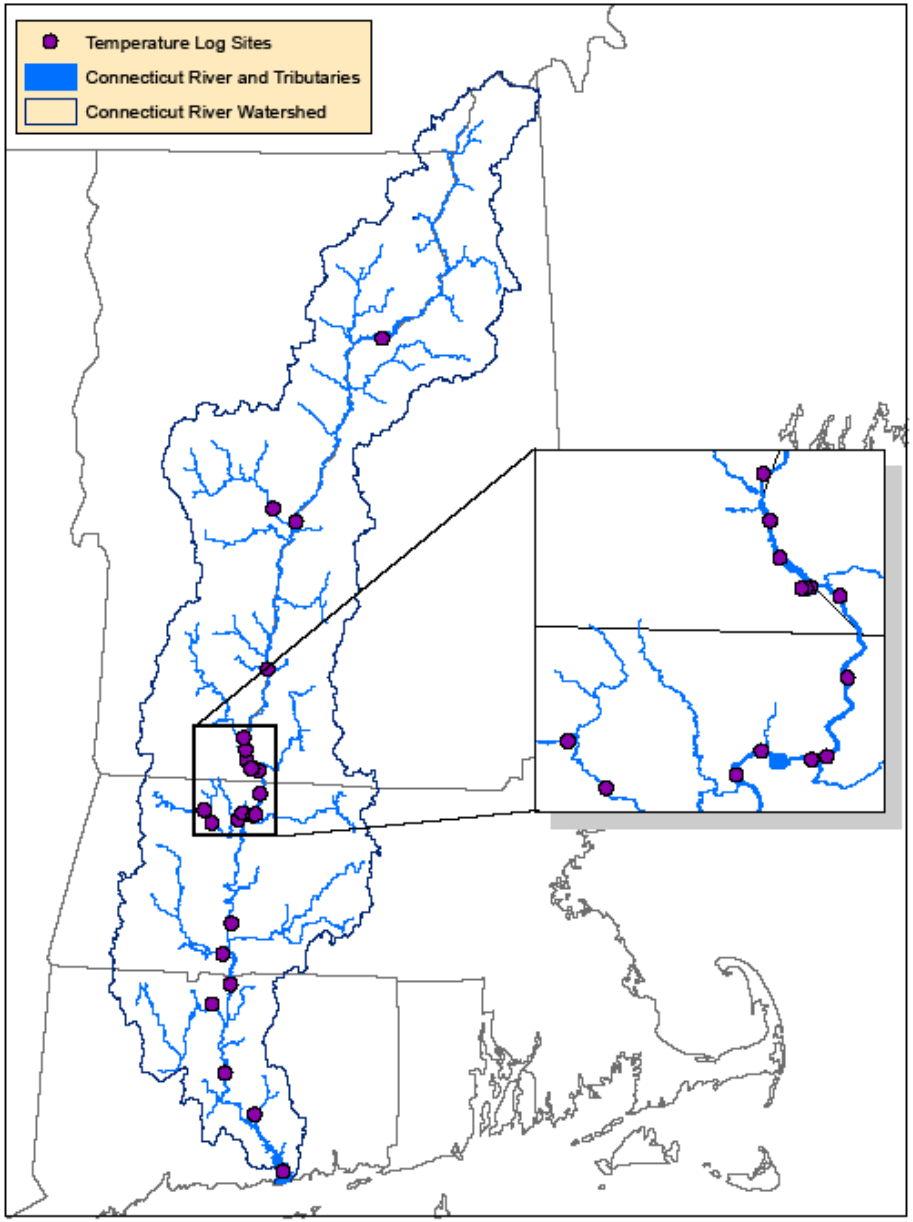





U.S.
FISH & WILDLIFE
SERVICE

Topic	US Fish and Wildlife-Ken Sprankle
Why we collect	To relate temp to fisheries data and establish a long-term monitoring program
What else do we need	We need to relate temp to flow, relate it to river operations (dams/ pump storage/heated discharge) – we need to relate it to changes in fish population dynamics and behavior, run timing, life history events (spawning) – and trend analyses
Our coverage (space & time)	Since fall 2009, n=20 loggers, Wilder Dam to Old Lyme and lower sections larger tribs, 20 min interval, +/- 1F precision
Device & Frequency	Onset Pendant 20 min interval, +/- 1F precision
Calibration	Factory
Data Management	USFWS – computer files/excel
Problems	Limited time to deal with data – want other to utilize, want to be strategic – coordinate – sometimes difficult to make time in fall for downloads/tending

Connecticut River Temperature Log Sites



Rhode Island

Topic	RI DEM- Office of Water Resources
Why we collect	Part of ambient water quality monitoring; Supports coldwater/warmwater fisheries designations in rivers; May be used to adjust DO and conductivity; in lakes and estuaries Helps define thermocline; Power plant/cooling water discharge permitting.
What else do we need	Need more continuous readings to better characterize temperature –related impairments; refine criteria, reduce data gaps and discern over time.
Our coverage (space & time)	Lakes – bi-weekly (May-Oct) – instantaneous measurements deepest point of the lake. River/Streams: Monthly instantaneous readings on non-wadeable rivers (6 stations – USGS) and 50-60 stations/year in wadeable streams – rotating basins; instantaneous readings. Fifteen real-time stations operated by USGS/Providence Water Supply & 1 real-time station – Wood River (USGS). 13 continuous stations in estuarine waters (Narragansett Bay Fixed-Site Monitoring Network) – data every 15minutes;
Device & Frequency	Available upon request.
Calibration	Available upon request.
Data Management	Portions of data area entered into DEM –OWR water quality databases.
Problems	Lack of staffing to initiate expanded monitoring and support needed analysis of data.


BREAK TIME!!

Facilitated Discussion
Questions, Comments, ……