

Analysis of Temperature/Fish Data: NH, MA, CT

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

1. Develop Stream Temperature Database
2. Characterize CT, MA, and NH Stream Temperature by Presence or Absence of Coldwater Species
3. Characterize Temperature of Target Coldwater Streams
4. Quantify Impact of Habitat Position on Stream Temperature

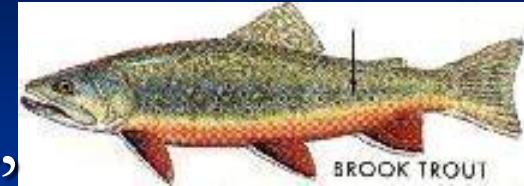
1. Stream Temperature ACCESS DB

- 391 Sites having collocated fish data, ~4.5 million observations

- MDFW (90)
- NHFG (60)
- MADEP (41)
- NHDES (48)
- CT DEEP (152)

■ Available Data

- 350 Sites
- ~4 million observations



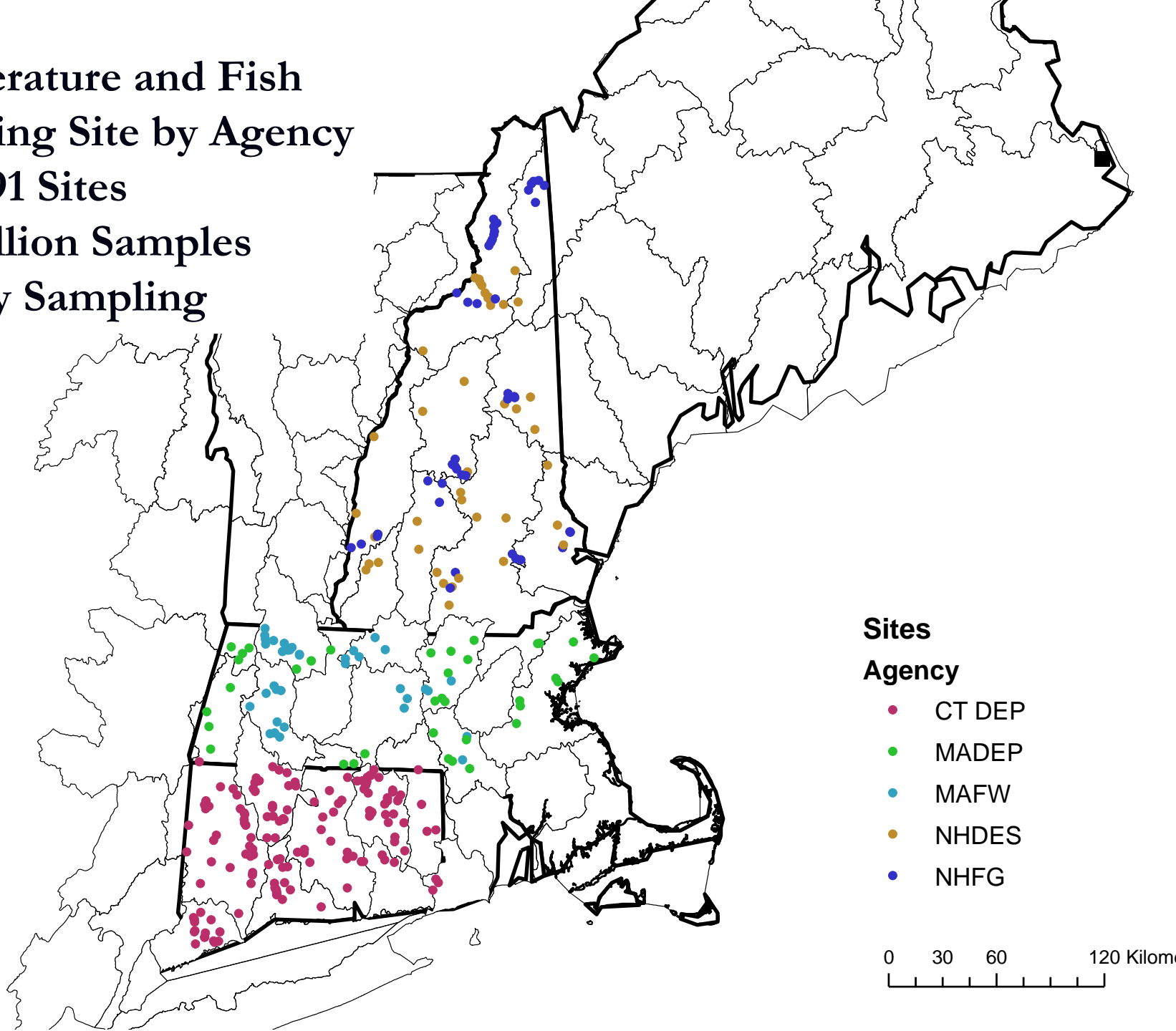
Pictures Credit:
NJ Freshwater Fish Identification

Temperature and Fish Sampling Site by Agency

N = 391 Sites

4.5 Million Samples

Hourly Sampling



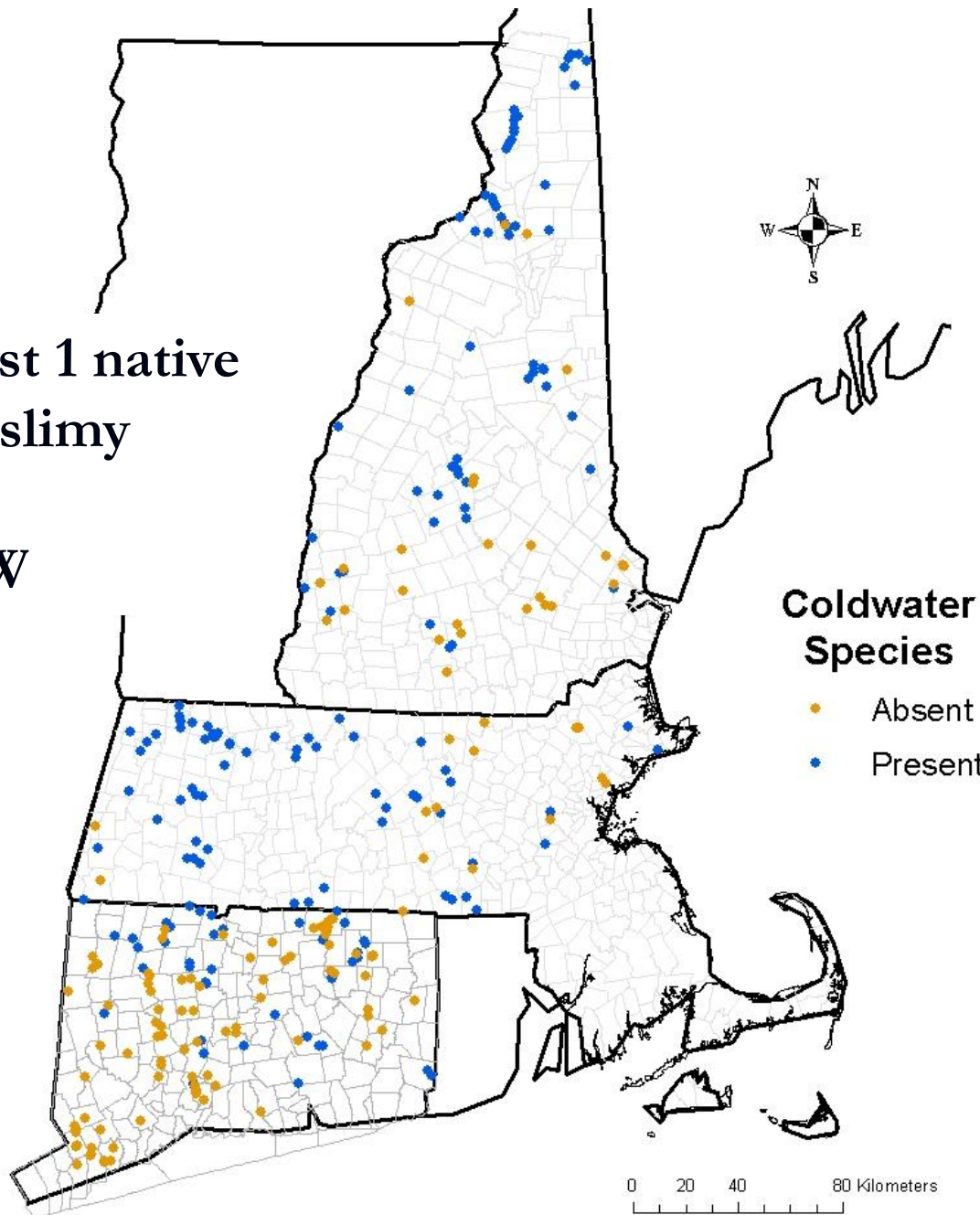
Database: Lessons Learned

- Common QAQC Errors
 - Sediment, Out of Water, Frozen, Light exposure, duplicate measurements
- More information is needed
 - Notes are needed about the site: indicators when a site is likely to be hot or cold would prevent good data being suspect.
 - Sampling locations (riffle, pool, run) should be noted.
 - Instrument type and ID
- More consistent formats across agencies would improve the collation process. Particularly noted is the date and units. Summary files differ greatly across agencies.

2. Stream Temperature Characteristics

- CT, MA, and NH Stream Temperature Characteristics by Presence or Absence of Coldwater Species
- Target CT and MA Coldwater Streams Temperature Characteristics

Temperature Sampling Locations



Present: At least 1 native
brook trout or slimy
sculpin
Absent: No CW

CT, MA and NH Temperature Regimes

Monthly Statistics

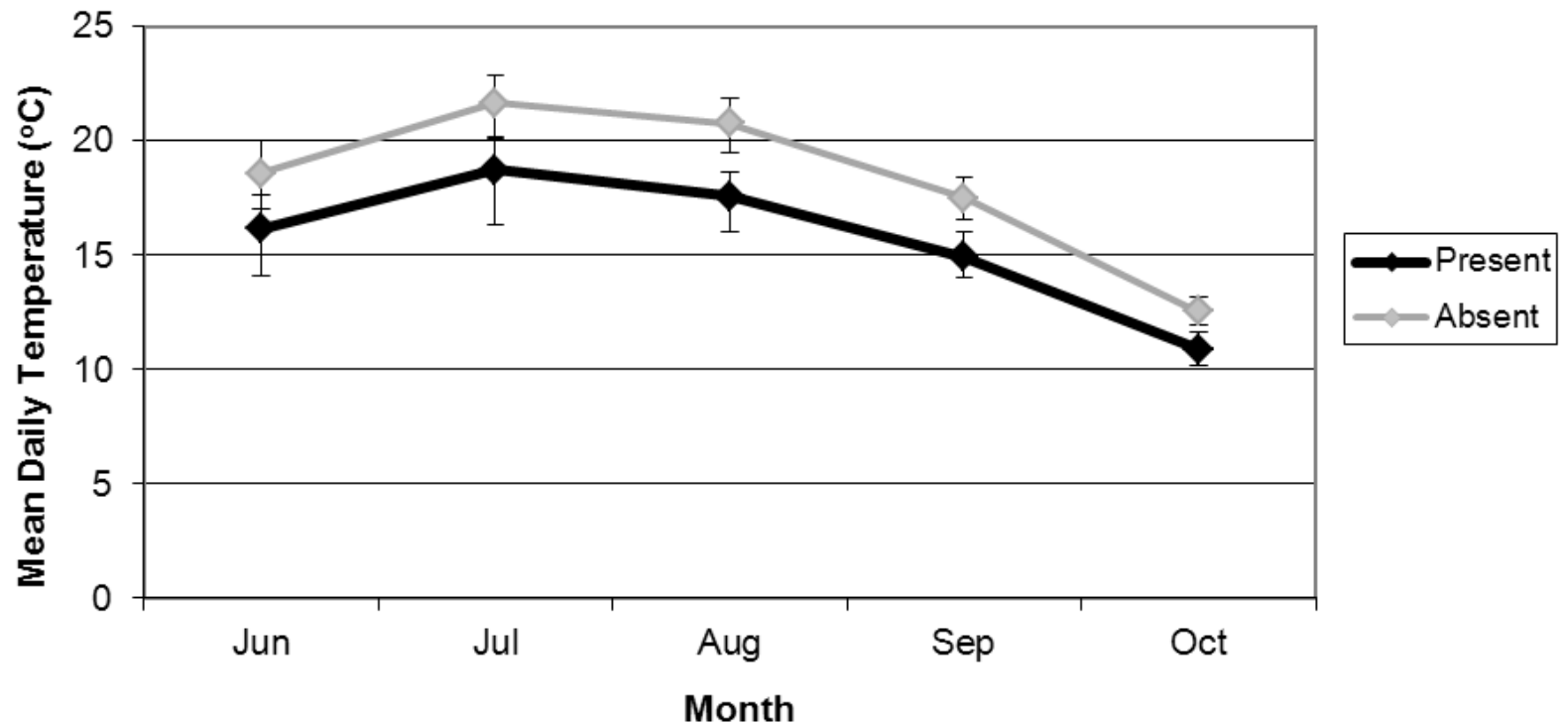
- **Monthly mean**, Standard deviation, Coolest day, Warmest day
- Daily minimum, maximum, and range
- Minimum temperature threshold exceedance
- Average duration of exceedance
- Warmest period 7-day moving window average
- Temperature duration curves

Comparison to Michigan & Wisconsin (Lyons et al.)

Monthly Statistics

Daily mean stream temperature

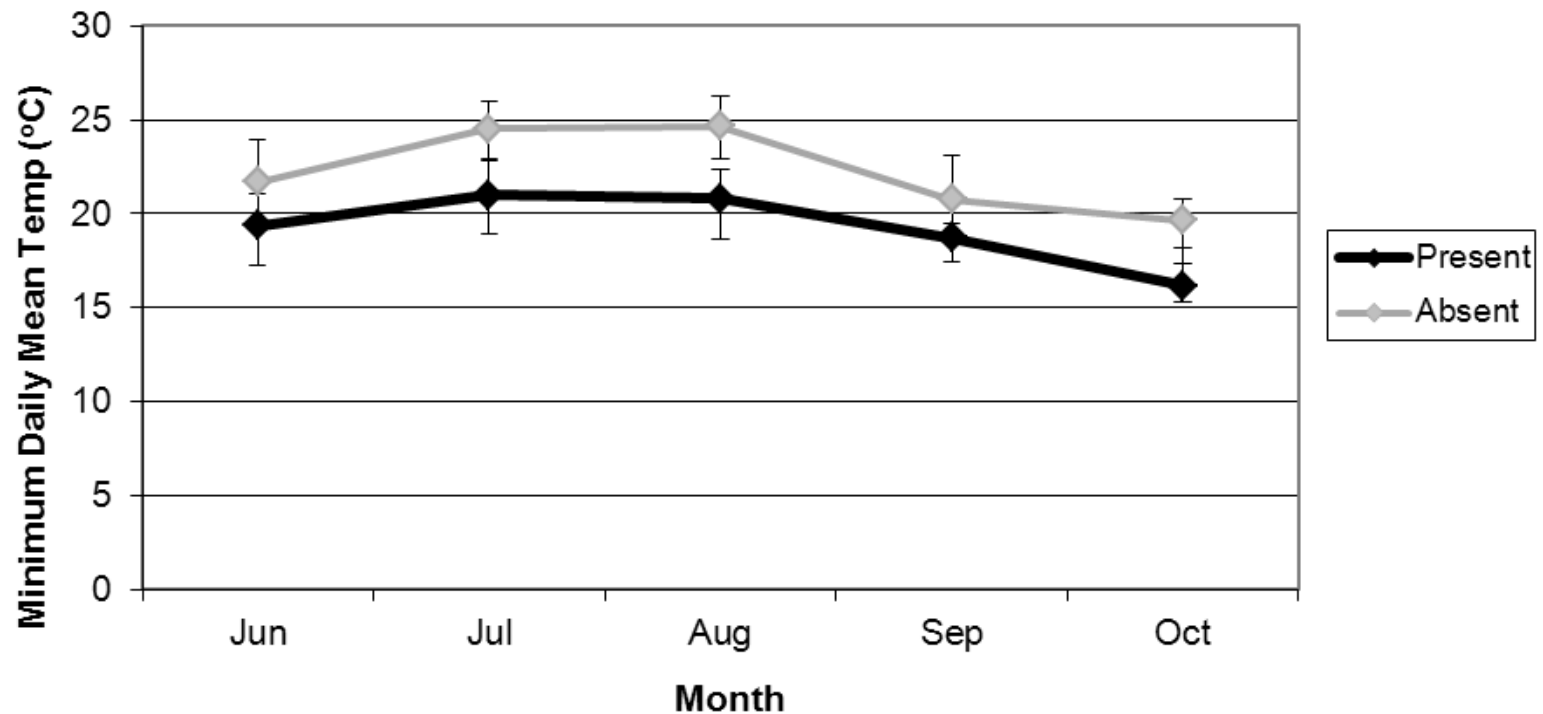
July median values were 18.7 and 21.6°C



Monthly Statistics

Warmest average daily stream temperature

July, the warmest month, had 25% of the streams exceeding temperatures of 22.9°C for one day.

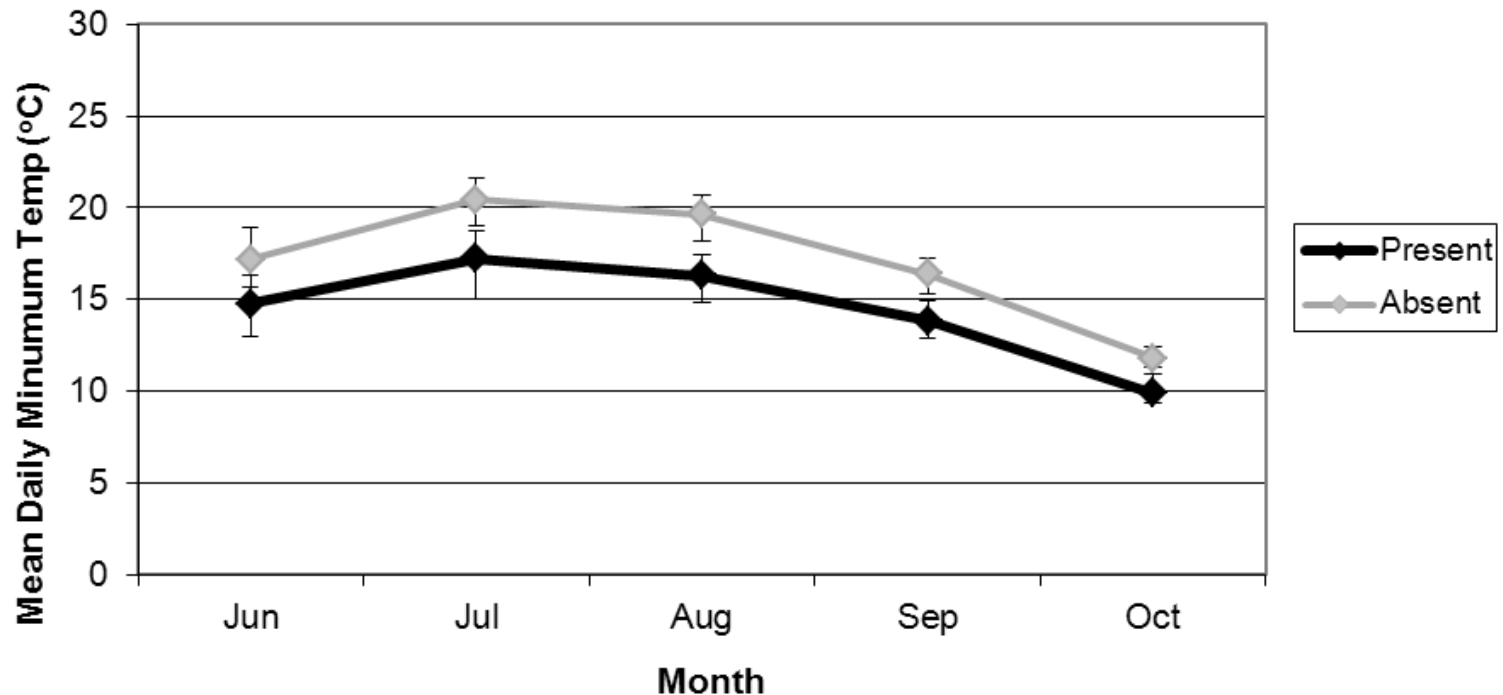


Monthly Statistics

Typical daily minimum stream temperature

CW cooled 17.2 and 16.3°C in July and August.

WW lows only 20.4 and 19.6°C in July and August

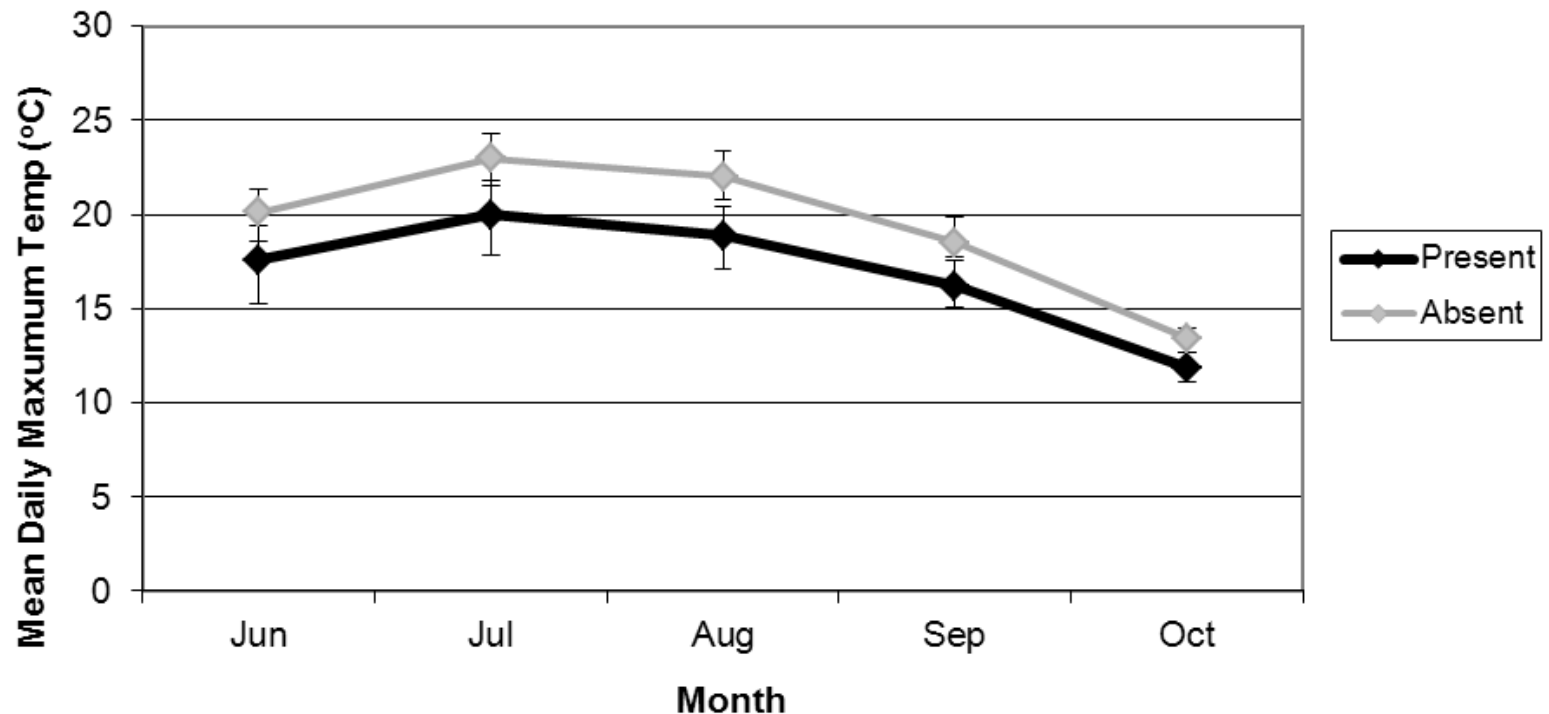


Monthly Statistics

Typical daily maximum stream temperature

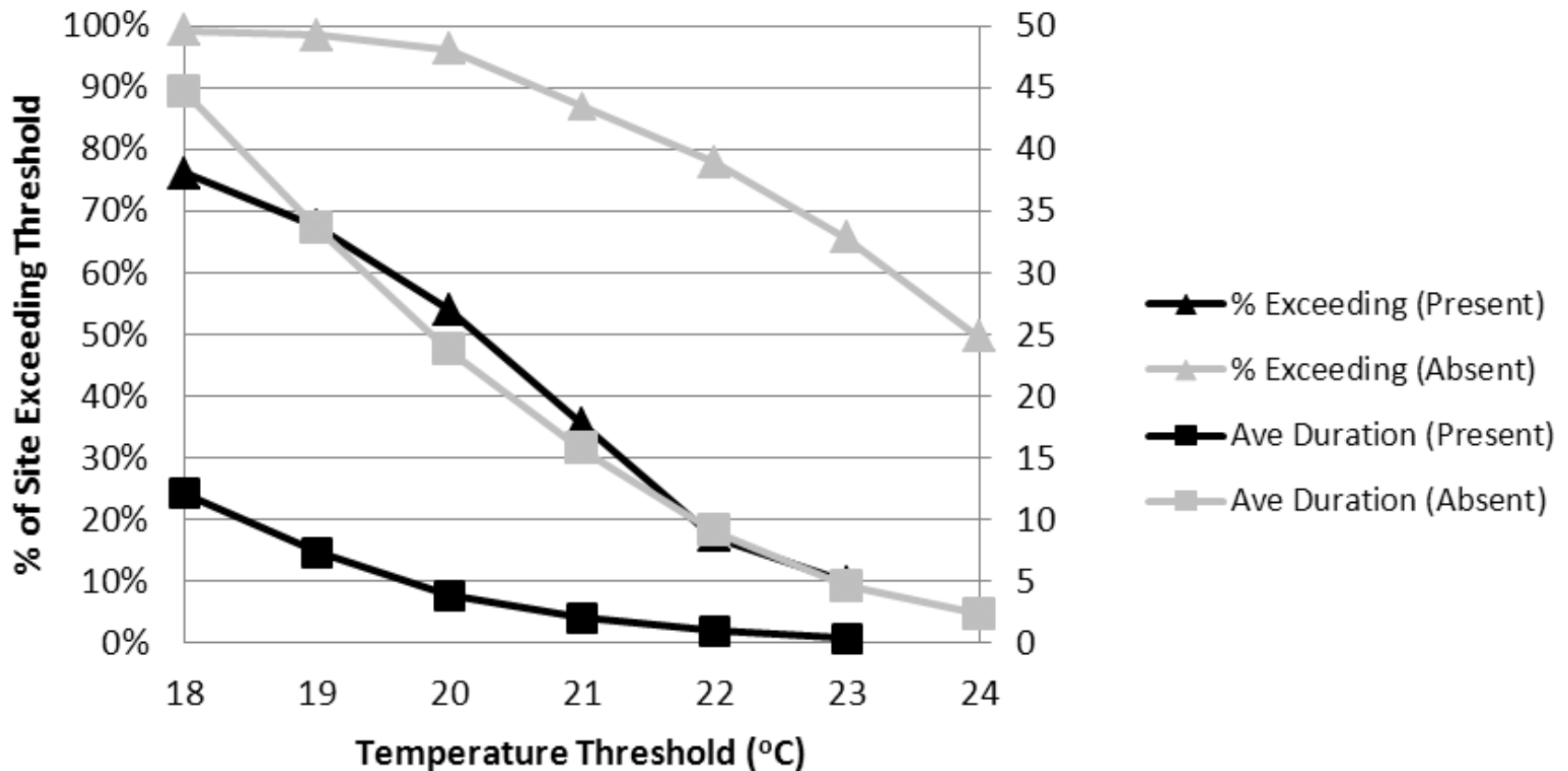
CW warmed to 20.0 and 18.9°C in July and August.

WW highs were 23.0 and 22.0°C in July and August



Other Statistics

Thresholds – magnitude and duration temperature

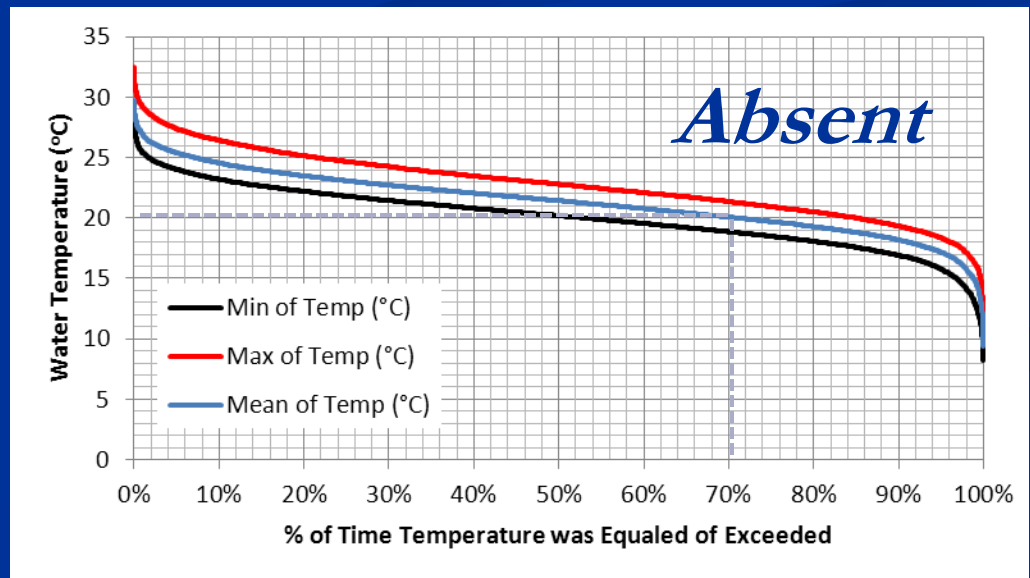
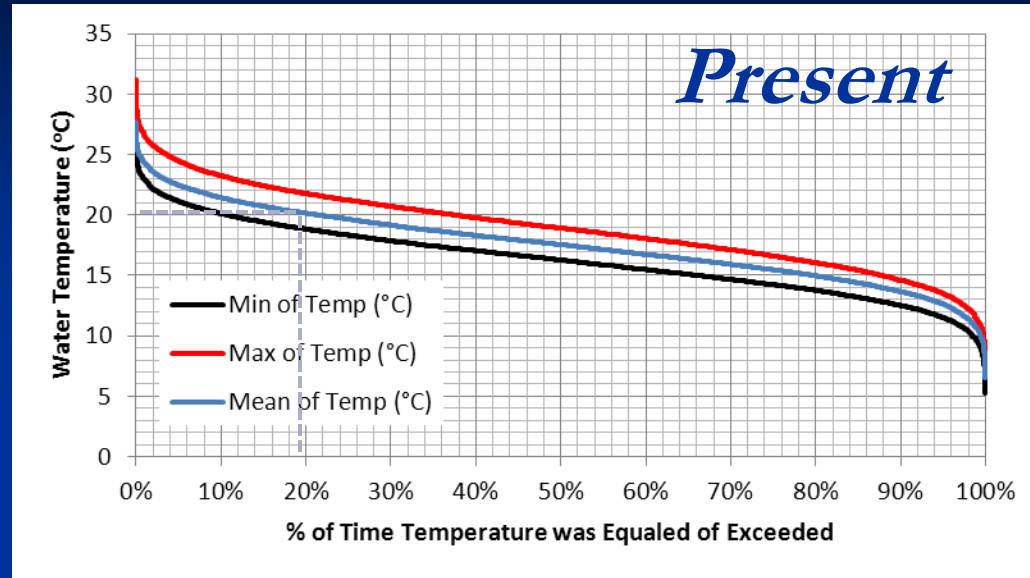


Other Statistics

Temperature duration curves

Rank order the temps from warmest to coolest for all summer days across sites.

Assign an exceedance probability to each observation



3. Can Temp Obs. Predict Coldwater Fish?

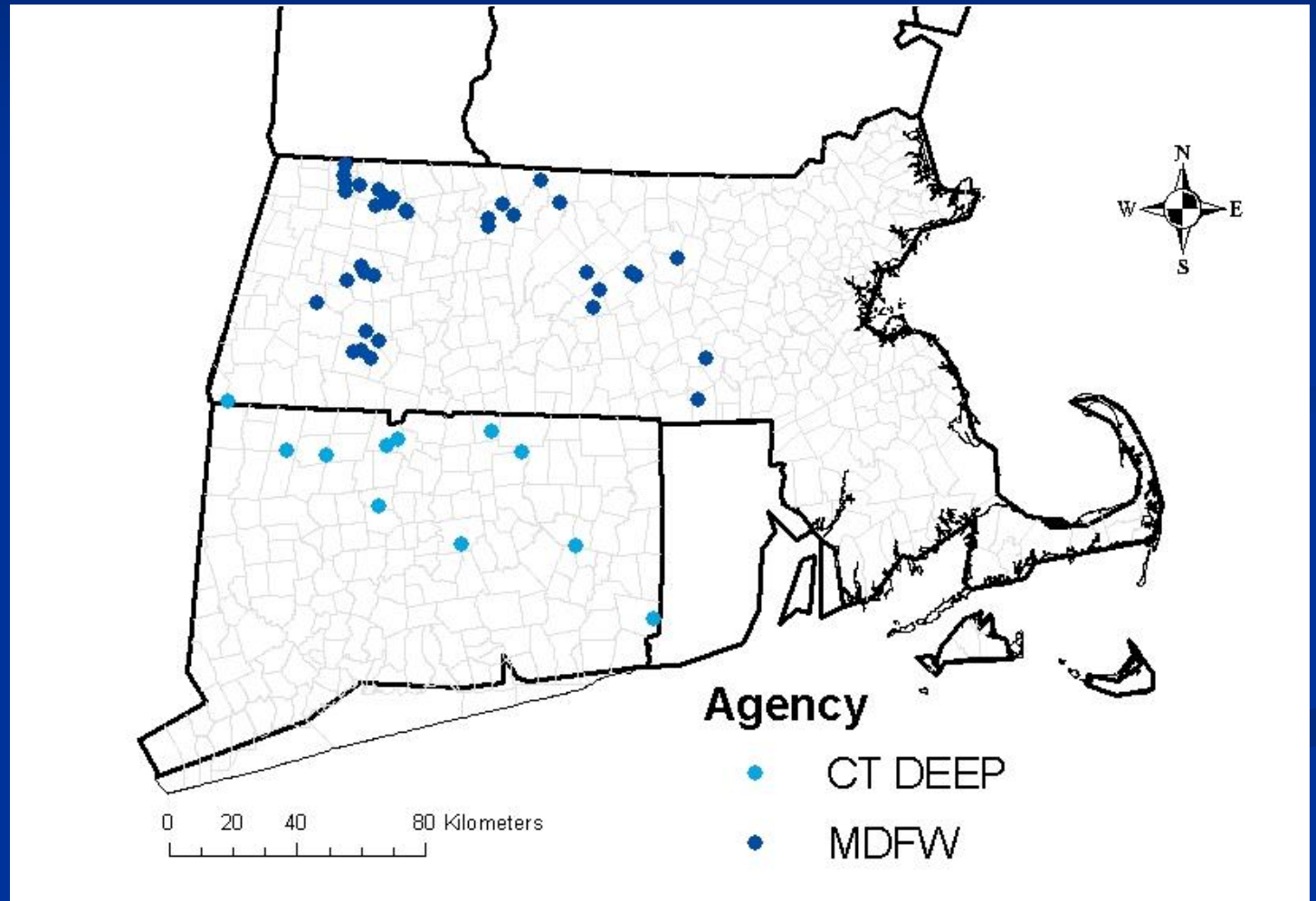
Metric 1: Lyons et al. Classification (Michig & Wisc)

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

Target Coldwater Streams

MDFW: N = 27; two year, year round dataset

CT DEEP: N = 10; multiple years, May to Aug



Site ID	Count	June – August Mean (° C)	July Mean (°C)	Maximum Daily Mean (°C)
Lyons Criteria		< 17.0	< 17.5	< 20.7
MA Bron55	133	15.7	16.8	19.6
MA Cold55	197	15.3	16.3	19.6
MA Dunb55	111	14.7	14.8	19.8
MA Fife55	203	13.0	13.6	17.4
MA Firs55	118	16.1	16.2	20.2
MA Gibb55	126	15.6	16.3	19.7
MA Kear55	225	15.1	15.6	19.9
MA Maxw55	69	14.6	15.7	18.8
MA UntM55	224	16.2	17.0	20.3
MA HogH55	210	16.4	17.4	21.7
MA Stag55	218	16.1	16.8	21.1
MA Tiff55	126	16.1	17.3	20.8
MA Clak55	110	16.6	18.1	22.0
MA Gulf55	226	16.8	18.0	21.4
MA Roar55	218	16.8	17.6	21.7
MA Whet55	224	17.0	17.8	21.5
MA Cobb55	197	19.9	21.7	25.9
MA Coll55	226	18.5	19.6	23.9
MA Lyon55	224	20.4	22.3	26.0
MA Mayn55	197	19.5	21.0	24.9
MA Park55	197	19.2	20.8	23.9
MA Pleas55	197	19.1	20.3	23.5
MA Roar60	225	19.2	20.6	24.5
MA SWac55	184	17.3	18.6	22.1
MA Towe55	126	17.4	18.9	21.8
MA Warr55	197	17.6	18.7	23.2
MA Weke55	105	19.2	20.9	23.6
MA Upper Quartile		18.8	20.0	23.5
CT 1440	92	15.5	16.4	18.0

Site ID	Count	June – August Mean (° C)	July Mean (°C)	Maximum Daily Mean (°C)
Lyons Criteria		< 17.0	< 17.5	< 20.7
MA Upper Quartile		18.8	20.0	23.5
CT_1440	92	15.5	16.4	18.0
CT_1456	92	16.2	17.2	19.6
CT_1916	92	14.5	15.0	16.7
CT_717	92	17.4	18.8	20.7
CT_1083	92	19.2	20.7	22.8
CT_2394	92	17.7	19.0	20.9
CT_2515	92	18.2	19.6	21.2
CT_359	92	19.1	20.5	22.3
CT_480	92	19.2	20.6	23.0
CT_606	92	19.3	20.7	22.3
CT Upper Quartile		19.2	20.6	22.3
Combined CT and MA Upper Quartile		19.1	20.5	23.0
Combined CT and MA Upper 90 %		19.3	20.9	24.6
MA Coll55	226	18.5	19.6	23.9
MA Lyon55	224	20.4	22.3	26.0
MA Mayn55	197	19.5	21.0	24.9
MA Park55	197	19.2	20.8	23.9
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MI and WI versus MA and CT Criteria

Class and Subclass	June – Aug Mean (° C)	July Mean (°C)	Max. Daily Mean (°C)
Lyons Cold Water	< 17.0	< 17.5	< 20.7
Lyons Warm Water	< 20.5	< 21	< 24.6
CT & MA Target Coldwater 75%	< 19.1	< 20.5	< 23.0
CT & MA Target Coldwater 90%	< 19.3	< 20.9	<24.6

2/3. Temperature Regime

Conclusion

- A number of metrics provide good separation between streams supporting coldwater species and those not supporting cold water species.
- August values appear to provide better separation than July value
- A suite of nonredundant metrics has the potential to effectively differentiate streams.
- Metrics should be developed using local data.
- There is a need to differentiate cold from cool water streams.

4. Habitat and Stream Temperature

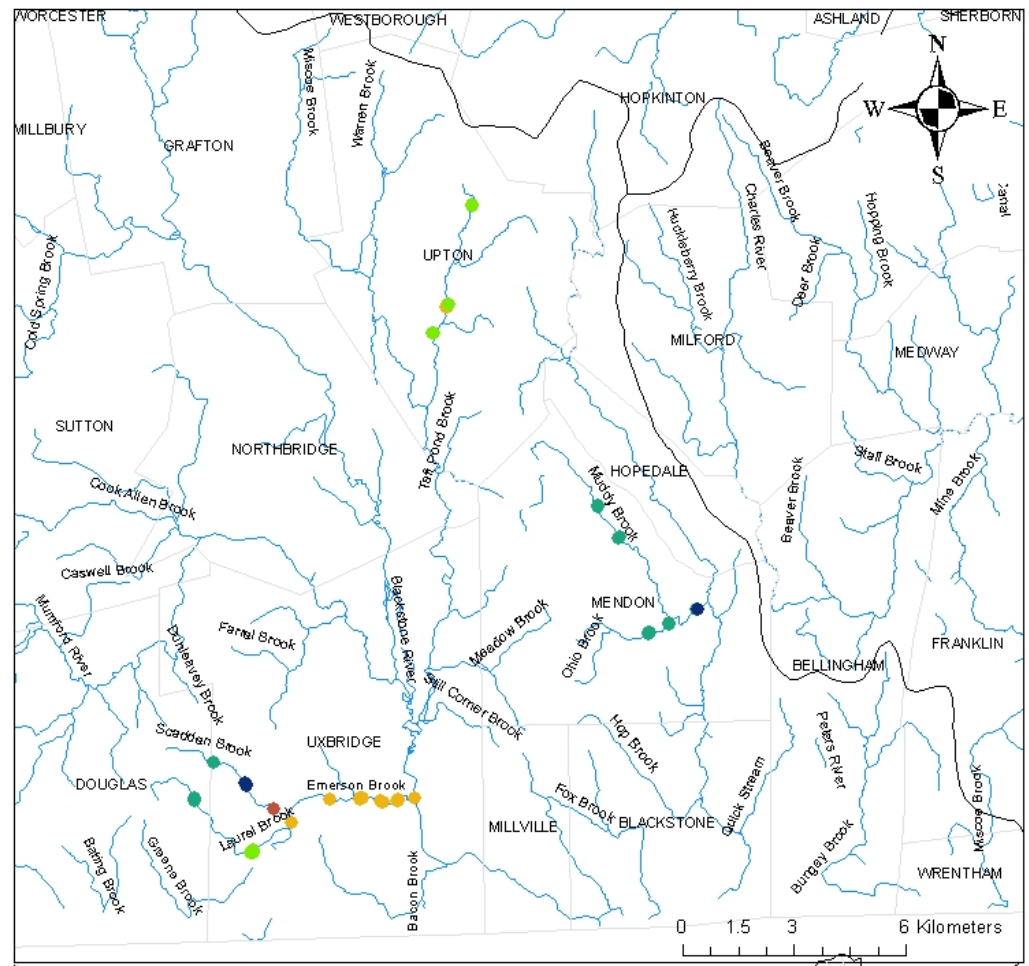
- Is there a statistically significant difference in the temperature observations in pools, riffles and runs?
- Is there a statistically significant difference in the annual and monthly temperature statistics calculated for a stream segment when determined from samples collected in pools, riffles or runs?

Study Overview : Temperature Sampling

- Blackstone Watershed
- 7/08 to 10/09
- 30 minute samples aggregated to daily mean
- 20 reaches
- 15 segments with riffles, pools, and runs

Methods:

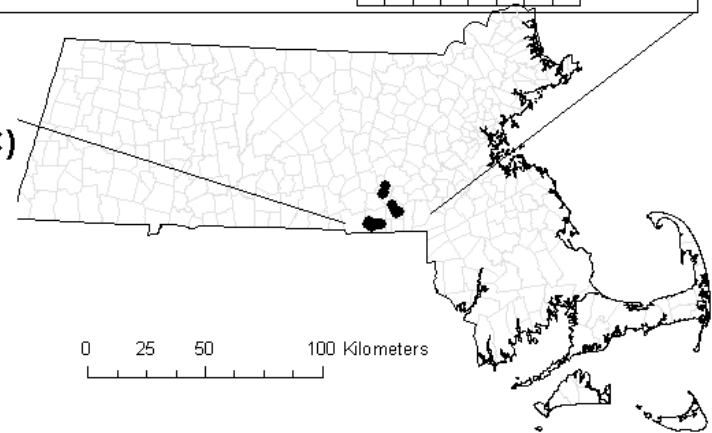
- ANOVA F-test on population means
- Tukey's HSD on individual pairs



Study Sites

July Mean Temp (°C)

- < 17.0
- 17 - 18.5
- 18.5 - 20
- 20 - 22
- >22



Is there a statistically significant difference in the temperature observations in pools, riffles and runs?

Table B.3.2. July and August daily mean temperature for each site and all sites combined by position in segment (pool, riffle, or run). All differences are significant at the $\alpha = 0.05$ level except those colored red.

Site	N	Mean Temperature (°C)			Temperature Difference (°C)		
		Pool	Riffle	Run	Riffle - Pool	Run - Pool	Run - Riff
Ce 03	86	19.85	19.87	19.80	0.02	-0.05	-0.07
Ce 06	86	20.30	20.22	20.28	-0.08	-0.02	0.06
Em 01	92	22.48	22.49	22.47	0.01	-0.01	-0.03
Em 02	92	21.08	21.13	21.09	0.05	0.02	-0.03
Em 03	93	20.88	20.74	20.89	-0.13	0.01	0.15
Em 04	92	20.63	20.64	20.63	0.01	0.00	-0.01
La 01	94	18.24	18.25	17.98	0.01	-0.26	-0.26
La 02	94	18.90	18.63	19.05	-0.27	0.14	0.42
Mu 01	92	18.11	18.28	18.13	0.17	0.02	-0.15
Mu 02	87	17.78	17.69	17.78	-0.09	0.00	0.10
Mu 03	91	17.61	17.55	17.43	-0.05	-0.18	-0.13
Sc 01	95	17.76	17.73	17.74	-0.03	-0.02	0.02
Sc 02	95	17.01	17.55	17.55	0.54	0.54	-0.01
Sp 01	86	18.16	18.36	18.34	0.19	0.17	-0.02
Sp 02	91	16.56	18.25	18.10	1.69	1.54	-0.15
All Sites	1366	19.02	19.15	19.15	0.14	0.13	-0.01

HOBO Water Temp Pro instruments have an accuracy of $\pm 0.21^\circ$ C from 0° to 50° C and a resolution of 0.02° C at 25° C.

There are only two sites where the summer stream water temperatures monitored at the riffle exceeds that at the pool by more than 0.5° C.

Is there a statistically significant difference in the annual and monthly temperature statistics calculated for a stream segment when determined from samples collected in pools, riffles or runs?

Position	Number	Mean	Std Error	Lower 95%	Upper 95%
Temperature Mean					
Pool	6016	11.56	0.089	11.39	11.74
Riffle	6031	11.54	0.089	11.37	11.72
Run	6004	11.61	0.089	11.44	11.79
Temperature Range					
Pool	6016	2.05	0.017	2.01	2.08
Riffle	6031	2.14	0.017	2.11	2.17
Run	6004	2.12	0.017	2.08	2.15

- Annual Basis: No overall difference in the mean, minimum, or maximum stream temperature by stream position
- Monthly Basis: No overall difference in the mean, minimum, or maximum stream temperature by stream position for any month.
- Monthly Basis: Daily temperature **ranges** were smaller in pools than riffles in August, September, October, and November.
- Monthly Basis by Segment:
 - July - One segment had a cooler pool
 - August – Three segments had cooler pools

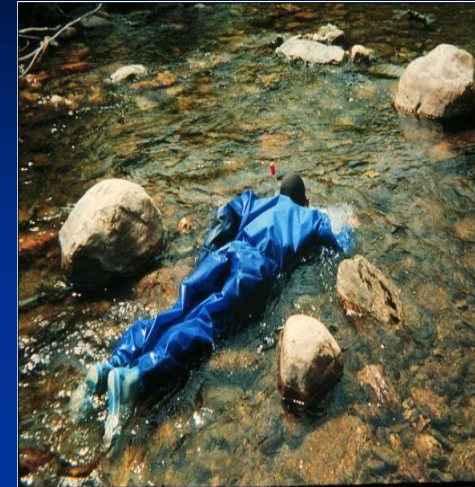
4. Habitat and Stream Temperature

- For the Blackstone River study streams, the position of sampling device within a randomly selected pool, riffle or run is unlikely to result in temperature differences in stream temperature daily mean, minimum, and maximum values for any summer month that exceed instrument accuracy.
- When differences occur, the pools will be likely be cooler than riffles or runs.
- These findings indicate that the variations along a reach on any given day are relatively small compared to day-to-day temperature difference, which impact the entire reach.

Final Reflections

Questions?
Closer Look?

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Project Title
Temperature Regime Characteristics of High-Quality Coldwater Streams in New England

Project Results:
Stream Temperature Database

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Connecticut Department of Energy and Environmental Protection
Hartford, CT 06106-5127

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Temperature Regime Characteristics of High-Quality Coldwater Streams in New England

MA Division of Fish and Wildlife
Temperature Characteristics of High Quality Coldwater Streams

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MA Division of Fish and Wildlife
Habitat and Stream Temperature

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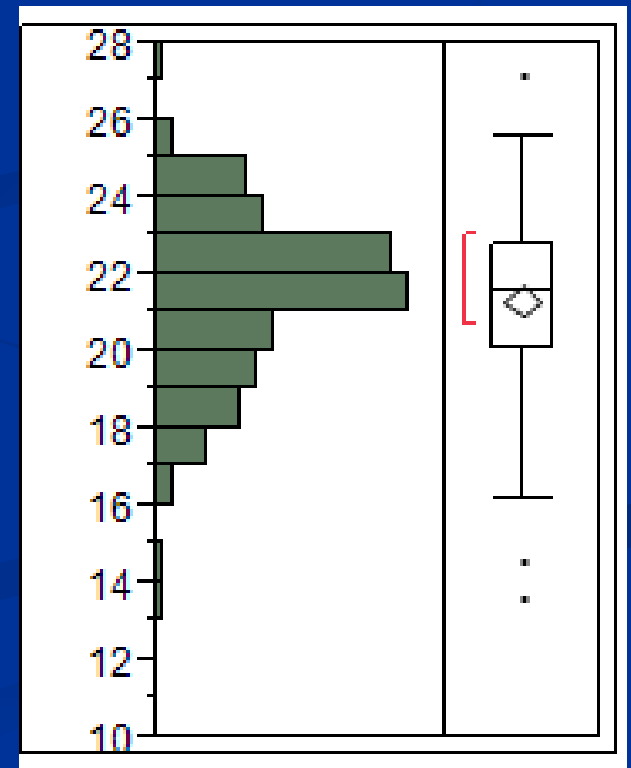
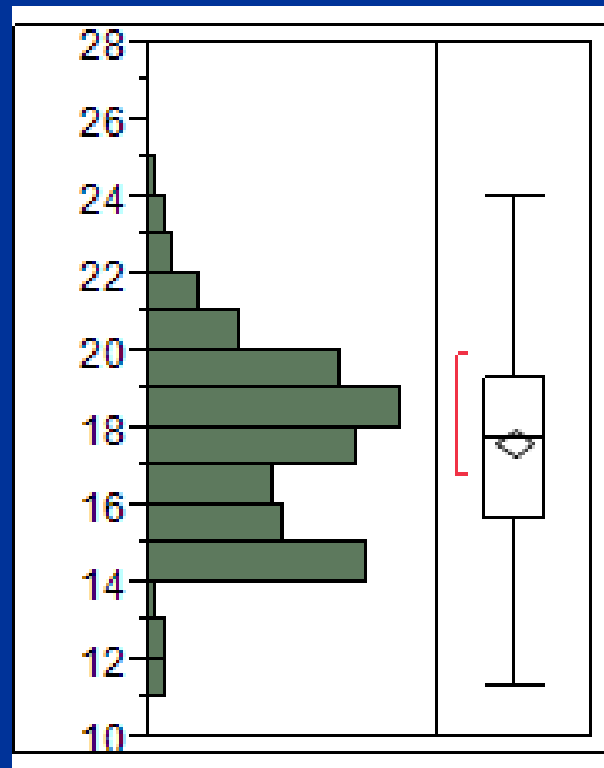
December 2013

Other Statistics

Maximum 7-day average

50 and 75% of CW streams were 17.8 and 19.3°C

50 and 75% of WW streams were 21.5 and 22.8°C, respectively



Michigan and Wisconsin (Lyons et al.)

Class and Subclass	June – Aug Mean	July Mean	Max. Daily Mean
Lyons Cold Water	< 17.0	< 17.5	< 20.7
Present (All Criteria 28%)	44%	37%	39%
Absent (All Criteria 0%)	0%	0%	1%
CT & MA Target Coldwater 75%	< 19.1	< 20.5	< 23.0
Present (All Criteria 64%)	77%	79%	74%
Absent (All Criteria 10%)	15%	28%	18%
CT & MA Target Coldwater 90%	< 19.3	< 20.9	<24.6
Present (All Criteria 79%)	83%	88%	91%
Absent (All Criteria 15%)	17%	36%	43%