Road Salt Impacts on Drinking Water in the Wachusett Watershed

dcr Massachusetts

Jamie Carr, Environmental Analyst, DCR Division of Water Supply Protection, Wachusett Section

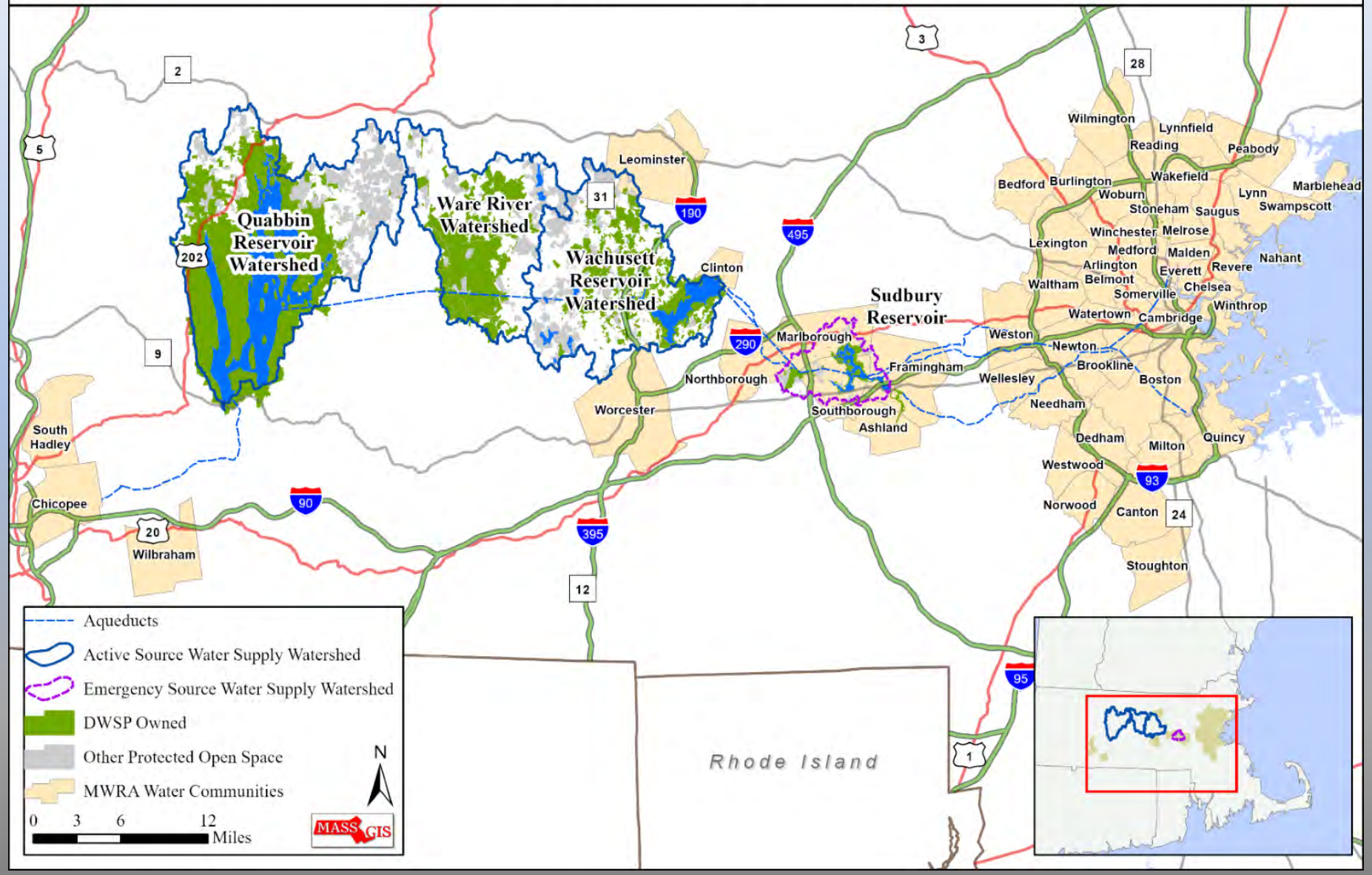
PRESENTATION OUTLINE

- **Watershed overview**
- **Recent water quality trends**
- **What problems does salt cause?**
- **Expanding DCR research: how do we protect water quality?**

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
Department of Conservation & Recreation

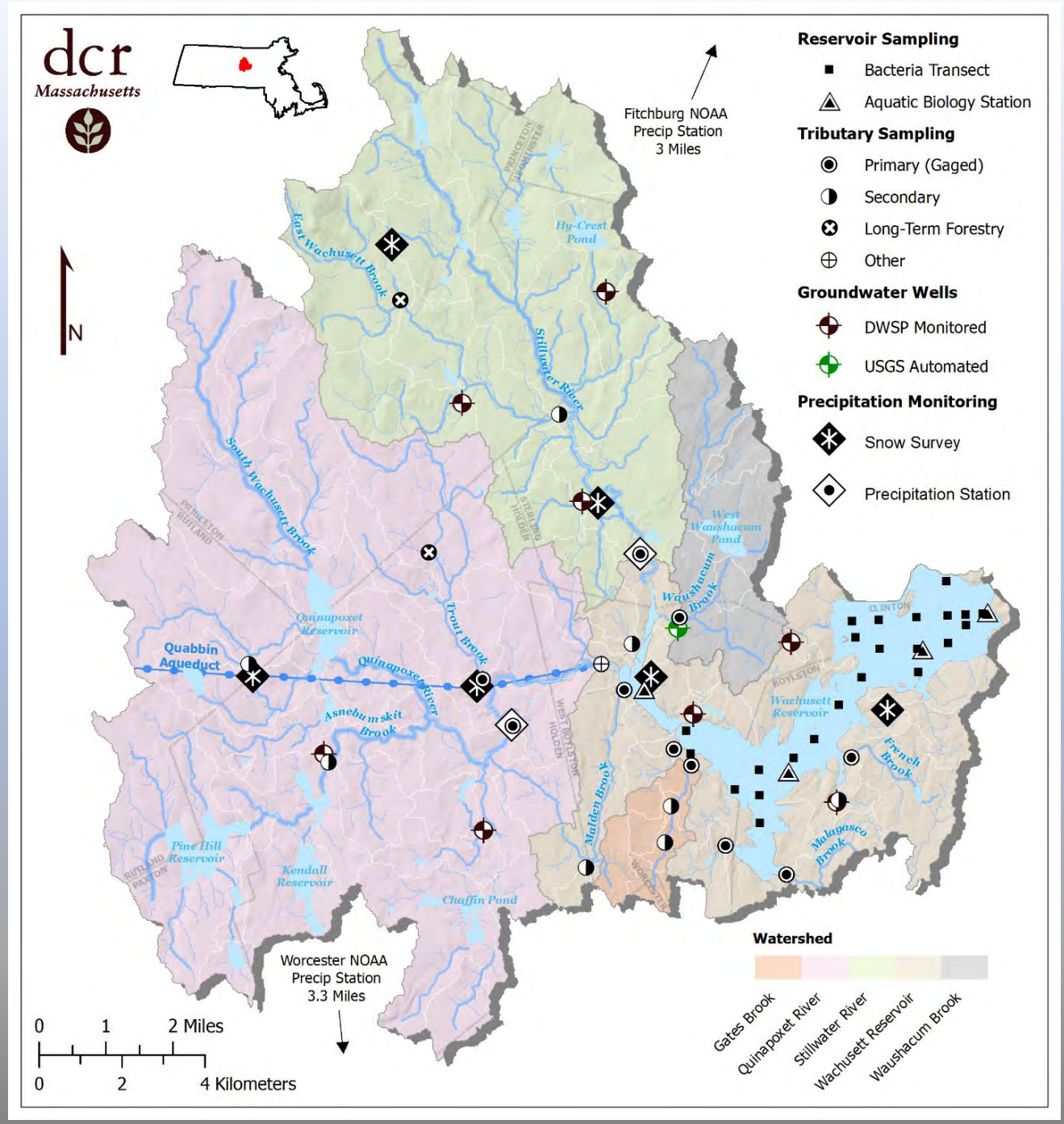
General Plan of the DCR/MWRA Watershed System

Division of Water Supply Protection - Office of Watershed Management



Map of the Wachusett Reservoir watershed with sampling stations

Environmental Analyst David Getman recording a specific conductivity measurement in a watershed tributary

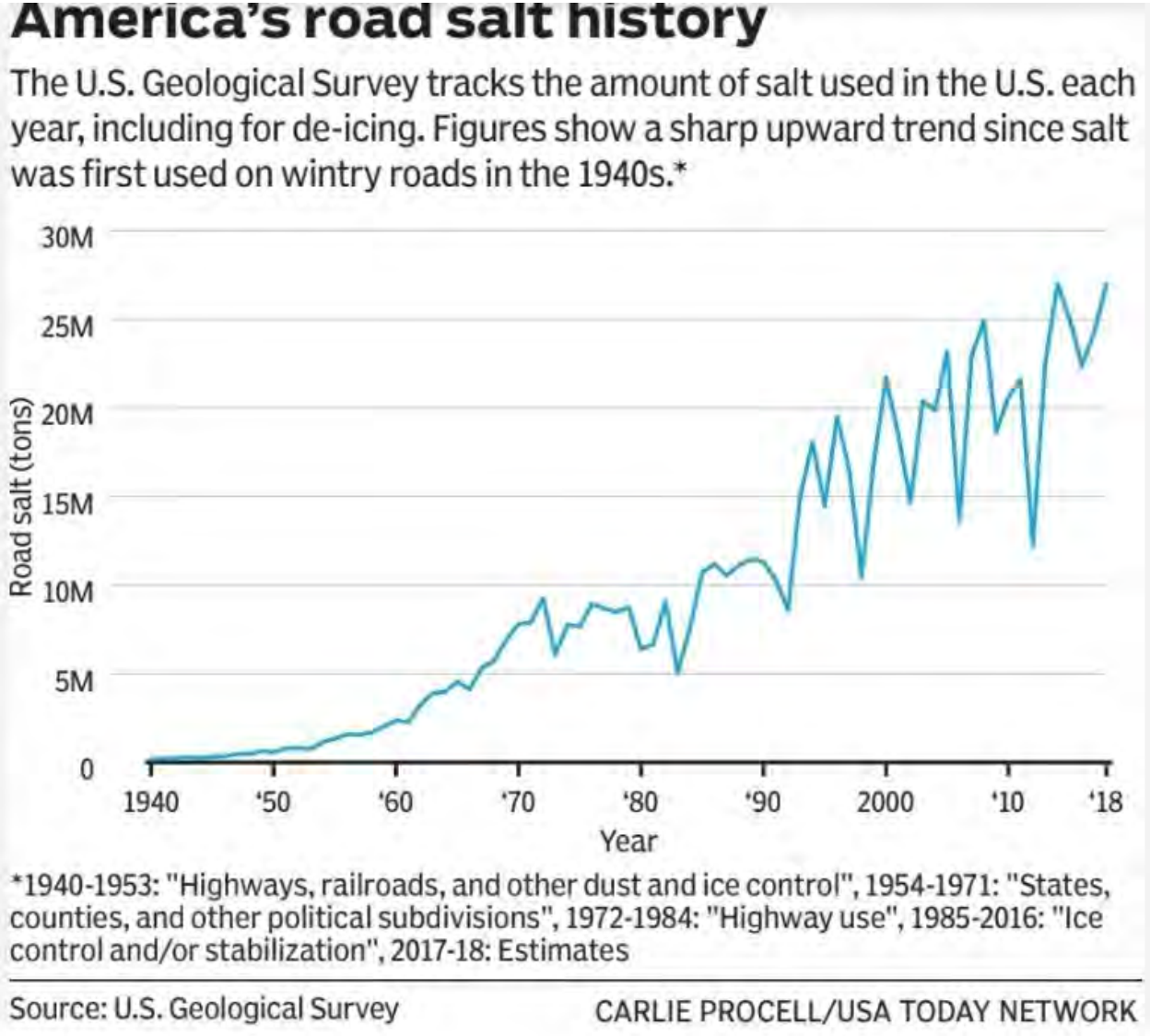


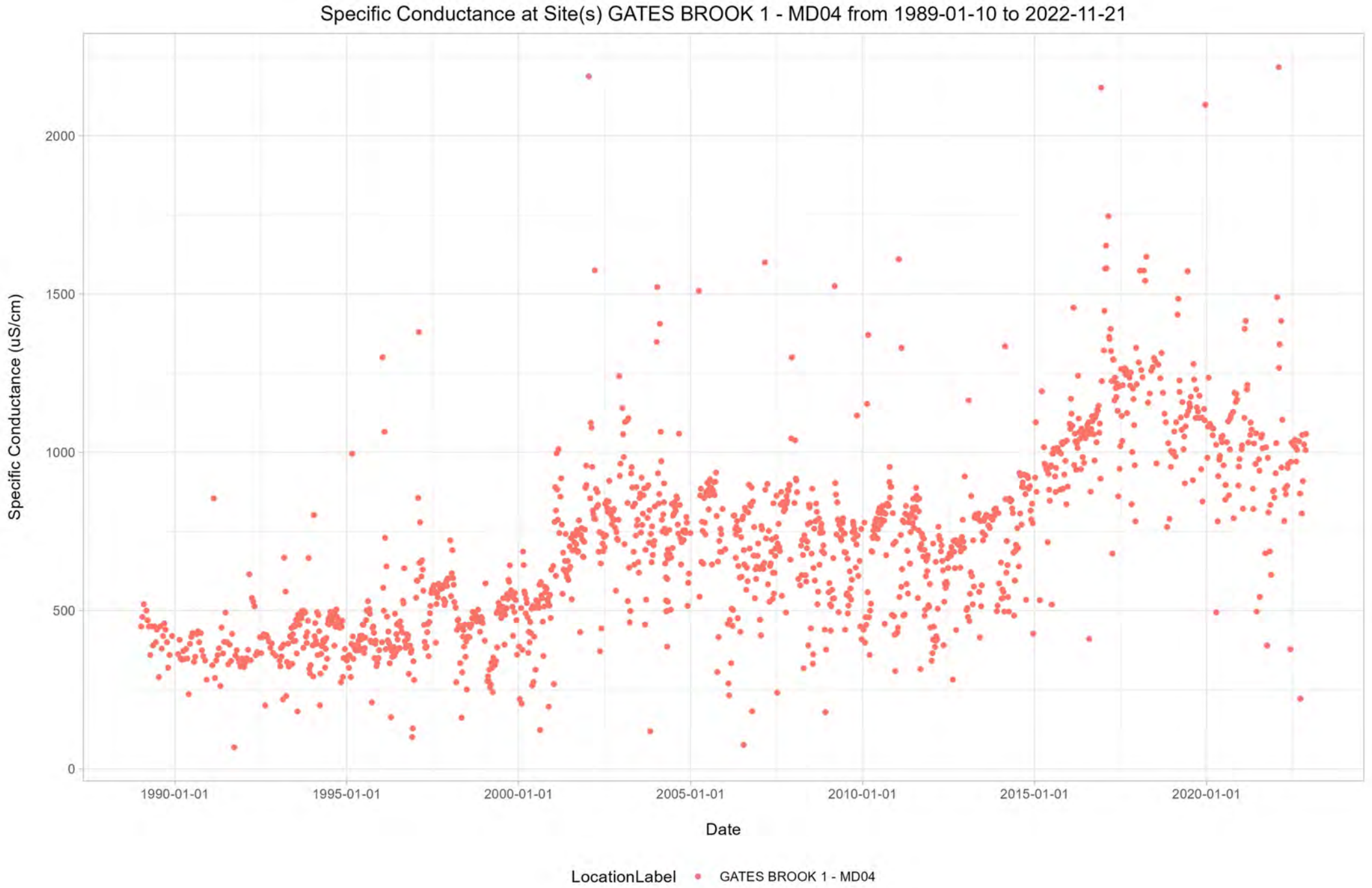
WHERE DOES THIS SALT COME FROM?

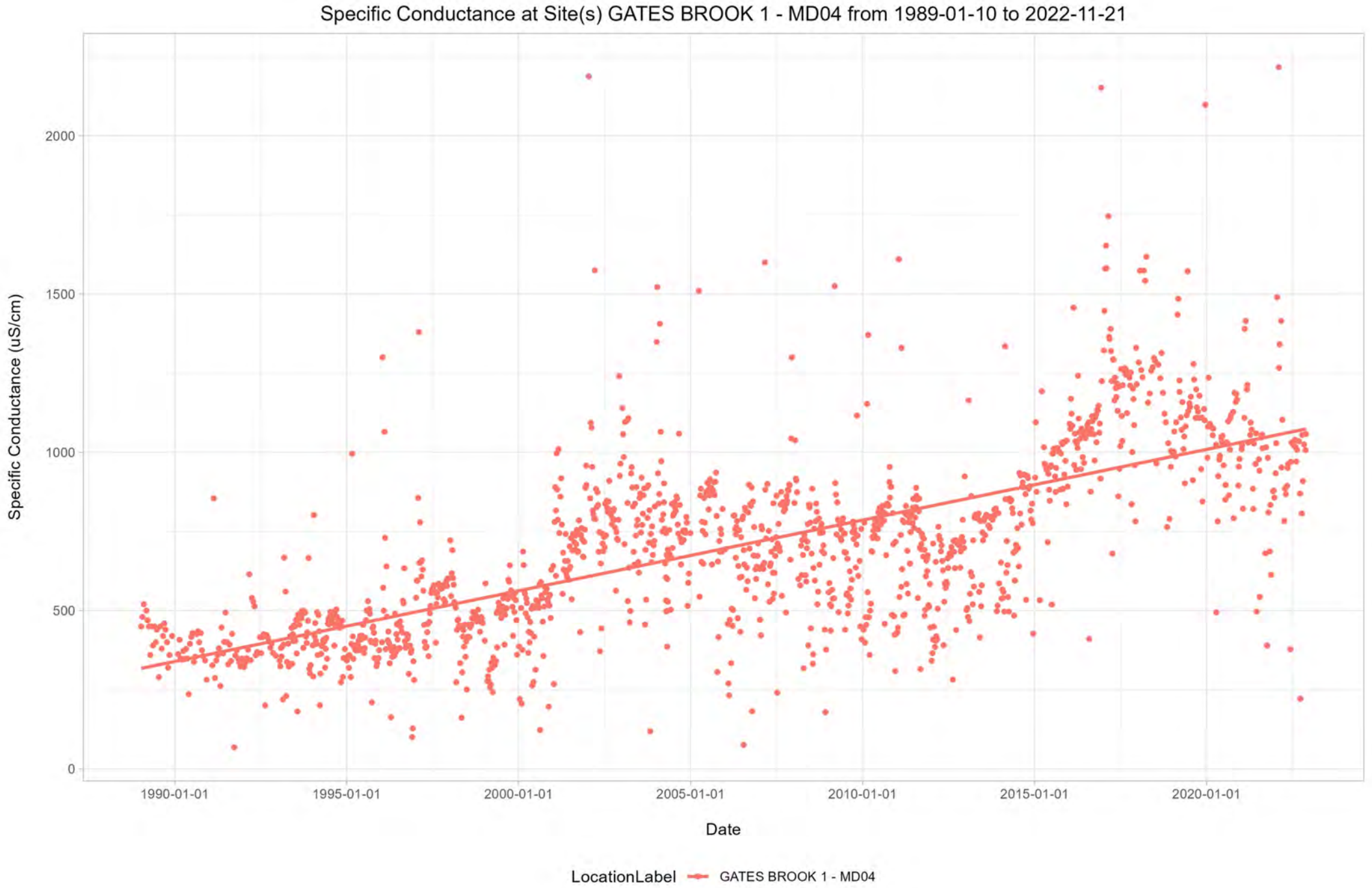
Multiple Sources:

- **Atmospheric Deposition**
- **Weathering of Soil and Rock**
- **Wastewater**
- **Agricultural Sources (Fertilizers, Animal Waste, and Irrigation)**
- **Landfills**
- **Deicing Chemicals**

WHERE DOES THIS SALT COME FROM?




Specific Conductance at Site(s) GATES BROOK 1 - MD04 from 1989-01-10 to 2022-11-21
Specific Conductance (uS/cm)
2000
1500
1000
500
0
1990-01-01
1995-01-01
2000-01-01
2005-01-01
2010-01-01
2015-01-01
2020-01-01
Date
LocationLabel
GATES BROOK 1 - MD04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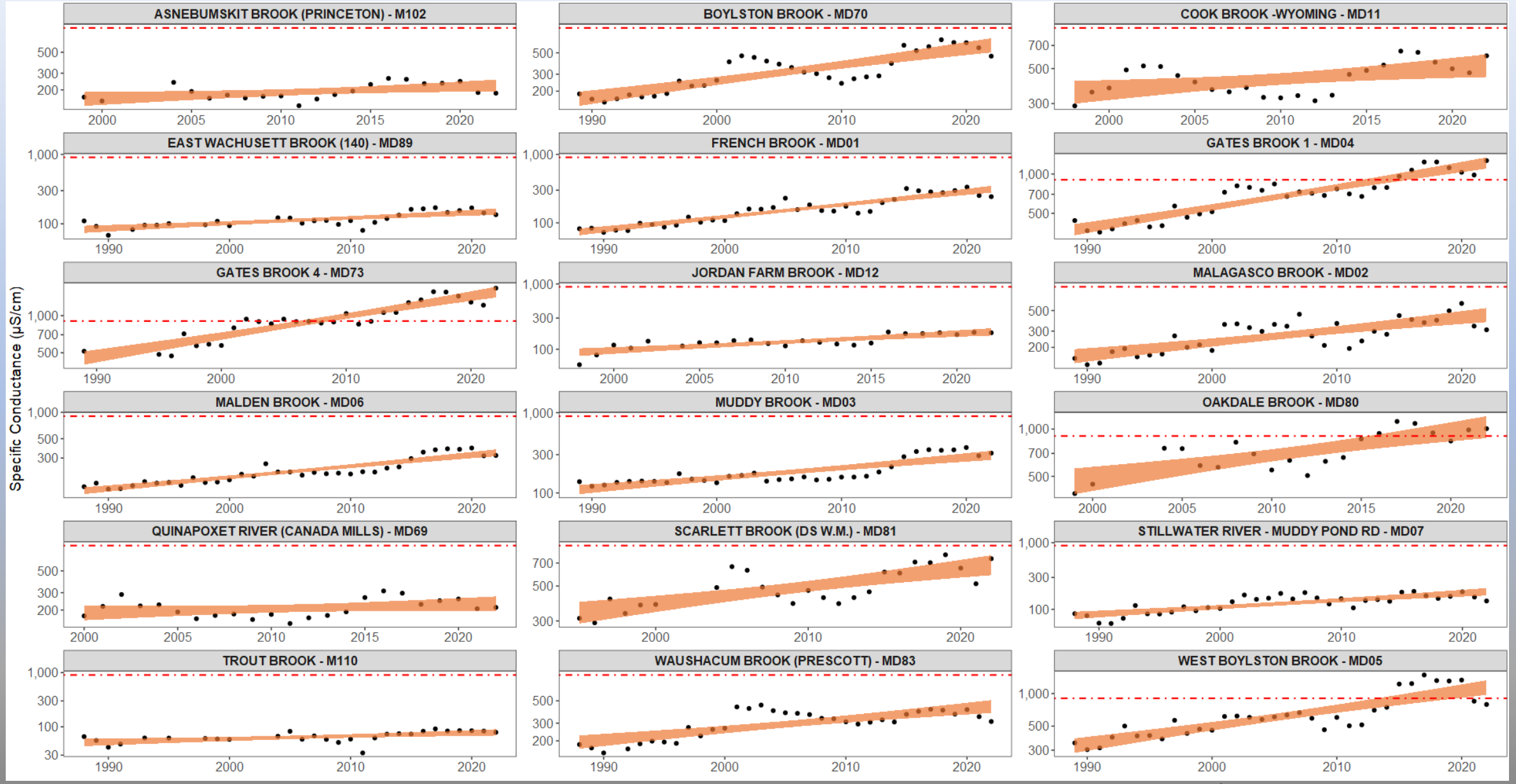
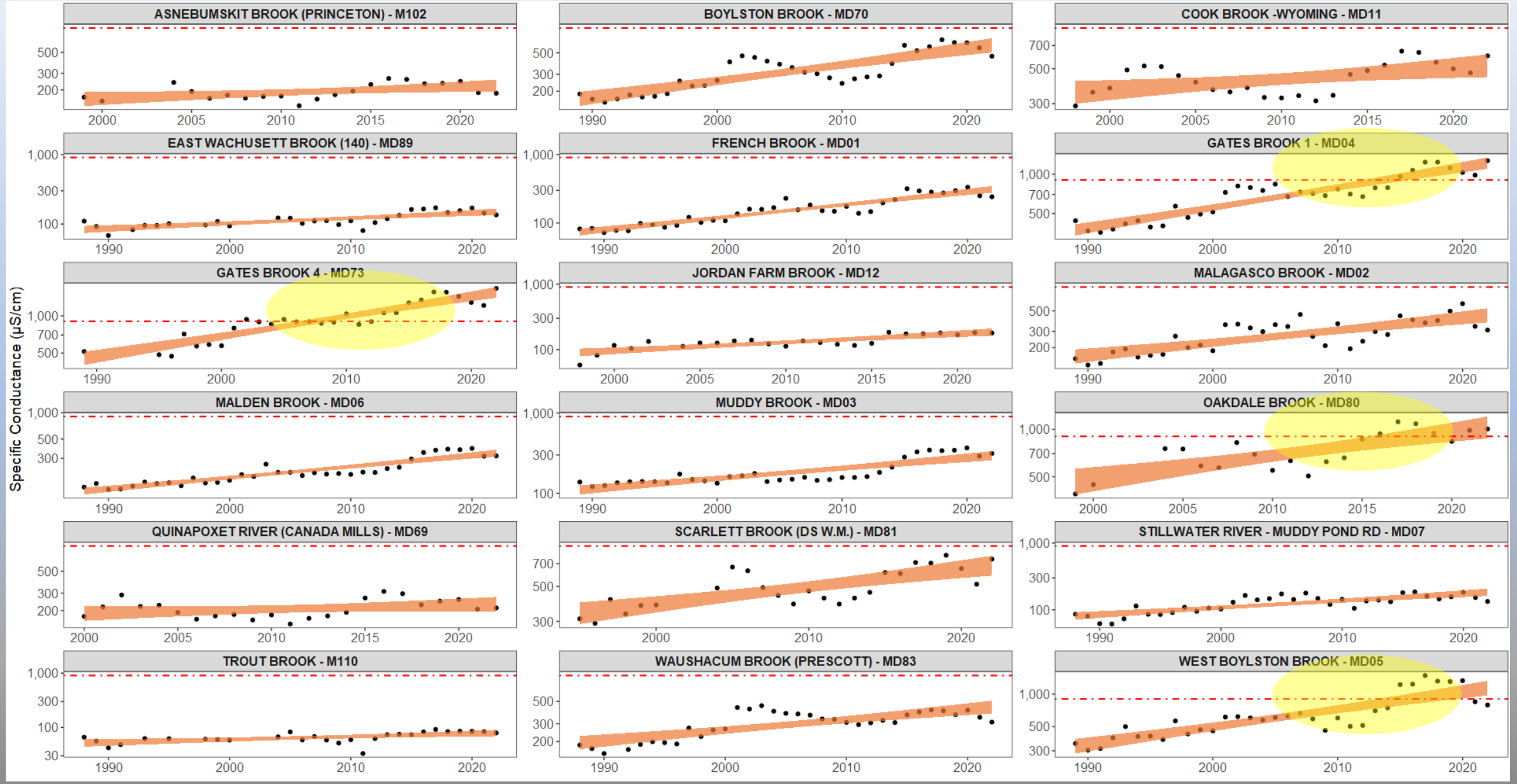
Specific Conductance (uS/cm)
2000
1500
1000
500
0
1990-01-01
1995-01-01
2000-01-01
2005-01-01
2010-01-01
2015-01-01
2020-01-01
Date
LocationLabel
GATES BROOK 1 - MD04

Annual Median Specific Conductance



The red dashed line is the MassDEP proxy chronic Cl toxicity threshold of 904 µS/cm.

Annual Median Specific Conductance



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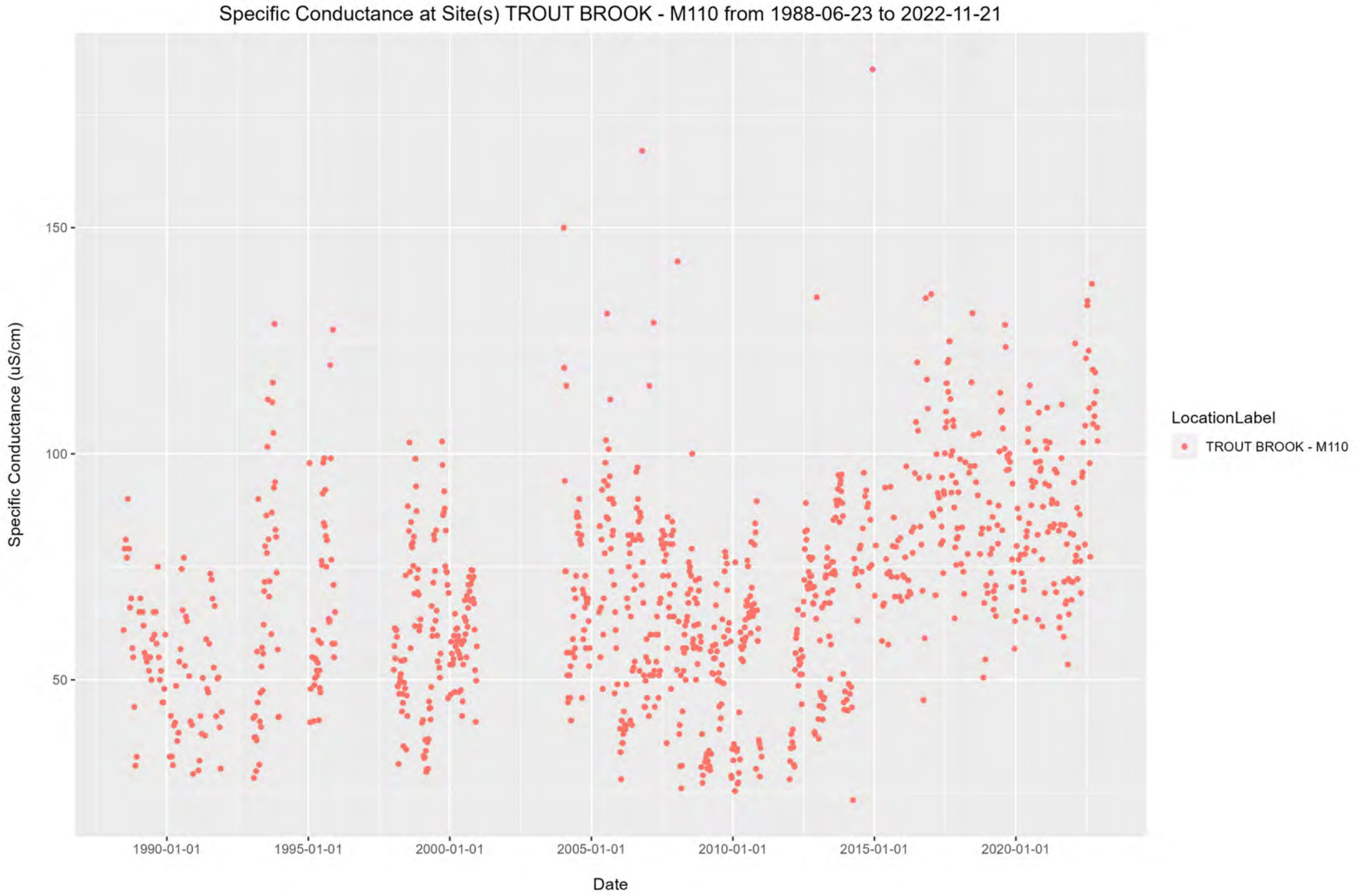
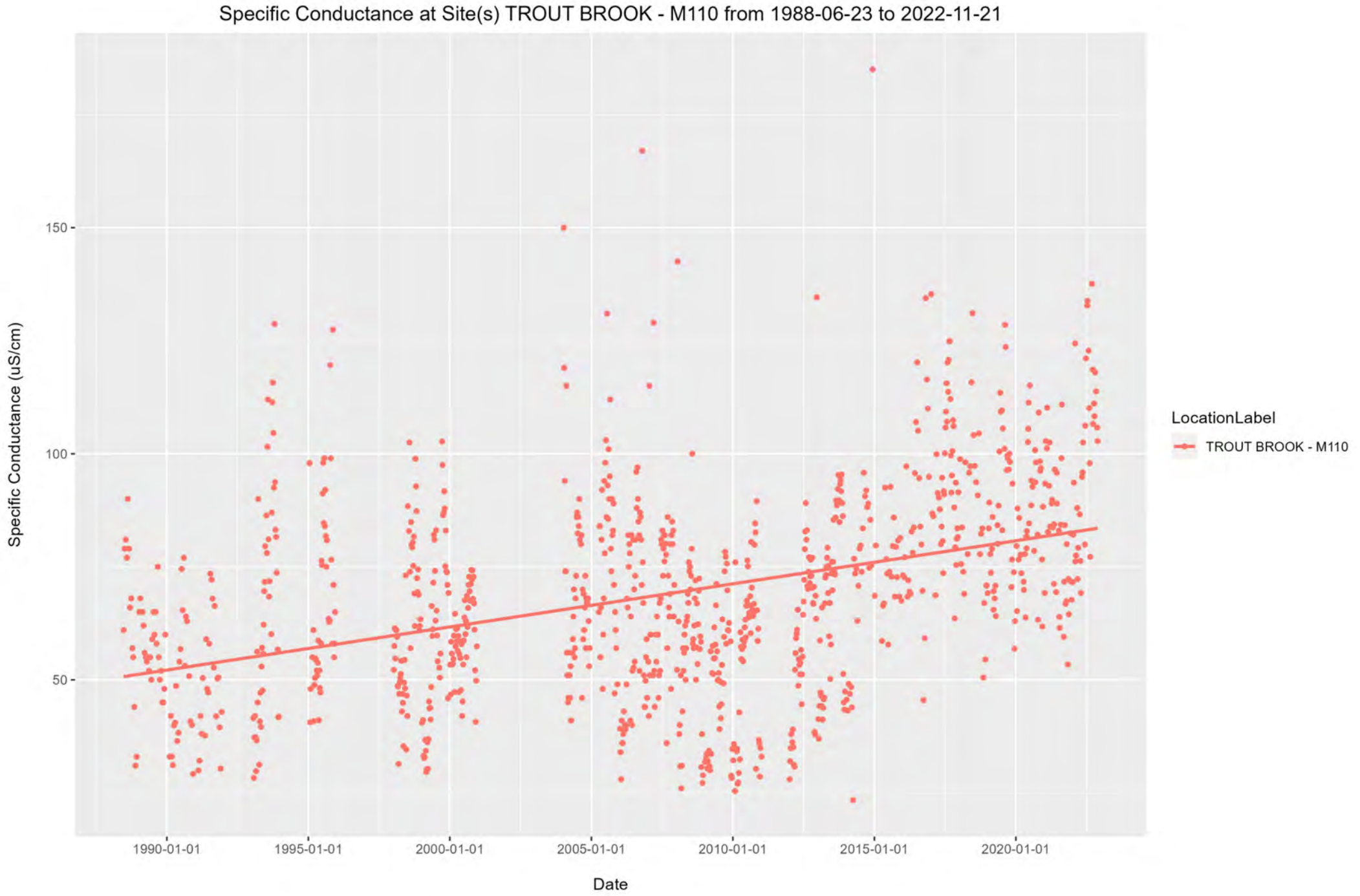
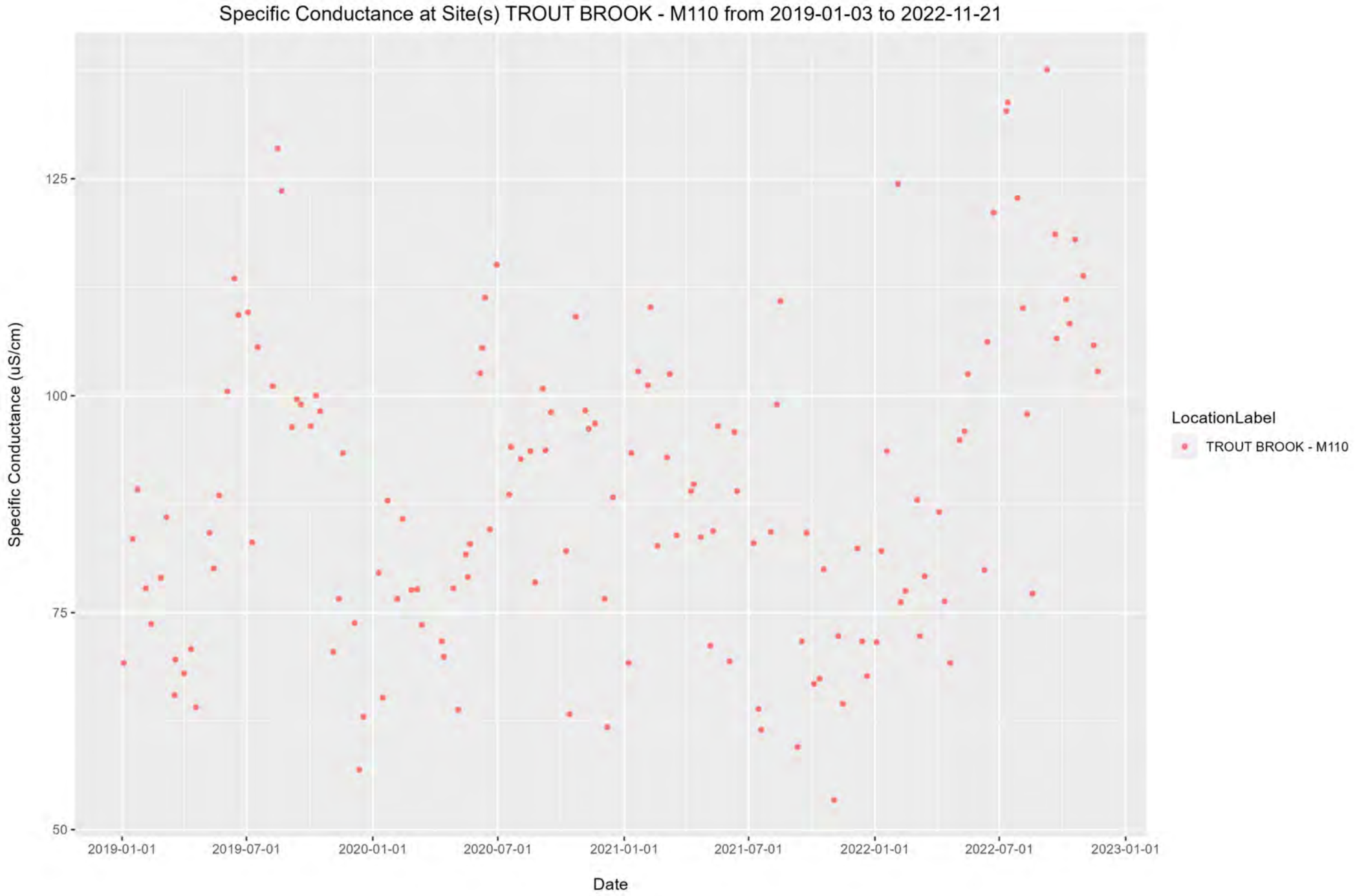
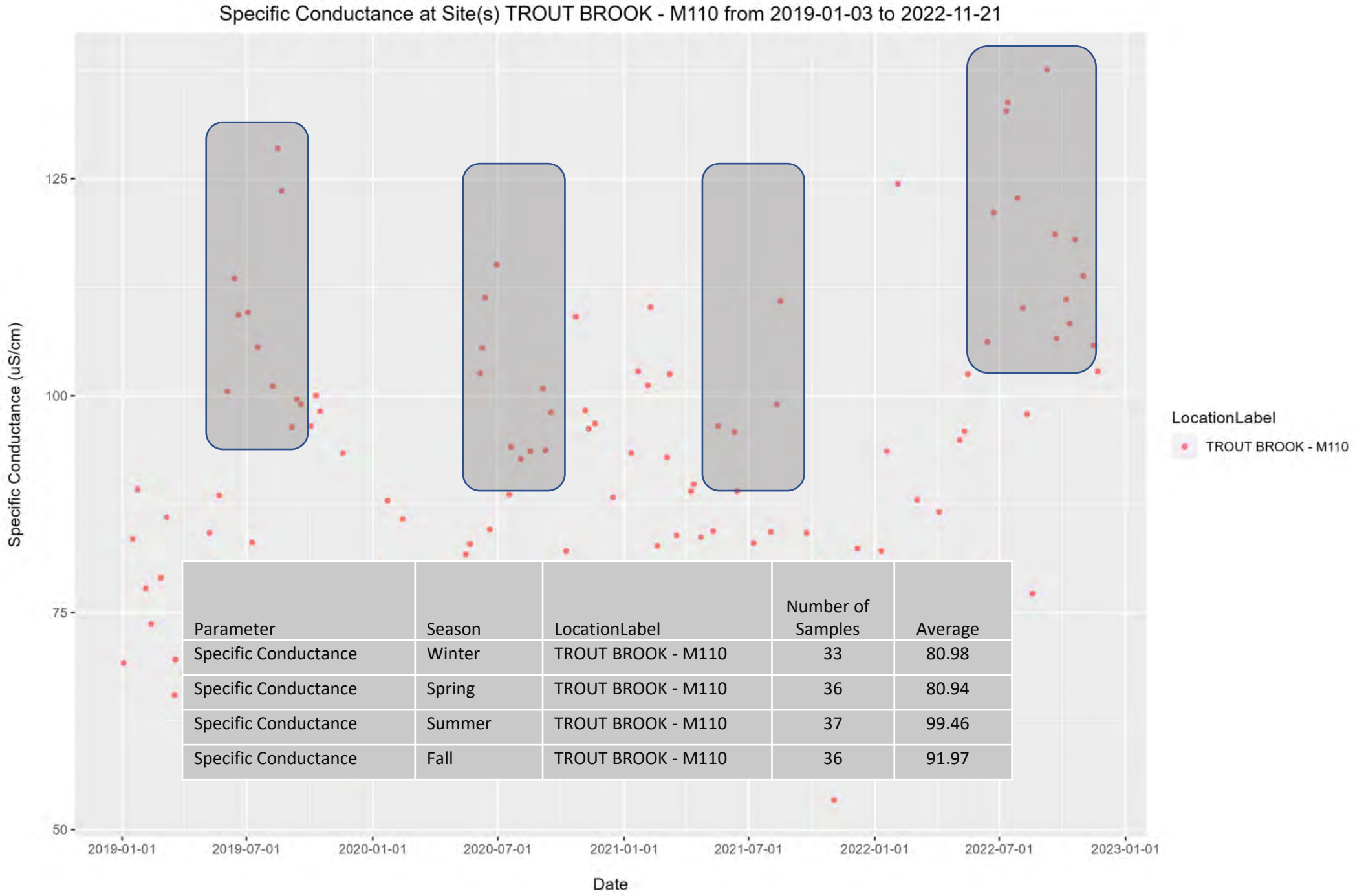

Specific Conductance at Site(s) TROUT BROOK - M110 from 1988-06-23 to 2022-11-21
Specific Conductance (uS/cm)
150
100
50
1990-01-01
1995-01-01
2000-01-01
2005-01-01
2010-01-01
2015-01-01
2020-01-01
Date
LocationLabel
TROUT BROOK - M110


Specific Conductance at Site(s) TROUT BROOK - M110 from 1988-06-23 to 2022-11-21
Specific Conductance (uS/cm)
150
100
50
1990-01-01
1995-01-01
2000-01-01
2005-01-01
2010-01-01
2015-01-01
2020-01-01
Date
LocationLabel
TROUT BROOK - M110


Specific Conductance at Site(s) TROUT BROOK - M110 from 2019-01-03 to 2022-11-21
Specific Conductance (uS/cm)
125
100
75
50
2019-01-01
2019-07-01
2020-01-01
2020-07-01
2021-01-01
2021-07-01
2022-01-01
2022-07-01
2023-01-01
Date
LocationLabel
TROUT BROOK - M110



Parameter	Season	LocationLabel	Number of Samples	Average
Specific Conductance	Winter	TROUT BROOK - M110	33	80.98
Specific Conductance	Spring	TROUT BROOK - M110	36	80.94
Specific Conductance	Summer	TROUT BROOK - M110	37	99.46
Specific Conductance	Fall	TROUT BROOK - M110	36	91.97

PROBLEMS DUE TO EXCESS ROAD SALT APPLICATIONS AND HIGH CHLORIDE CONCENTRATIONS:

- Harmful to fish, amphibians and roadside vegetation
- Causes damage to vehicles, bridges, and buildings
- Financial impact on municipal and state budgets- it's expensive!
- Contamination of private and municipal drinking water wells
- Health concerns from high sodium levels in drinking water
- Increased possibility of corrosion in water-distribution systems and increased threats from copper and lead

Freshwater Biology

ORIGINAL ARTICLE

Salted roads lead to oedema and reduced locomotor function in amphibian populations

Steven P. Brady, Debora Goedert, Lauren E. Frymus, Francisco Javier Zamora-Camacho, Peter C. Smith, Caroline J. Zeiss, Mar Comas, Timothy A. Abbott, Silvia P. Basu, Jason C. DeAndressi ... See all authors

First published: 30 March 2022 | https://doi.org/10.1111/fwb.13907

A bloated wood frog found near a road in New England. Credit: Steven Brady

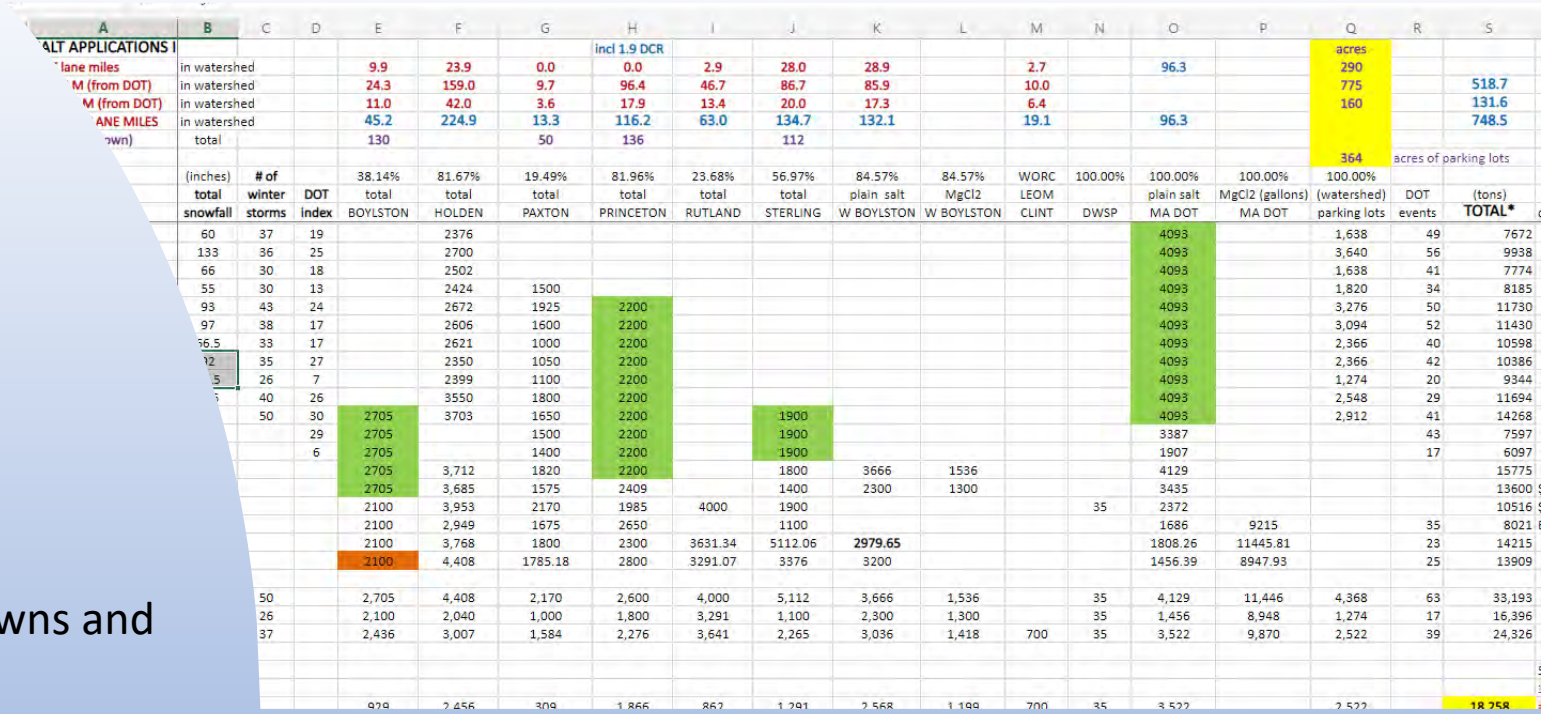
The eggs on the left were taken from a polluted roadside pond, while the ones on the right were from a clean pond. The roadside eggs are more numerous, but have darker jelly due to pollution. Credit: Steven Brady

EXPANDING DCR RESEARCH:

How do we protect water quality?

- **Improve data collection**
- **Model impact of reducing inputs**
- **Education and training**
- **Provide a salt reduction grant program to assist Wachusett watershed communities**
- **Upgrade DCR practices**

Improve Data Collection



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
ALT APPLICATIONS I							incl 1.9 DCR									acres		
lane miles	in watershed			9.9	23.9	0.0	0.0	2.9	28.0	28.9		2.7		96.3		290		
M (from DOT)	in watershed			24.3	159.0	9.7	96.4	46.7	86.7	85.9		10.0				775		518.7
M (from DOT)	in watershed			11.0	42.0	3.6	17.9	13.4	20.0	17.3		6.4				160		131.6
ANE MILES	in watershed			45.2	224.9	13.3	116.2	63.0	134.7	132.1		19.1		96.3				748.5
own)	total			130		50	136		112									
																364	acres of parking lots	
	(inches)	# of		38.14%	81.67%	19.49%	81.96%	23.68%	56.97%	84.57%	84.57%	WORC	100.00%	100.00%	100.00%	100.00%		
	total	winter	DOT	total	total	total	total	total	total	plain salt	MgCl2	LEOM		plain salt	MgCl2 (gallons)	(watershed)	DOT	(tons)
	snowfall	storms	index	BOYLSTON	HOLDEN	PAXTON	PRINCETON	RUTLAND	STERLING	W BOYLSTON	W BOYLSTON	CLINT	DWSP	MA DOT	MA DOT	parking lots	events	TOTAL*
	60	37	19		2376									4093		1,638	49	7672
	133	36	25		2700									4093		3,640	56	9938
	66	30	18		2502									4093		1,638	41	7774
	55	30	13		2424	1500								4093		1,820	34	8185
	93	43	24		2672	1925	2200							4093		3,276	50	11730
	97	38	17		2606	1600	2200							4093		3,094	52	11430
	66.5	33	17		2621	1000	2200							4093		2,366	40	10598
	2	35	27		2350	1050	2200							4093		2,366	42	10386
	5	26	7		2399	1100	2200							4093		1,274	20	9344
		40	26		3550	1800	2200							4093		2,548	29	11694
		50	30	2705	3703	1650	2200		1900					4093		2,912	41	14268
			29	2705		1500	2200		1900					3387			43	7597
			6	2705		1400	2200		1900					1907			17	6097
				2705	3,712	1820	2200		1800	3666	1536			4129				15775
				2705	3,685	1575	2409		1400	2300	1300			3435				13600
				2100	3,953	2170	1985	4000	1900				35	2372				10516
				2100	2,949	1675	2650		1100					1686	9215		35	8021
				2100	3,768	1800	2300	3631.34	5112.06	2979.65				1808.26	11445.81		23	14215
				2100	4,408	1785.18	2800	3291.07	3376	3200				1456.39	8947.93		25	13909
		50		2,705	4,408	2,170	2,600	4,000	5,112	3,666	1,536		35	4,129	11,446	4,368	63	33,193
		26		2,100	2,040	1,000	1,800	3,291	1,100	2,300	1,300		35	1,456	8,948	1,274	17	16,396
		37		2,436	3,007	1,584	2,276	3,641	2,265	3,036	1,418	700	35	3,522	9,870	2,522	39	24,326
				929	2,456	309	1,866	862	1,291	2,568	1,199	700	35	3,522		2,522		18,258

- Gather information on annual salt use by towns and MADOT
- Track the type and quantity of all deicing materials used during all future winter storms by DCR watershed maintenance staff
- Best estimate is that 18,000 tons of salt is applied in the watershed on an annual basis

WHAT DOES 18,000 TONS LOOK LIKE?

3,000 African elephants (average weight 6 tons)

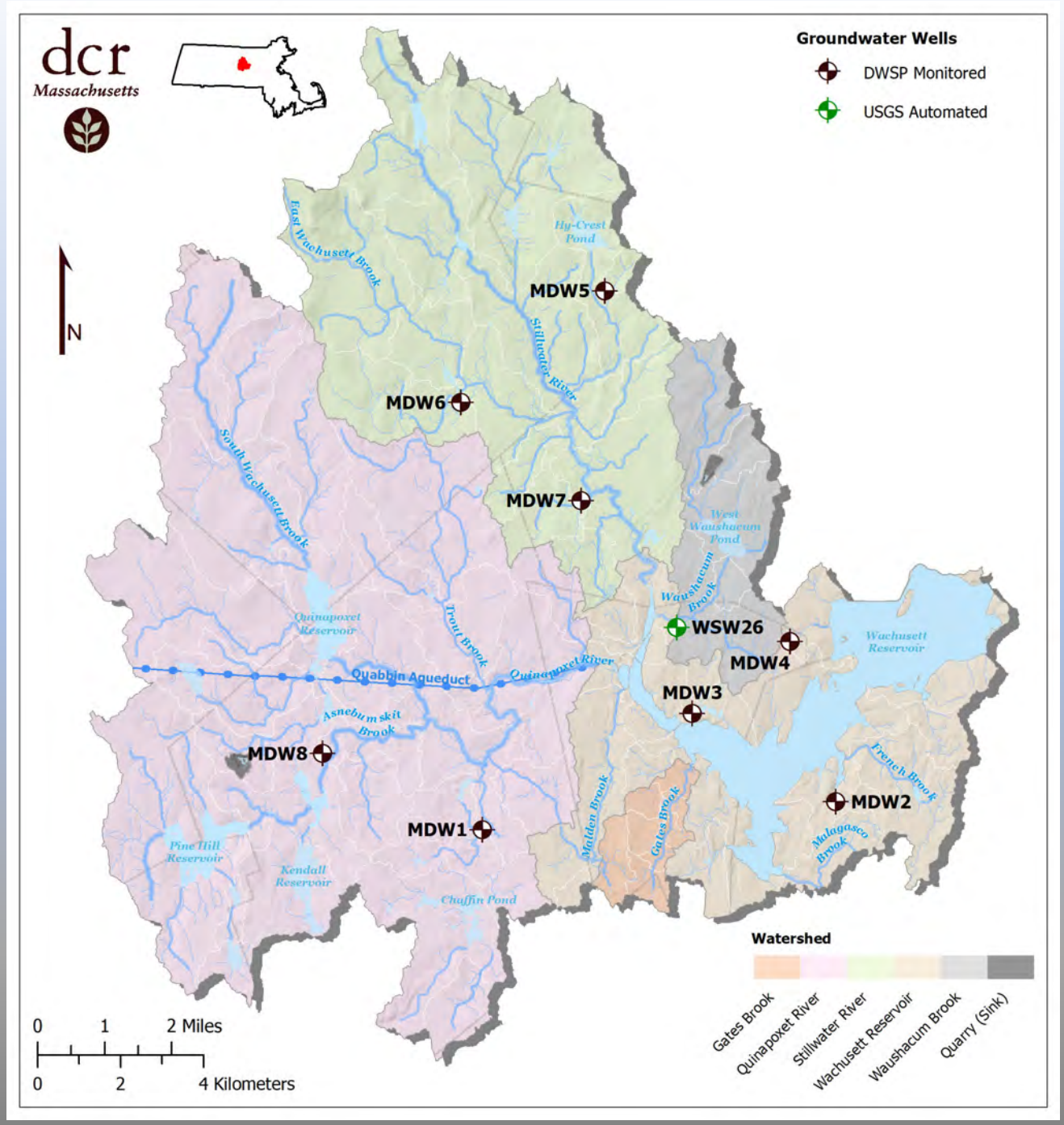
Improve Data Collection

WATWEL Groundwater Monitoring Project (2019-present):

- Monthly chloride sampling at 7 former USGS monitoring wells on DWSP property

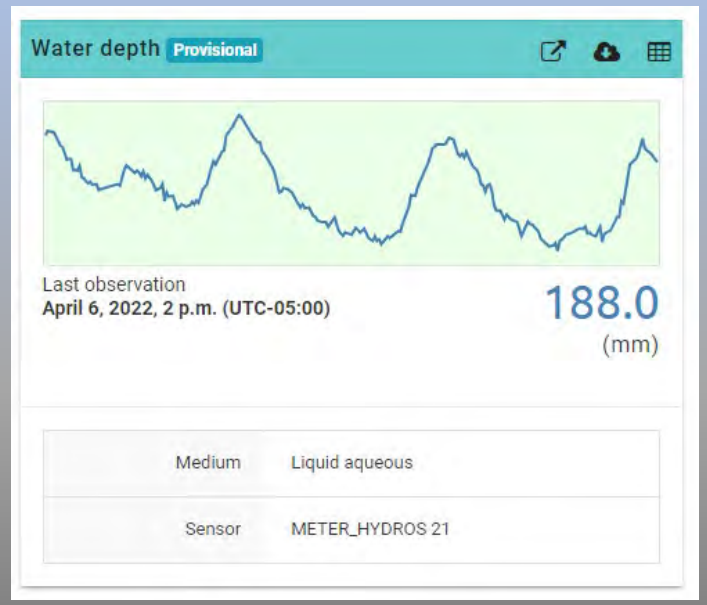
Other parameters measured:

- Depth to Water (ft)
- Water temperature (C)
- Specific Conductance (uS/cm)



Improve Data Collection

- Installation of seven DIY low-cost Mayfly Data Loggers across the watershed
- Powered by solar panels and lithium-ion batteries, with the ability to obtain real-time specific conductance data.

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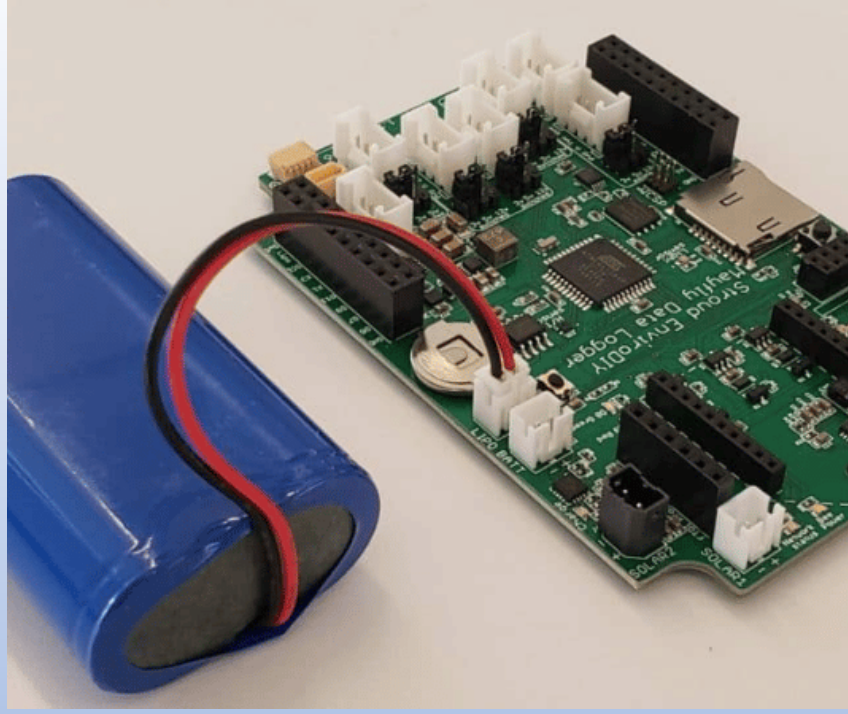
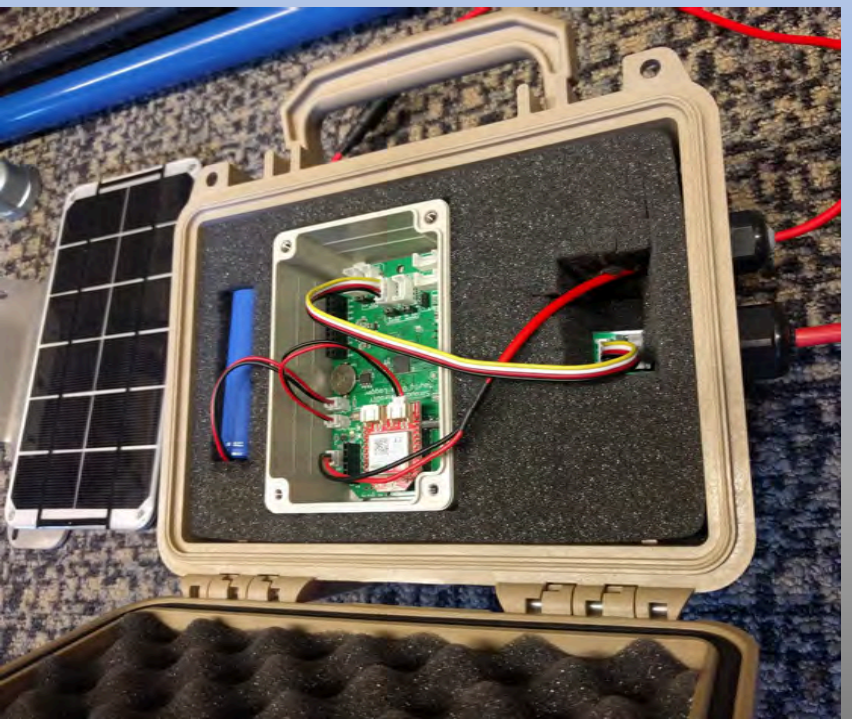
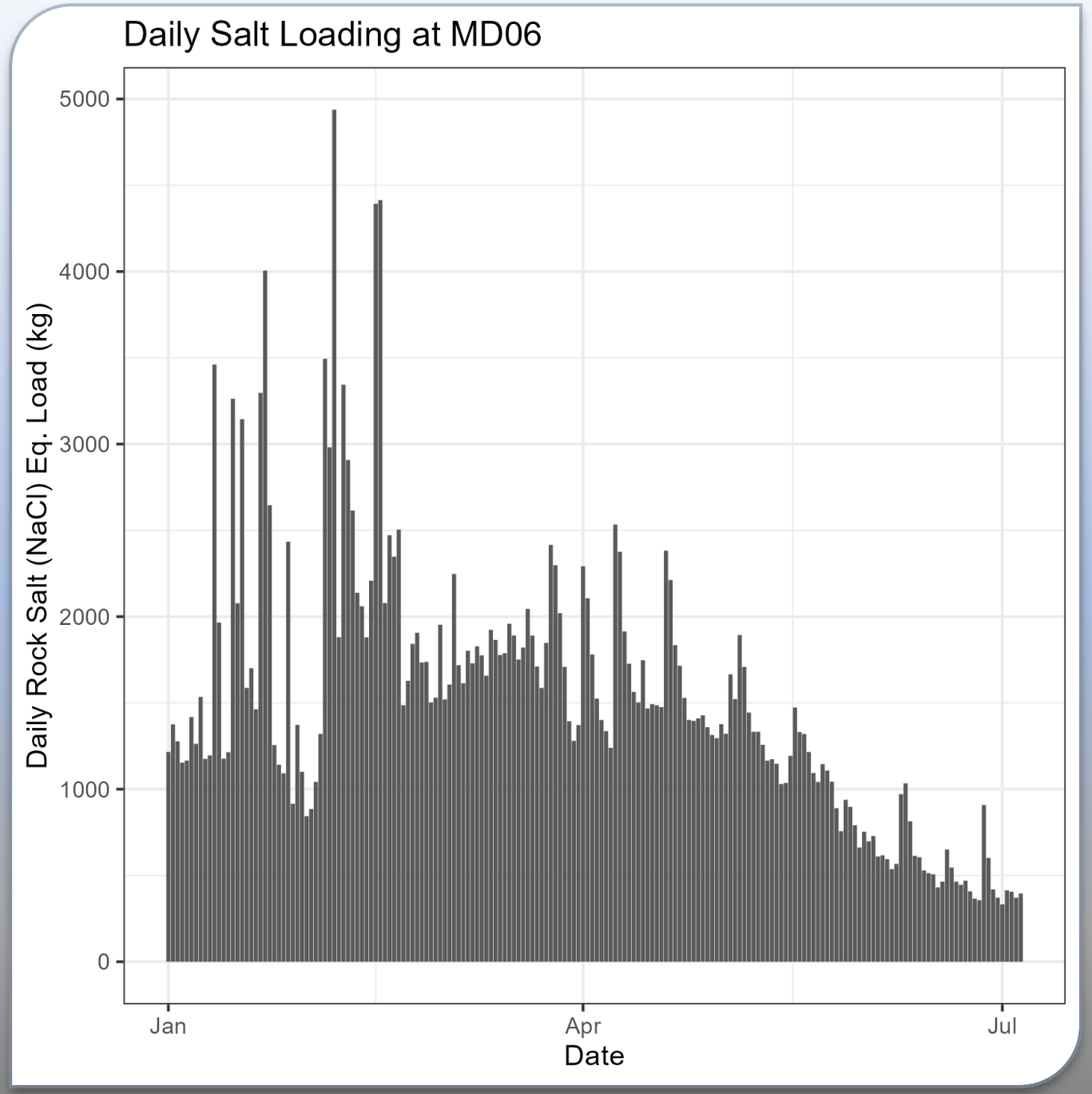
MASSACHUSETTS DEPARTMENT OF CONSERVATION AND RECREATION
WAUSHACUM BROOK (MD83)
WATER QUALITY AND HYDROLOGIC MONITORING STATION
This monitoring station is recording water depth, water temperature, and conductivity every 15 minutes. To see these data live on the web, scan the QR code below with your smartphone or visit:
http://monitormywatershed.org/sites/WACHUSETT-01/
EnviroDIY
For additional information or to report damage to this station please contact:
DCR-DWSP
Environmental Quality Section
508-792-7806

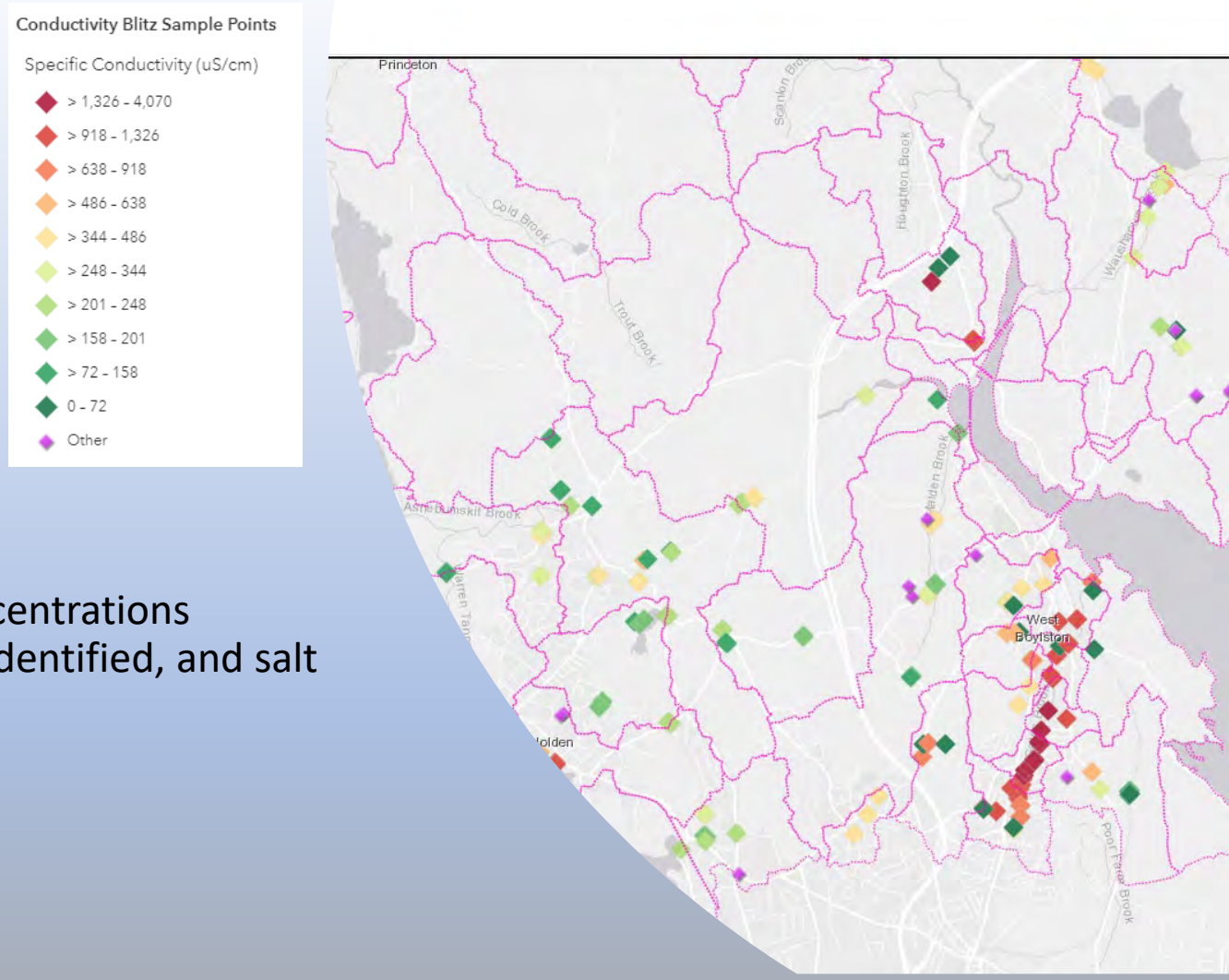

Stroud EnviroDIY
Mayfly Data Logger
LIPO BATT
SOLAR2
SOLAR1




Gauging Station For Hydrologic Monitoring
Please Do Not Tamper With Gauging Equipment


Daily Salt Loading at MD06
Daily Rock Salt (NaCl) Eq. Load (kg)
5000
4000
3000
2000
1000
0
Jan
Apr
Jul
Date

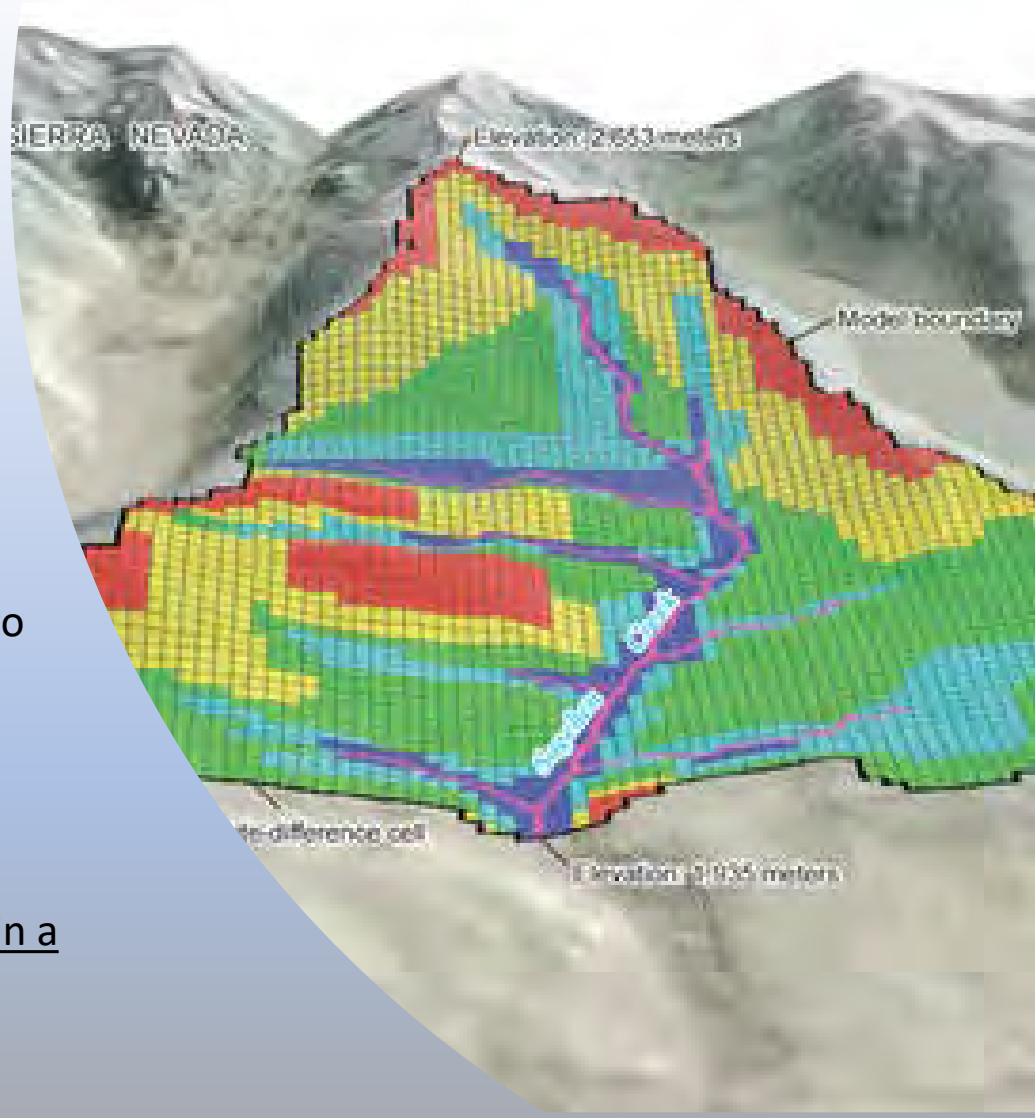
Improve Data Collection



- Conductivity “Blitz” in 2021-2022
- Goal: Improve spatial understanding of chloride concentrations throughout the watershed so that hot spots can be identified, and salt reduction measures can be geographically targeted.

Modelling Efforts

- Partner with UMASS-Amherst to investigate watershed-based reservoir inputs and to use their existing hydrodynamic and water quality model to predict various outcomes under a variety of conditions
- Investigate and model impact of reducing inputs of chlorides to the reservoir and to predict changes to chloride concentrations at the Cosgrove Intake
- Soper et al. 2021. Long-term analysis of road salt loading and transport in a rural drinking water reservoir watershed. Journal of Hydrology: "… measurable water quality improvements will only be realized with a sustained long-term decrease in the amount of road salt applied."



Education and Training

- DCR and MWRA have cooperated to provide Baystate Roads (UMASS Transportation Center) training on Snow and Ice Operations in the fall of 2019, 2021, and 2022

Education and Training

- Pre-treatment of bare pavement BEFORE a storm prevents snow and ice from binding to pavement which makes it easier to plow and uses less salt overall
- MA DOT District 3 has seen an estimated 30% reduction in the amount of salt applied with no reduction in safety
- Application of salt brine to roads before storm events is the best approach but requires specialized equipment to produce and apply the brine

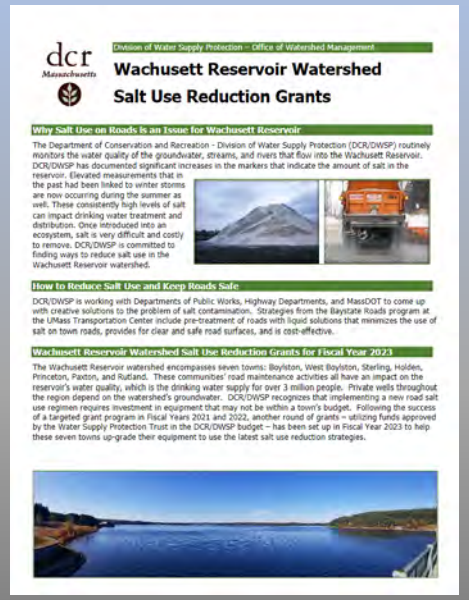
"We are now pre-treating always due to the training you provided."

Education and Training

- Concentrated effort on DCR educational programs to include additional messaging on the dangers of salt use and promote behavioral changes that would reduce use
- Production of a salt use reduction educational video by Interpretive Services for this winter season: "**The Importance of Road Salt Reduction**" on MassDCR YouTube channel
- Reducing salt does not mean reducing public safety!
- Changing public expectations is a necessary component of long-term success

Salt Reduction Grant Program

- Launched in FY21, dedicated funding in DWSP budget to administer a 50/50 matching grant of up to $20,000 to facilitate adoption of salt reduction technologies in watershed towns
- Total grant distribution of $109,000 over three years has been awarded to the towns of Holden, West Boylston, Princeton, Sterling, and Paxton.
- FY23 resulted in four matching grants being awarded (in process).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Division of Water Supply Protection – Office of Watershed Management

Wachusett Reservoir Watershed

Salt Use Reduction Grants

Why Salt Use on Roads is an Issue for Wachusett Reservoir

The Department of Conservation and Recreation - Division of Water Supply Protection (DCR/DWSP) routinely monitors the water quality of the groundwater, streams, and rivers that flow into the Wachusett Reservoir. DCR/DWSP has documented significant increases in the markers that indicate the amount of salt in the reservoir. Elevated measurements that in the past had been linked to winter storms are now occurring during the summer as well. These consistently high levels of salt can impact drinking water treatment and distribution. Once introduced into an ecosystem, salt is very difficult and costly to remove. DCR/DWSP is committed to finding ways to reduce salt use in the Wachusett Reservoir watershed.

How to Reduce Salt Use and Keep Roads Safe

DCR/DWSP is working with Departments of Public Works, Highway Departments, and MassDOT to come up with creative solutions to the problem of salt contamination. Strategies from the Baystate Roads program at the UMass Transportation Center include pre-treatment of roads with liquid solutions that minimizes the use of salt on town roads, provides for clear and safe road surfaces, and is cost-effective.

Wachusett Reservoir Watershed Salt Use Reduction Grants for Fiscal Year 2023

The Wachusett Reservoir watershed encompasses seven towns: Boylston, West Boylston, Sterling, Holden, Princeton, Paxton, and Rutland. These communities' road maintenance activities all have an impact on the reservoir's water quality, which is the drinking water supply for over 3 million people. Private wells throughout the region depend on the watershed's groundwater. DCR/DWSP recognizes that implementing a new road salt use regimen requires investment in equipment that may not be within a town's budget. Following the success of a targeted grant program in Fiscal Years 2021 and 2022, another round of grants – utilizing funds approved by the Water Supply Protection Trust in the DCR/DWSP budget – has been set up in Fiscal Year 2023 to help these seven towns up-grade their equipment to use the latest salt use reduction strategies.

New salt storage building in Princeton

Upgrade DCR DWSP Winter Operations

- Pre-treatment with granular salt
- Salt brine generator
- Equipment to apply brine
- Replace and upgrade our salt shed
- Provide training

Thank You!

Jamie Carr, Division of Water Supply Protection

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