Volunteer Road Salt Monitoring: Assessing Impacts of Winter Safety Measures on Stream Quality in Wisconsin

Photo by Jim Gennrich

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UW Extension University of Wisconsin–Extension

ERC Environmental Resources Center

USGS science for a changing world

Wisconsin Dept. of Natural Resources

Water Action Volunteers

Water Action Volunteers Stream Monitoring Program

- Sponsored by UW Extension & DNR
- Goal is to help preserve and protect Wisconsin's rivers, streams and lakes
- Three-levels
  - Accommodate varied interests & time availability of citizens
  - Road salt project is Level 3 – special research

Photo by Erin Vennie-Vollrath

Volunteer Road Salt Monitoring Project

- Builds upon USGS research[1]
- Goals
  1. To understand the breadth of impact from road salt on WI streams
  2. Assess functionality of an economical field meter for specific conductance (SC) measurement
  3. Assess relation between chloride and SC at monitored sites
  4. Assess how this works as a volunteer monitoring project

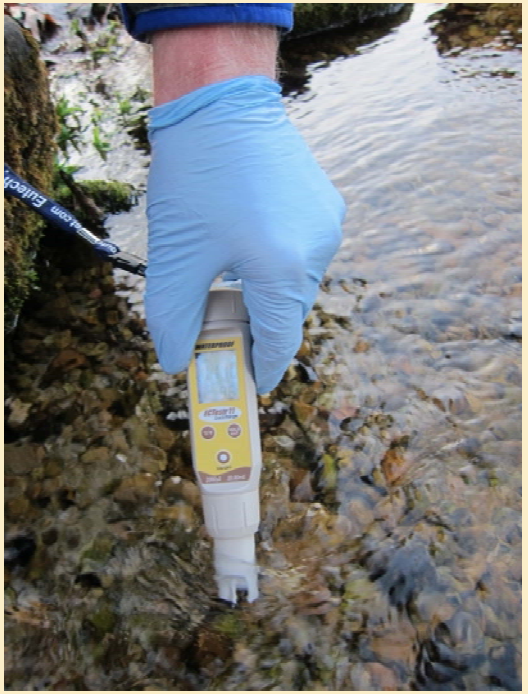


Photo by Eric Bannerman

[1]Corsi, S.R., Graczyk, D.J., Geis, S.W., Booth, N.L., and Richards, K.D. 2010. A fresh look at road salt: Aquatic toxicity and water-quality impacts on local, regional and national scales. Environ. Sci. Technol. 44:7376-7382.

PROJECT TIMELINE 2011

21 volunteers trained

34 urban-impacted sites monitored

Volunteers monitored monthly

for specific conductance, plus 1 chloride grab sample

33 new monitors trained

monitored 27 new sites

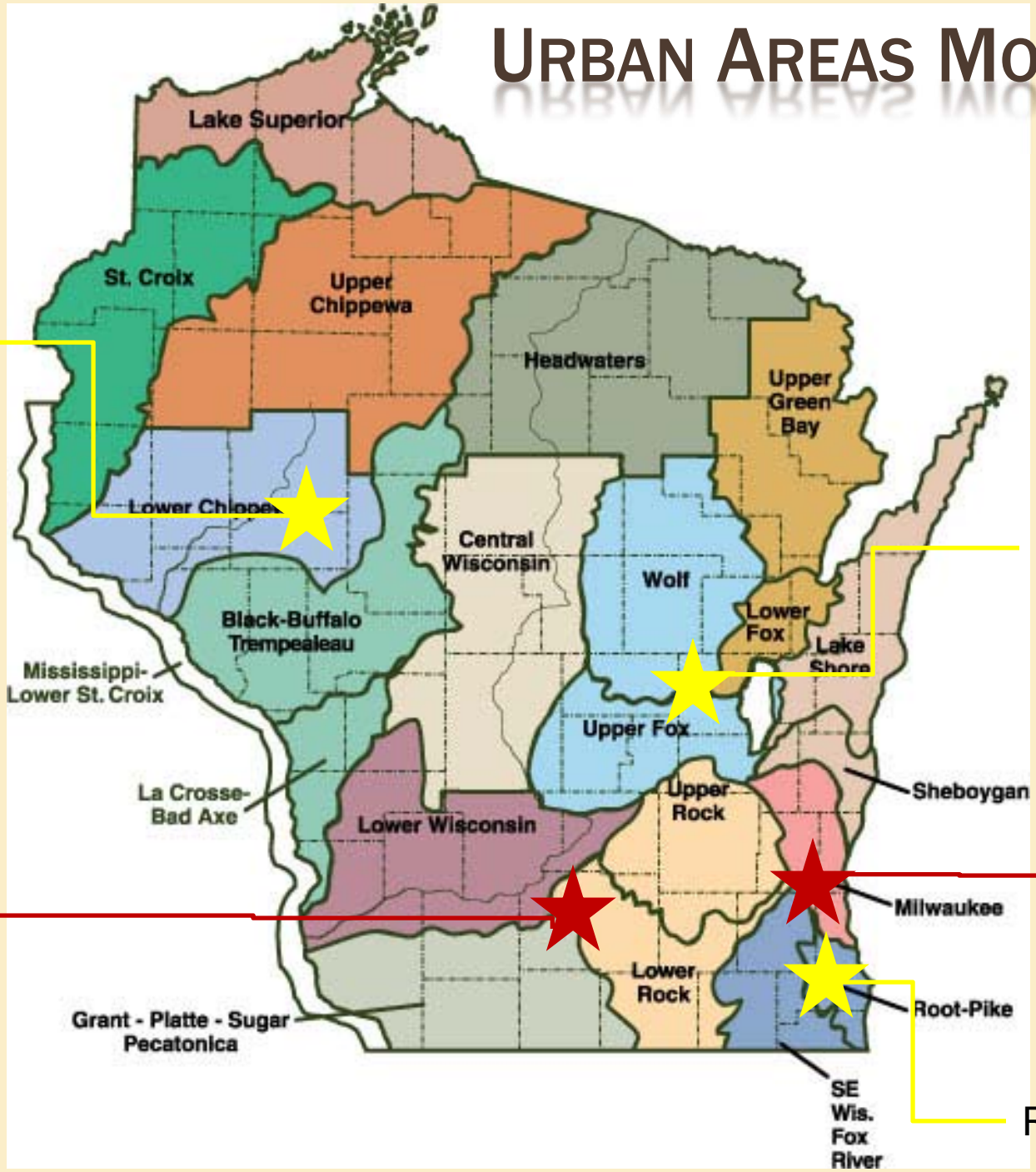
Volunteers monitored bi-weekly plus "triggered" monitoring

for specific conductance plus 5 chloride grab samples

Bi-weekly monitoring resumed

- Chloride samples represented a range of specific conductivities
- Triggered monitoring alerts came from USGS continuous monitoring sites

URBAN AREAS MONITORED



Eau Claire

Fox Valley

Milwaukee

Madison

Racine

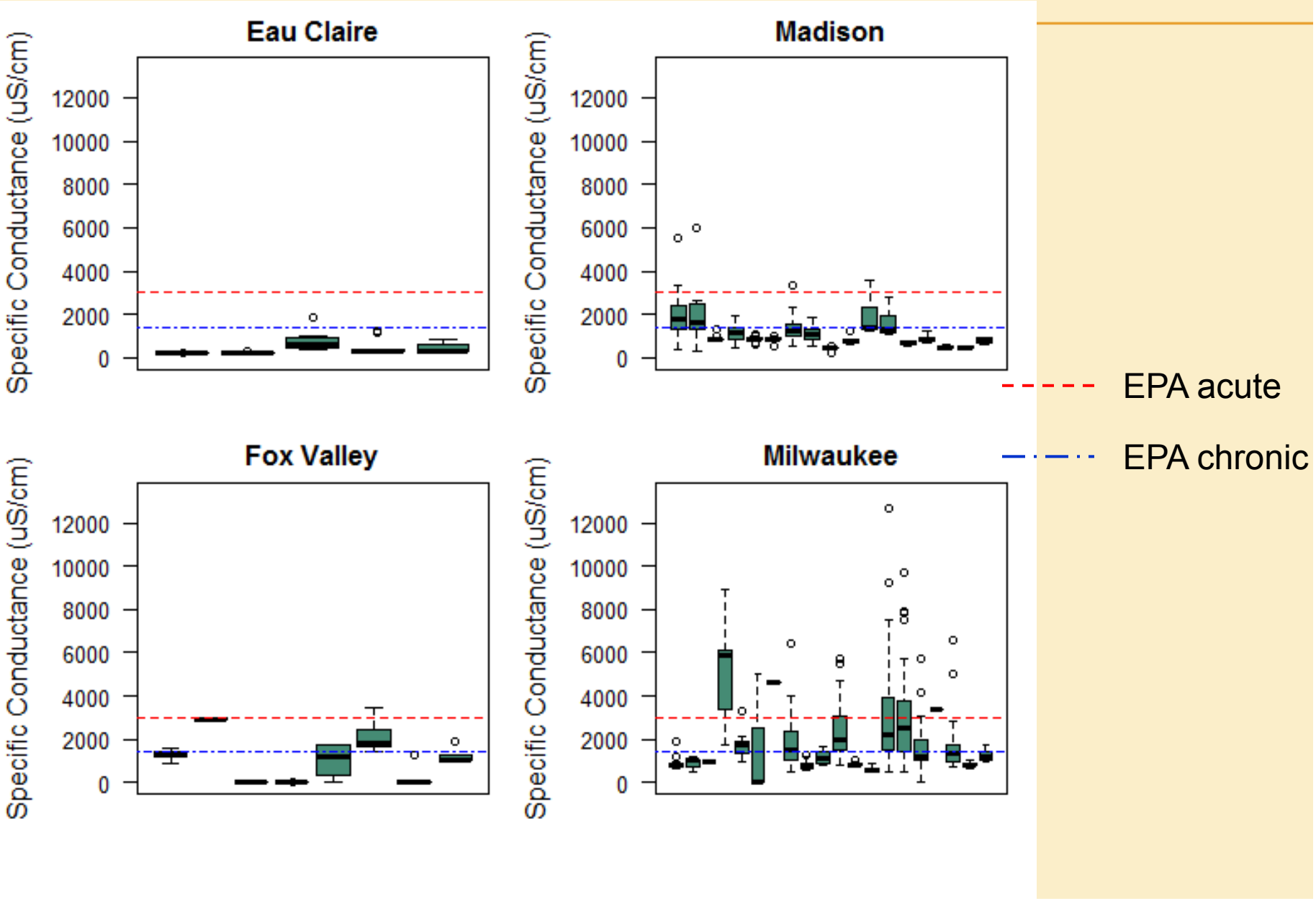
Monitoring Results

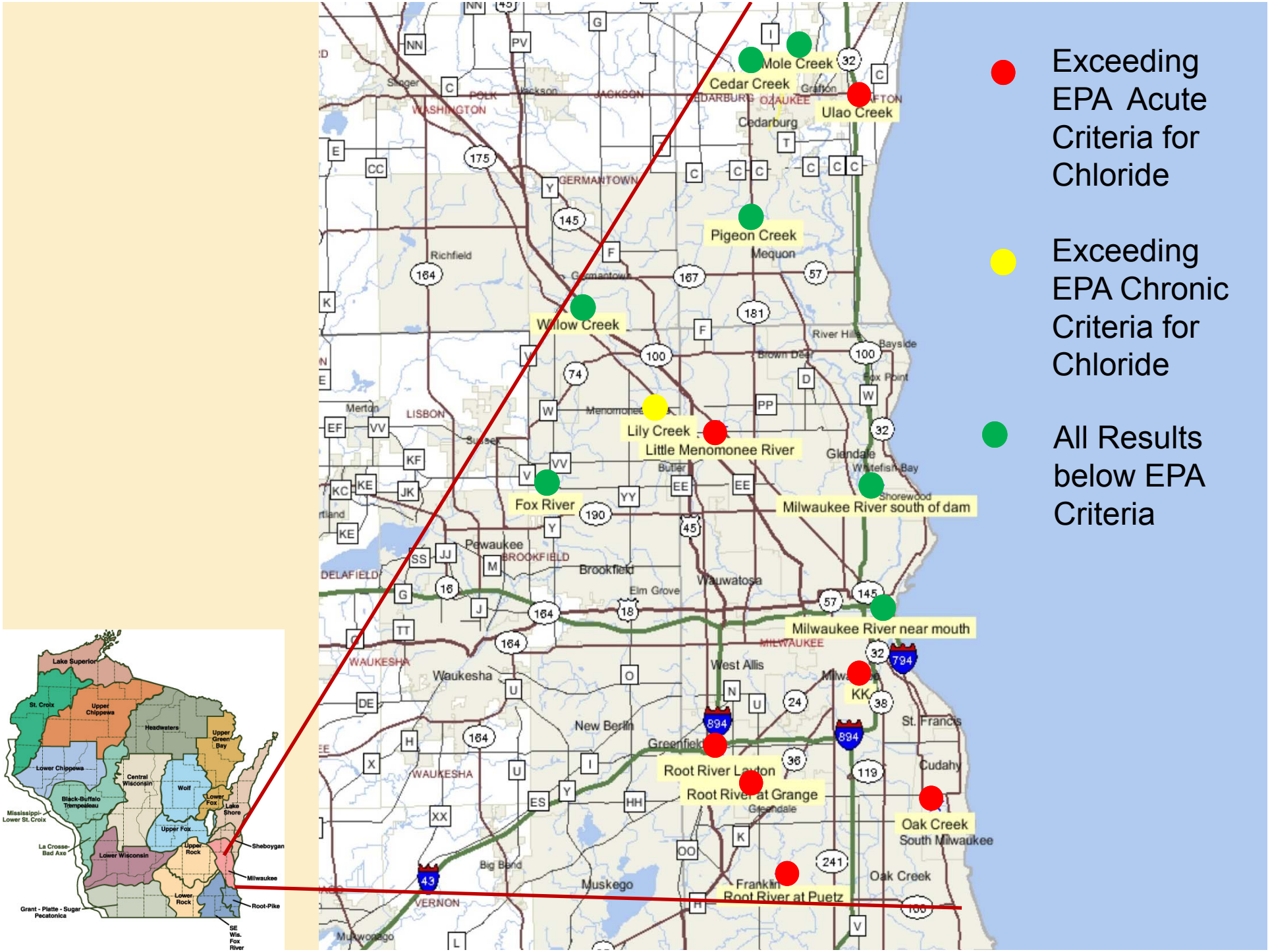
- 61 sites monitored
- 87 EPA acute chloride standard exceedences at 13 sites
  - Chloride >860 mg/L
  - Exceedences have occurred in Milwaukee, Madison, Oshkosh (Fox Valley), and Racine
- Plus, 150 additional EPA chronic chloride standard exceedences* at 26 sites
  - Chloride >230 mg/L
  - Exceedences have occurred in all participating cities

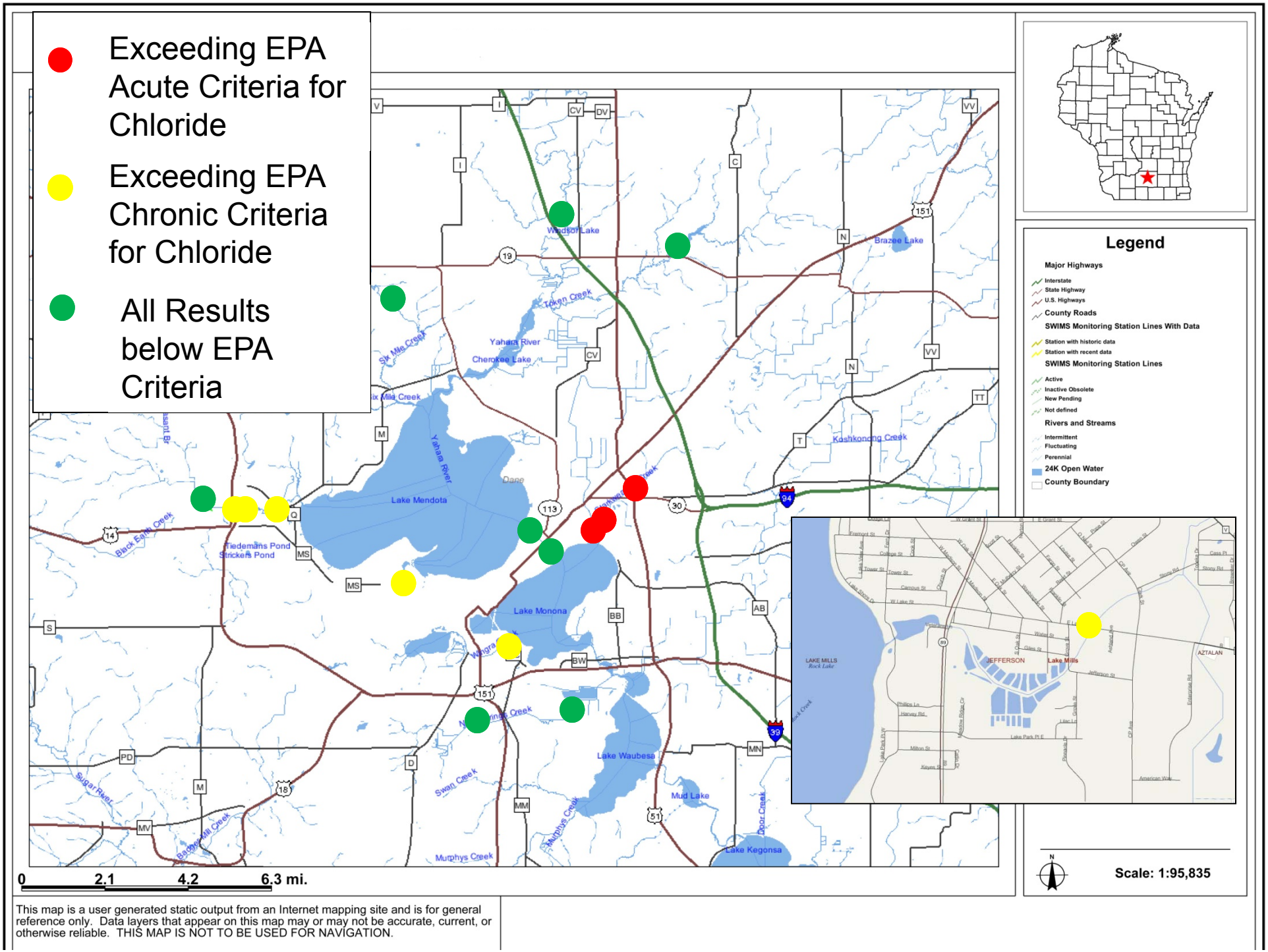
Photo by Kris Stepenuck

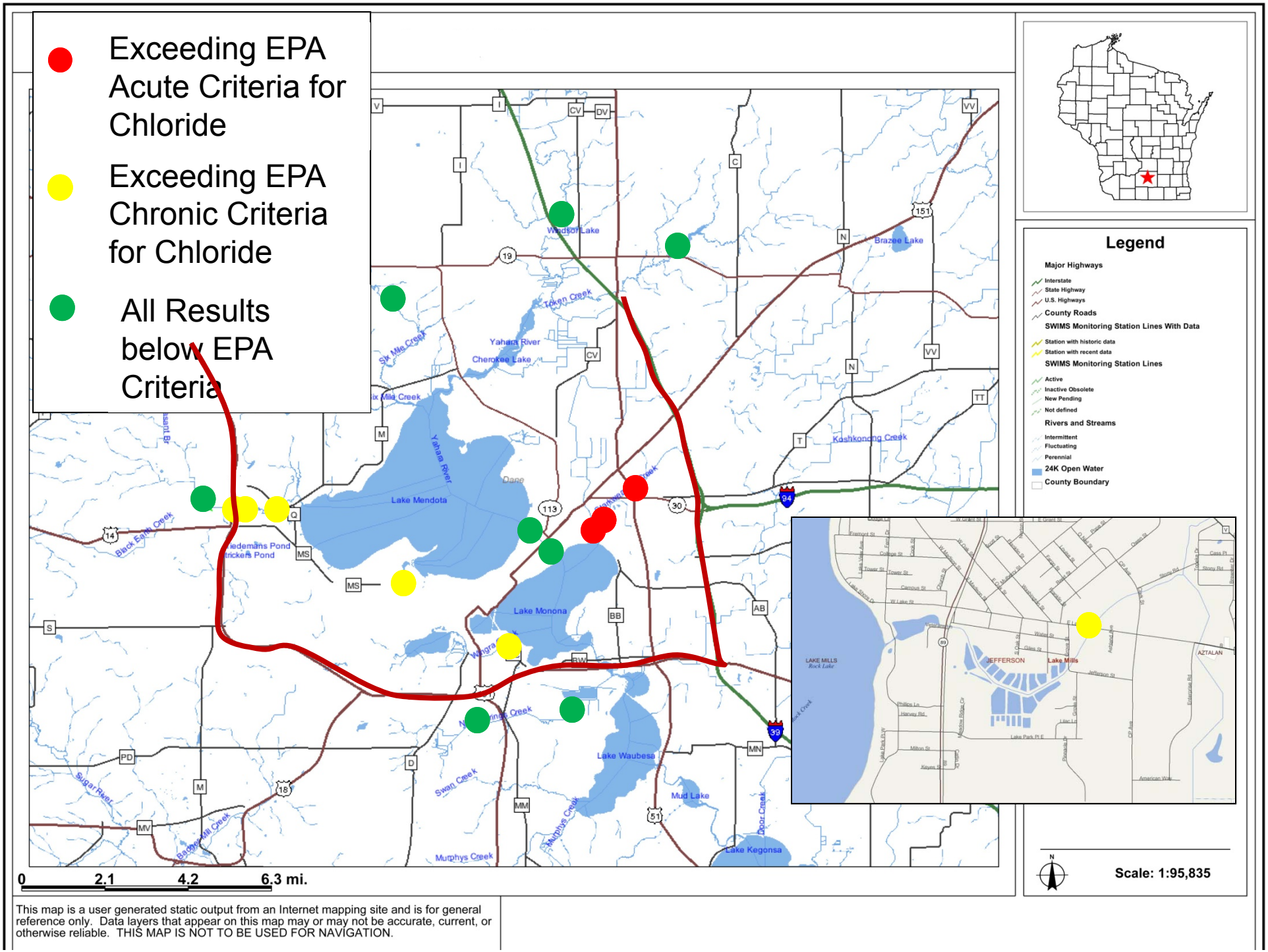
* Estimated. Chronic standard is four day average concentration. Only single point samples collected.

SPECIFIC CONDUCTANCE 2011-12




Mole Creek
Cedar Creek
Ulao Creek
Pigeon Creek
Willow Creek
Lily Creek
Little Menomonee River
Fox River
Milwaukee River south of dam
Milwaukee River near mouth
Root River Lawton
Root River at Grange
Root River at Puetz
Oak Creek
Exceeding EPA Acute Criteria for Chloride
Exceeding EPA Chronic Criteria for Chloride
All Results below EPA Criteria


Exceeding EPA Acute Criteria for Chloride
Exceeding EPA Chronic Criteria for Chloride
All Results below EPA Criteria
Legend
Major Highways
Interstate
State Highway
U.S. Highways
County Roads
SWIMS Monitoring Station Lines With Data
Station with historic data
Station with recent data
SWIMS Monitoring Station Lines
Active
Inactive Obsolete
New Pending
Not defined
Rivers and Streams
Intermittent
Fluctuating
Perennial
24K Open Water
County Boundary
Lake Mendota
Lake Monona
Lake Waubesa
Lake Kegonsa
Mud Lake
Brazee Lake
Cherokee Lake
Yahara River
Kashkonong Creek
Token Creek
Six Mile Creek
Black Earth Creek
Tiedemans Pond
Strickers Pond
Swan Creek
Murphys Creek
Door Creek
Sugar River
Badger Mill Creek
LAKE MILLS
Rock Lake
JEFFERSON
Lake Mills
AZTALAN
0 2.1 4.2 6.3 mi.
Scale: 1:95,835
This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.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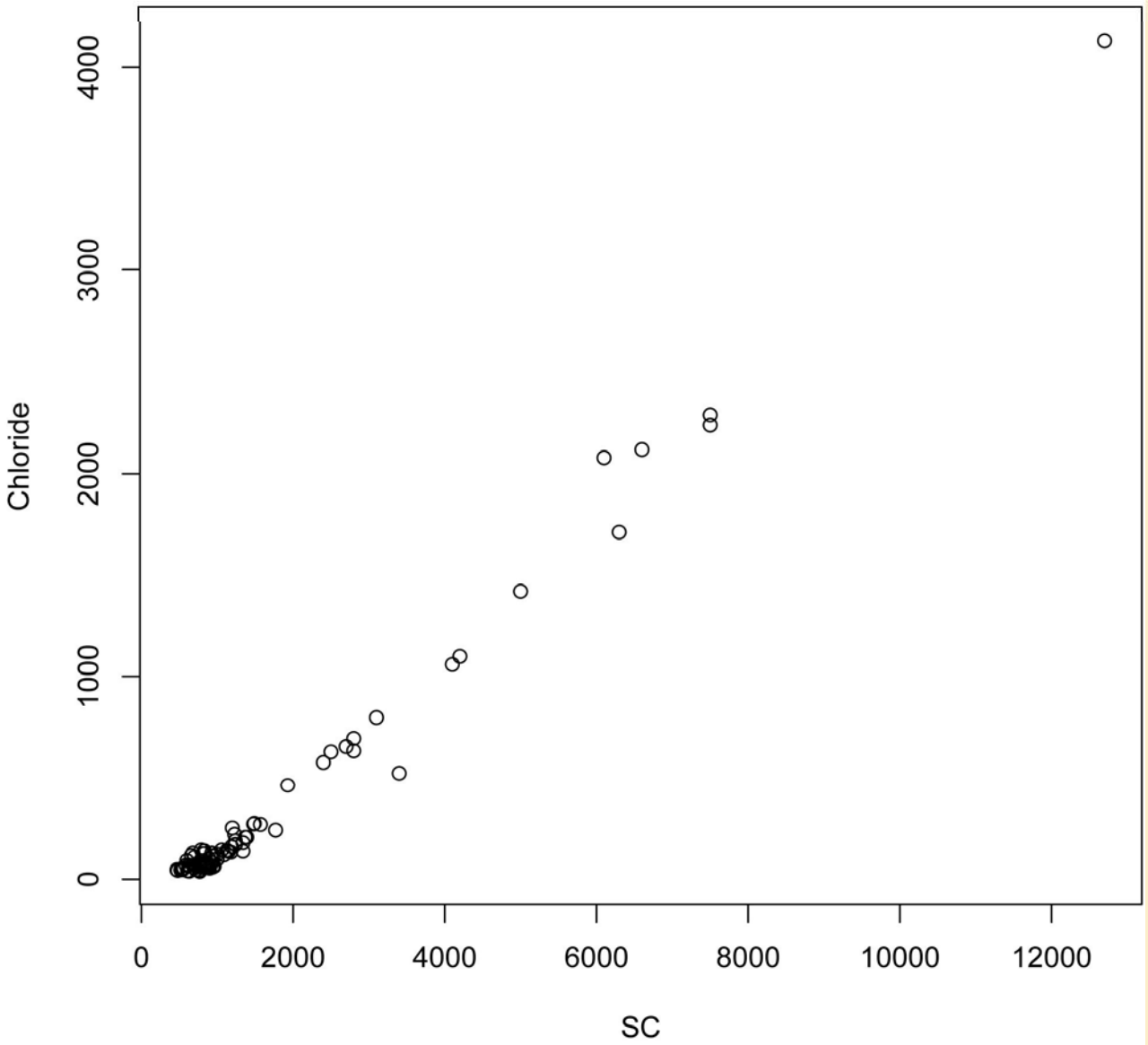
Months with Chronic Exceedences in Madison

Site	F	M	A	M	J	J	A	S	O	N	D
Pheasant Century	■	■									
Pheasant Deming	■	■									
Pheasant Hwy 12	■	■									
Rock storm drain	■										
Starkweather Milwaukee	■	■									■
Starkweather Commercial	■	■									■
University Sewer			■								
Wingra Olin	■										

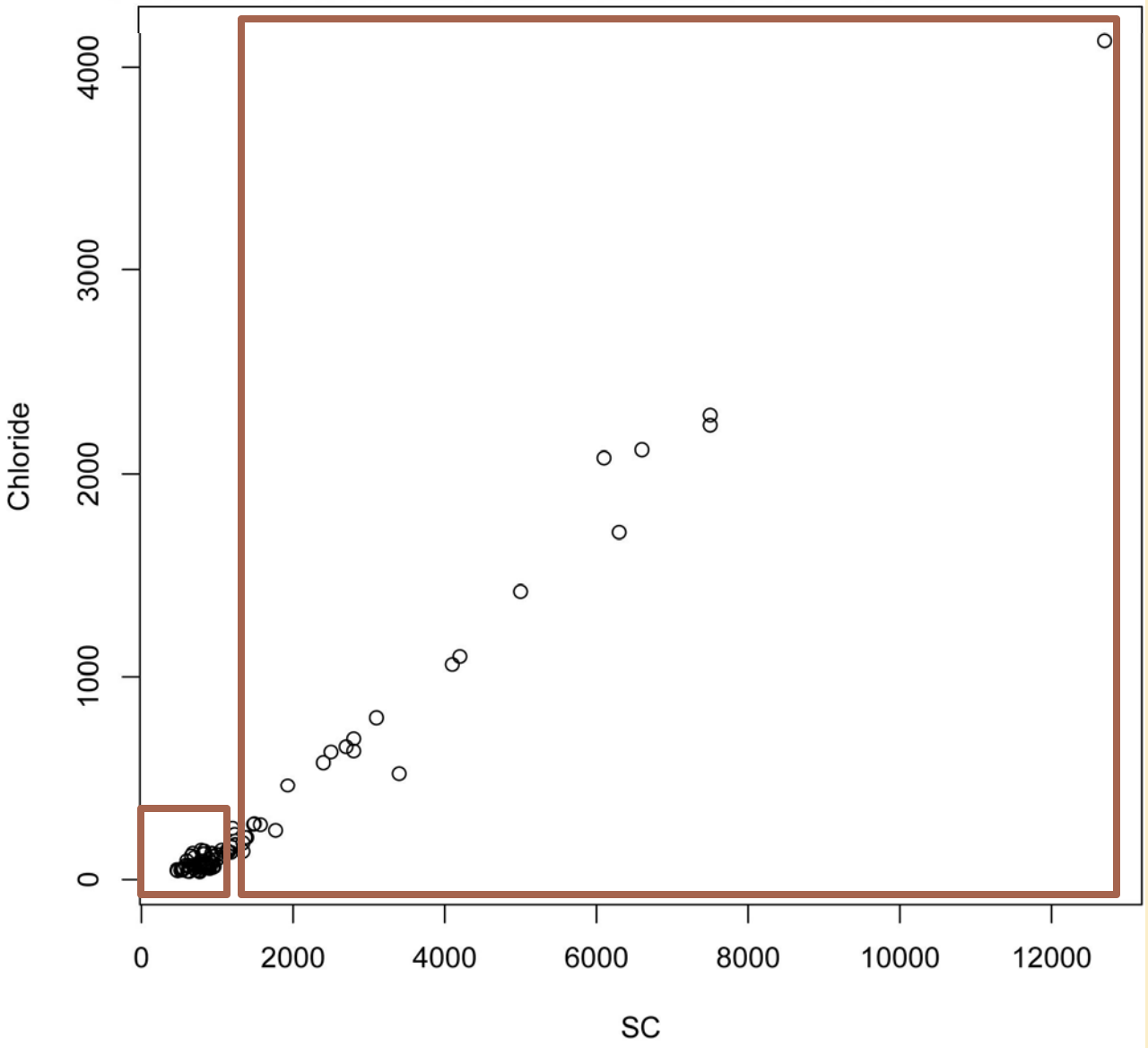
Months with Chronic Exceedences Milwaukee-Racine

Site	F	M	A	M	J	J	A	S	O	N	D
Kinnickinnic 11th	■	■	■		■				■		
Lily Good Hope	■	■	■		■						
Little Menom. Hwy 145	■	■									
Oak S. Milwaukee	■	■	■	■	■	■	■				■
Root Grange	■	■	■	■			■			■	
Root Layton	■	■	■	■			■				
Root Puetz	■	■	■								
Ulao Hwy 60	■	■						■			

SPECIFIC CONDUCTANCE-CHLORIDE RELATIONSHIP



How Did the Meters Work?



When SC >1540 µS/cm:
Cl = 0.3441 * SC – 291
adj R^2 = 0.98

When SC ≤ 1540 µS/cm:
Cl = 1.044 * (exp(0.001609 * SC + 3.046))
adj R^2 = 0.65

Lessons Learned

- Best to include field practice during training and go through *all* the motions
- Triggered monitoring tough for some – Others loved being out all year
- Slippery steep bank / ice safety concerns in winter
- Thermometers on ECTestrs sometimes slow to settle
- Issue raised: Human safety by salting vs. impacts on streams

Photo courtesy of Jim Beecher

Cost Analysis

- USGS has 22 continuous monitoring stations in WI that include specific conductance
  - ~$10,000 - 15,000 /year operating cost per site
- Volunteer monitoring project costs
  - $175/kit (11 kits)
  - $175 for chloride analyses and shipping/site (34 sites)
  - ~$7000 for 250 hours staff time and benefits
  - Total: ~$14,100 for 34 sites

Photo by Christina Anderson

Next Steps

- Possible expansion to additional cities
- Analysis of watershed land use upstream of each site
- Further consideration into long term chronic trends

Photo by Christina Anderson

Take-Home Points

- Many small streams in Wisconsin are adversely impacted by road salt
  - Longer monitoring periods help define the magnitude of impact
- SC with low-cost sensors is proving to be an excellent surrogate for Cl
- The volunteer monitoring program structure is ideal for assessing many streams very efficiently

Photo courtesy of Jim Beecher

Acknowledgements

- Water Action Volunteers' monitors
- Wisconsin Department of Natural Resources
- University of Wisconsin Extension
- Milwaukee Riverkeeper
- Milwaukee Area Technical College
- Carthage College Chemistry Dept.
- UW-Oshkosh Environmental Studies Dept.
- UW-Eau Claire Geology Dept.
- CWTU Riverkeepers
- Jefferson County
- Milwaukee Metropolitan Sewerage District
- General Mitchell International Airport
- US Geological Survey
  - Co-op program, National Water Quality Assessment program,
  - Many people at USGS Wisconsin Water Science Center
- Wisconsin State Laboratory of Hygiene
- City of Madison