Appendices to

Impacts of chloride and urbanization on stream invertebrates: a 10-year citizen science field study of road salt in stormwater runoff

by

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Appendix A

The Missouri Stream Team Program

The genesis of the Missouri Stream Team program was the banding together in 1988 of a group of anglers who were upset by the amount of trash that had accumulated in their favorite trout fishing stream. This group influenced others to start cleaning up their favorite streams, and in 1989 the Missouri Department of Conservation (MDC) started formally supporting these groups in a Stream Team program. Seeing the value of enlisting volunteers to support stream health, in 1993 the Missouri Department of Natural Resources (MDNR) joined with the MDC to sponsor a Volunteer Water Quality Monitoring (VWQM) program as a citizen science branch of the Missouri Stream Team program. In addition, the Conservation Federation of Missouri joined as a sponsor to serve as a voice in citizens' advocacy efforts in stream conservation (1).

In the first year of operation, the VWQM program trained 200 volunteers in the collection of physical, biological, and chemical data on their adopted streams. By 2020, 6,935 individuals received at least the Introductory level training and over 6,0

00 Stream Teams have been formed (2). Moreover, these teams have turned in over 45,000 data sheets from over 32,500 monitoring trips at 3,471 monitoring sites (2,3). Moreover,

these teams and individuals have been become advocates and educators for stream health and conservation.

Under the Missouri VWQM program, there are four levels of training available for citizen scientists. At the Introductory level, participants learn about stream characteristics, site selection, stream discharge, and biological monitoring (4). They are given equipment to measure stream flow and a rain gauge. After choosing a site and submitting a Site Selection data sheet with stream discharge data, they are then given the equipment to monitor biological data: a net, forceps, magnifiers and vials. When they have submitted at least one data sheet of macroinvertebrate sampling (Figure A1), they are then eligible to take the Level 1 class (5). This class introduces water chemistry sampling and reviews macroinvertebrate identification. After this class, volunteers are given gloves, safety glasses, a transparency tube, pH and conductivity meters, as well as equipment to determine nitrate and dissolved oxygen levels at their stream site. They may receive other chemical monitoring equipment if of interest—such as phosphate or chloride monitoring kits. To present, 3,176 individuals have received Level 1 training.

After submitting data in all the above areas for two years, citizen scientists may then take the Level 2 class. In this class, citizen scientists review and are tested on their biological and chemical monitoring skills. During these sessions, water chemistry equipment is checked for proper function and any broken or malfunctioning equipment is replaced. It is essentially a Quality Assurance/Quality Control course. To maintain a Level 2 certification, this class or a similar quality validation class must be retaken every two years. Data submitted by Level 2 volunteers or above can be used by the MDNR for use in the development of watershed management plans, standard operating procedures, enforcement actions, and follow-up monitoring (6). At present, 808 individuals have received Level 2 certification.

To earn Level 3 certification, a volunteer must maintain Level 2 certification and submit at least 12 complete data sets. For this certification, MDNR personnel meet the citizen scientist one-on-one at their own field site and perform joint biological monitoring to verify that the volunteer is following proper methods and is successfully able to identify benthic macroinvertebrates in the field. In addition, the citizen scientist measures flow and chemical parameters which are compared to measurements made by the MDNR scientist with professional quality equipment to verify the accuracy of volunteer data. To date, 111 individuals have achieved Level 3 certification (3).

All training and certification are provided by professional staff of the MDC and MDNR. In the MDC, there are four regional Stream Team biologists as well as three local Stream Team assistants, any of whom can be contacted if an individual has questions about monitoring methodology or specimen identification. Furthermore, the Missouri Stream Team website has videos about proper monitoring and equipment calibration if a volunteer should feel the need of refreshing procedural information before a monitoring trip. Manuals and videos can be viewed at http://mostreamteam.org/training-materials-and-resources.html.

MACROINVERTEBRATE DATA SHEET

Please check the box next to the "Site #" ***if this is a new site and please be sure to attach a map.*** (PLEASE PRINT)

☐ Site # _____ Stream _____ County _____

Site Location _____

Date ____/____/____ Time (military time) _____ Rainfall (inches in last 7 days) _____ Water Temp. (°C) _____

Trained Data Submitter (responsible volunteer) _____ Stream Team Number _____

Participants _____

Invertebrate Type	***Net Set #1***	***Net Set #2***	***Net Set #3***	***Score***
Habitat type →				*After entering the **number(#) of organisms collected**, circle the number below for every type of organism collected. Add the numbers circled and record the totals as your Water Quality Rating.*
Net Type *(circle type)* →	*Kick Net* **or** *D-Net*	*Kick Net* **or** *D-Net*	*Kick Net* **or** *D-Net*	
Time Spent Picking (Minutes picking x number of people picking)	min. picking ____ × # people ____ = total min. ____	min. picking ____ × # people ____ = total min. ____	min. picking ____ × # people ____ = total min. ____	
Sensitive	**# of Organisms**	**# of Organisms**	**# of Organisms**	**Circle Types Present**
Caddisfly Larvae				3
Hellgrammites				3
Mayfly Nymphs				3
Gilled Snails (right)				3
Riffle Beetles				3
Stonefly Nymphs				3
Water Penny Larvae				3
Somewhat Tolerant	**# of Organisms**	**# of Organisms**	**# of Organisms**	**Circle Types Present**
Other Beetle Larvae				2
Clams/Mussels				2
Crane Fly Larvae				2
Crayfish				2
Dragonfly Nymphs				2
Damselfly Nymphs				2
Scuds				2
Sowbugs				2
Fishfly Larvae				2
Alderfly Larvae				2
Watersnipe Fly				2
Tolerant	**# of Organisms**	**# of Organisms**	**# of Organisms**	**Circle Types Present**
Aquatic Worms				1
Black Fly Larvae				1
Leeches				1
Midge Larvae				1
Pouch Snails (left)				1
Other Snails (flat)				1
< 12 = Poor	12-17 = Fair	18-23 = Good	>23 = Excellent	**Water Quality Rating** ____

Comments (mention any changes from your usual readings) _____

_____

_____

Fish Present (Please Mark) **Yes**☐ or **No**☐

Volunteer Monitoring - 12/15

Figure A1. Macroinvertebrate data sheet used by citizen scientists with the Missouri Stream Team.

References

1) Meier, Amy. 2014. Missouri Streams: In Good Hands. *Missouri Conservationist* 25:3, March 2014 (https://mdc.mo.gov/conmag/2014/03/missouri-streams-good-hands, accessed 1/3/2021).
2) Missouri Stream Team. 2020. Stream Team Annual Report 2019. (http://mostreamteam.org/assets/streamteamannualreport2019.pdf, accessed 1/3/2021).
3) Chris Riggert, Missouri Stream Team Coordination Biologist [Stream Team Program Coordinator], Missouri Department of Conservation, email correspondence, May 11, 2020
4) Missouri Stream Team. 2019. Missouri Stream Team Introduction to Volunteer Water Quality Monitoring. (http://mostreamteam.org/assets/notebook_complete.pdf, accessed 1/3/2021).
5) Missouri Stream Team. 2017. Volunteer Water Quality Monitoring, Level 1. (http://mostreamteam.org/assets/complete_notebook.pdf, 1/3/2021).
6) Missouri Department of Natural Resources. 2014. Levels of Volunteer Water Quality Data Use, July 24,2014. MDNR, Division of Environmental Quality, Environmental Services Program Water Quality Monitoring Section.

Appendix B

Anecdotal Evidence Regarding Salt Use in Commercial Areas

1) In mid-February 2021, a particularly cold winter storm dropped 4 to 8 inches of snow across the St. Louis region. Once the snow melted, a thin layer of residual salt was visible on some road surfaces where salt laden water had evaporated. Meanwhile, portions of many parking lots and sidewalks still retained layers and small piles of solid rock salt. See photos 1-5.
2) Uncovered or partially covered salt piles were observed by D. Haake at an apartment complex, two hospitals, and a university. See photos 6-11.
3) Overapplication on parking lots and sidewalks in various areas was observed by D. Haake, including at a university, a fast food restaurant, a convention center, and a seminary. See photos 12-16.
4) Uncovered or partially covered salt piles were observed by D.K. and M.K. at many locations over the course of several years. These have been reported to the Missouri DNR, U.S. EPA, and/or Missouri Stream Team.
5) An instance of high chloride concentration of over 20,000 mg/l was captured by D. Haake using a conductivity datalogger (unpublished data). This occurrence is theorized to be the result of an uncovered salt pile observed in a Google Earth image taken within a few days of the event. Other images from this location show a long succession of uncovered salt piles in winter. See photos 17-18.
6) Additional aerial imagery from Google Earth show salt piles that are contaminating local waterways. See photos 19-end.

Photo 1. Parking lot with residual salt film draining into stormwater basin - 2/21/21

Photo 2. Roadway with residual salt film - 2/21/21

Photo 3. Sidewalk with residual salt - 2/21/21

Photo 4. Parking lot with extensive residual salt - 2/21/21

Photo 5. Sidewalk with extensive residual salt - 2/21/24

Photo 6. Partially covered salt pile near a stormwater basin - 3/9/15

Photo 7. Partially covered salt pile - 3/9/15

Photo 8. Partially covered salt pile - 1/12/17

Photo 9. Partially covered salt pile - 1/18/17


Photo 10. Partially covered salt pile – 2/3/17

Photo 11. Partially covered salt pile - 4/23/17

Photo 12. Excessive salt on blacktop parking lot (all of the white is salt except for the small amount of residual snow near the curb in the upper portion of the photo) - 2/9/16

Photo 13. Residual salt on parking lot - 3/9/15

Photo 14. Excessive salt on blacktop parking lot immediately upstream of one of the monitoring sites - 1/9/17

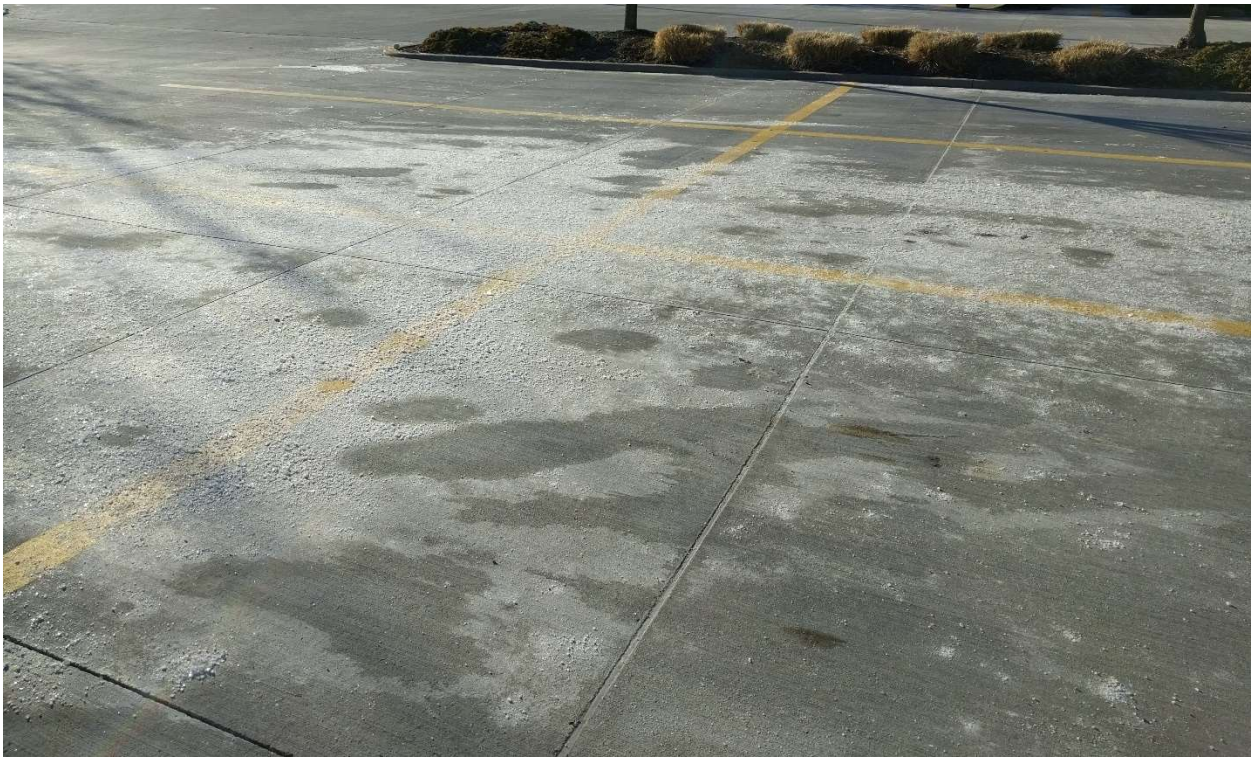

Photo 15. Excessive salt on parking lot - 1/29/16

Photo 16. Excessive salt on a sidewalk - 11/12/19

Photo 17. A screen shot of a Google Earth image with the uncovered salt pile in the upper right of the parking lot, a drainageway visible between the parking lot and driveway, and receiving stream in the wooded area of the lower right. Note the extensive drainage pattern coming from the area of the salt pile. - 2/24/18

A - 1/12/13

B - 11/24/14

C - 1/1/16

D - 1/4/16

E - 1/11/16

F - 1/14/16

G - 7/13/20

Note: In G, there appears to be a salt shelter. Some salt leakage is still evident.

Photo 18 A-F. A series of Google Earth images. Additional images taken in the summer did not show the salt pile, indicating that excess salt was removed seasonally.

Photo 19. Runoff from a parking lot at a healthcare facility - 6/30/18


Photo 20. Runoff from a parking lot at a healthcare facility (same as photo 19) - 7/13/20


Photo 21. A partly covered salt pile - 1/24/18

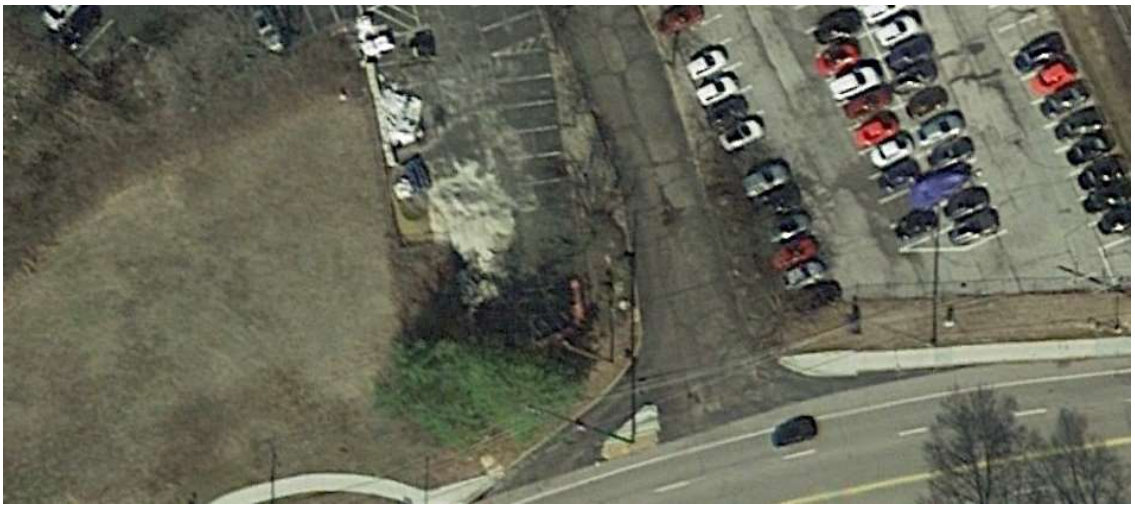

Photo 22. An uncovered salt pile - 2/24/18

Photo 23. An uncovered salt pile (same as photo 22) - 7/11/18

Photo 24. An uncovered salt pile in a commercial district - 2/24/18