
Photo: Mike Parsen

Uses of neonicotinoids on the landscape

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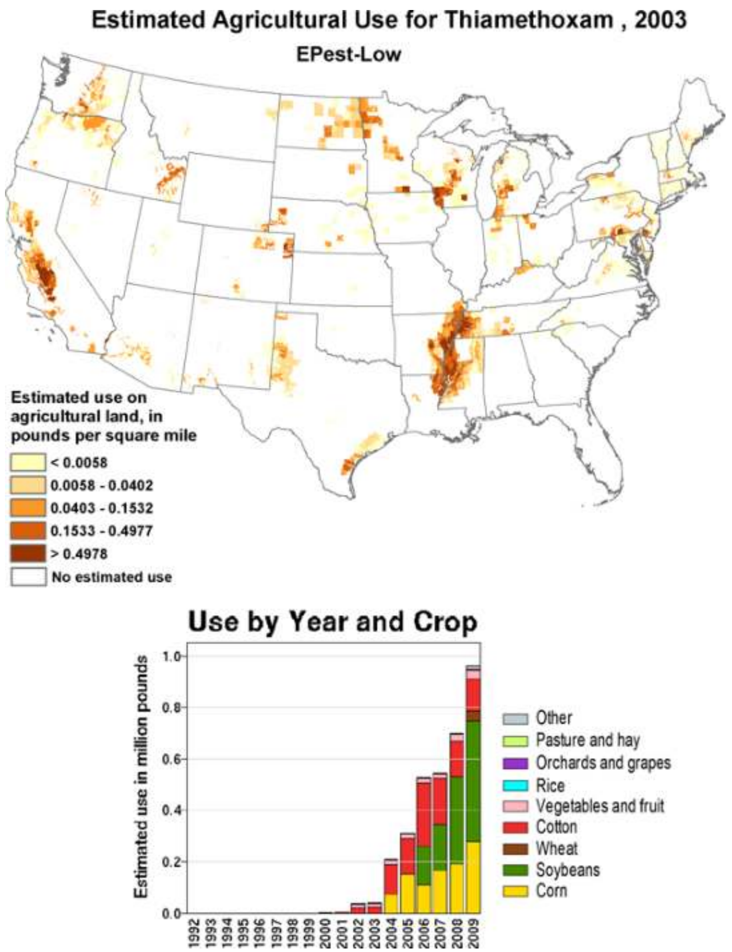
Wisconsin Specialty Crops

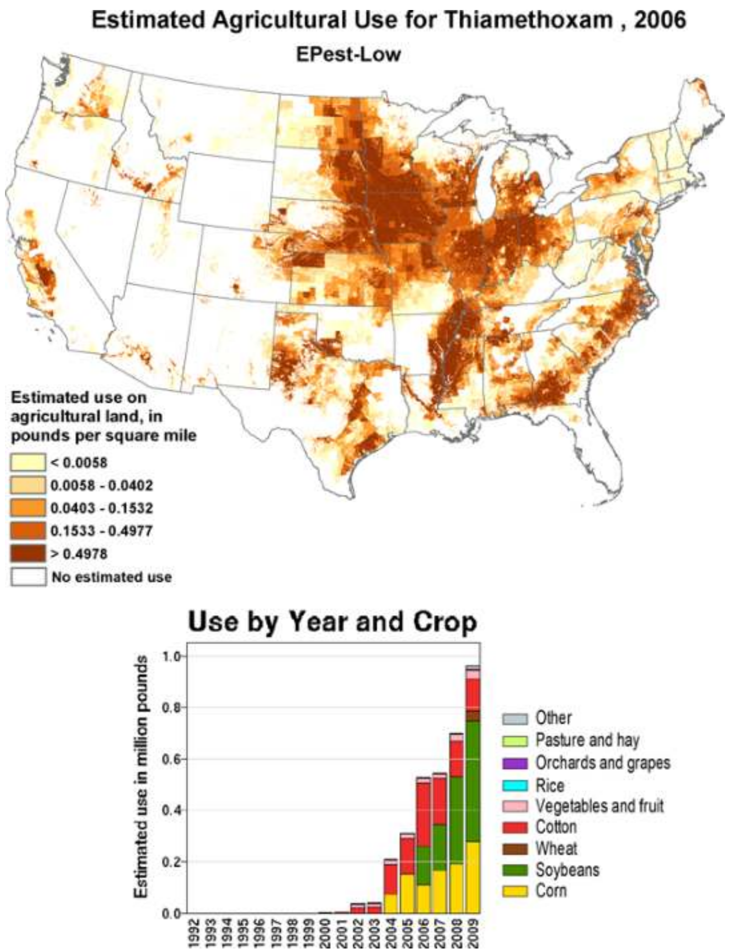
Crop	Nat. Rank[1]	Acres[1]	% of U.S. [1]	$ Value (millions) [1]	Estimated Neonic Use[2]
Major crops					
Potatoes	3	73,300	16	$498	92%
Sweet corn (Proc)	2	57,900	49	$303	95%
Sweet corn (Fresh)	--	8,300	8	$94	85%
Snap beans	1	67,900	55	$239	90%
Peas	3	29,300	26	$160	35%
Minor crops					
Cucumbers (pickles)	4	5,800	22	$38	0%
Cabbage (fresh)	8	2,100	10	$12	0%
Cabbage (kraut)	1	3,900	83	$18	0%
Carrots	2	3,100	67	$16	5%
Onions (storage)	8	2,200	8	$15	40%
Beets (table)	1	1,500	66	$11	0%

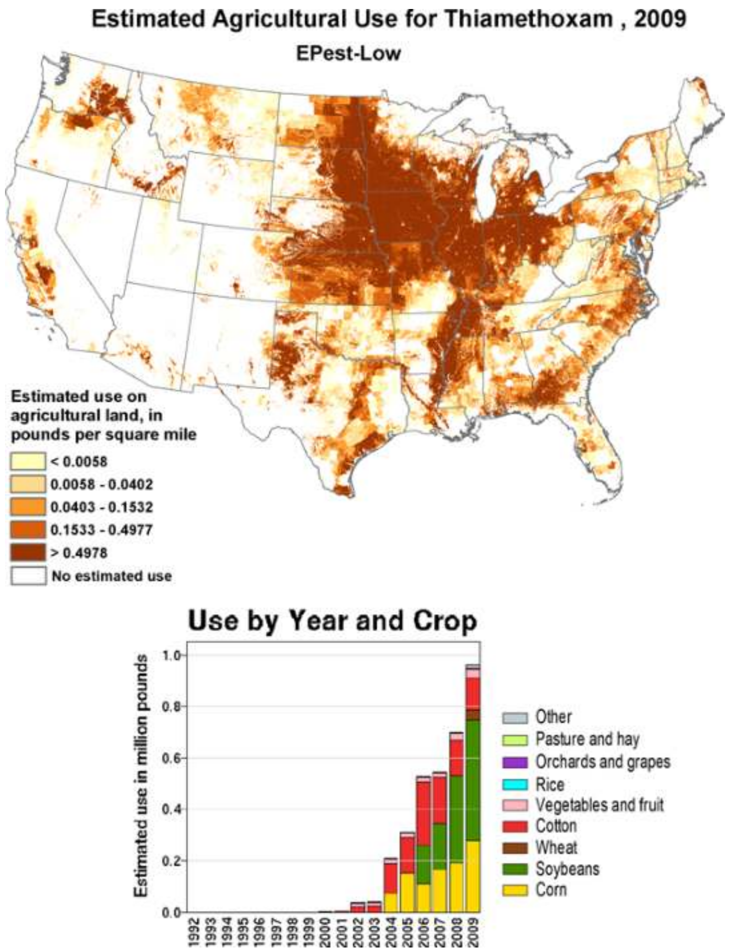
[1] https://www.nass.usda.gov/Statistics_by_State/Wisconsin/index.php

[2] Janousek, et al. (2022). https://doi.org/10.5066/P9H45NUG

Annual Changes in Crop Usage: THMX 2003 – 2006 - 2009

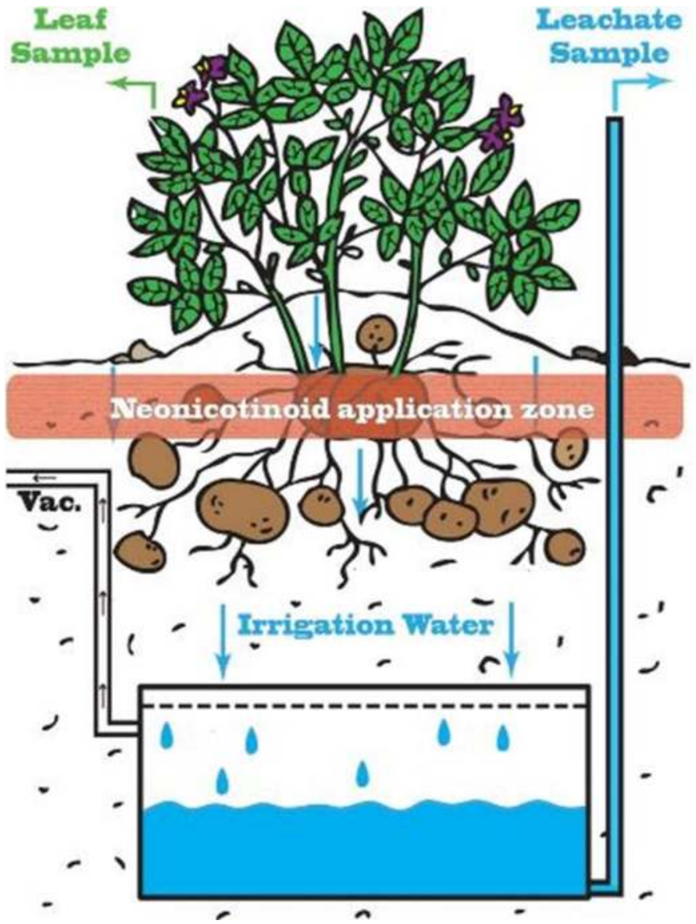


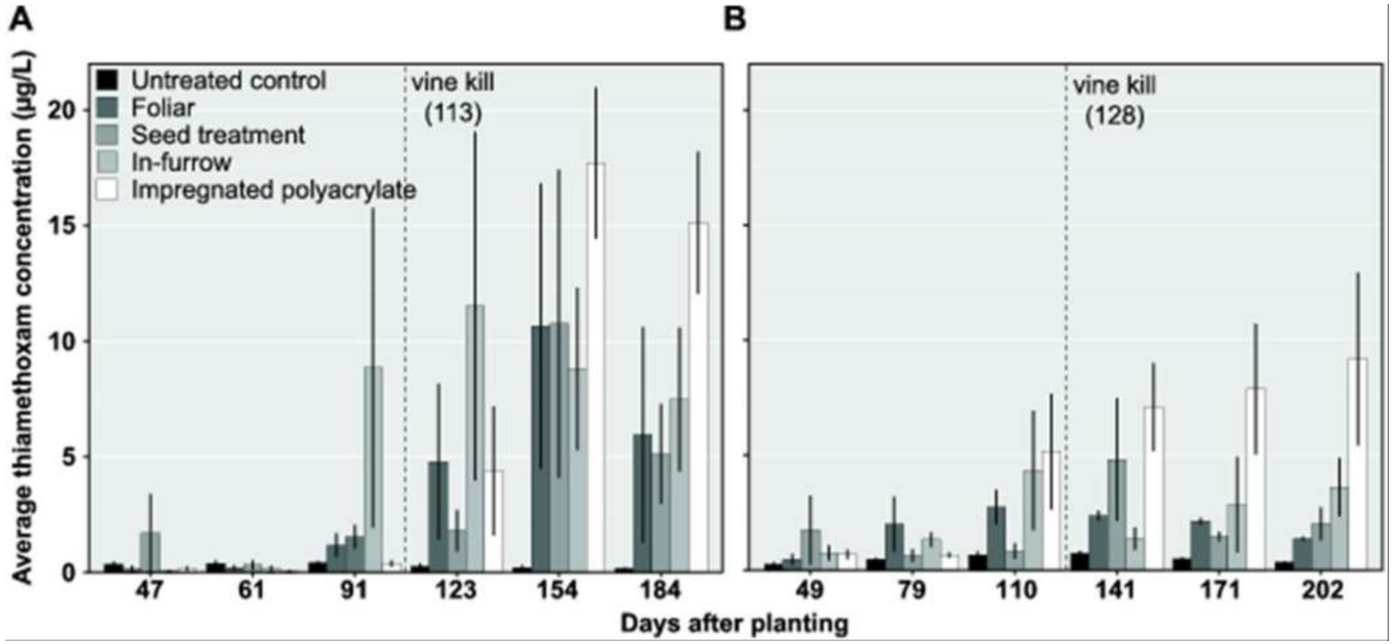




https://water.usgs.gov/nawqa/pnsp/usage/maps/compound_listing.php

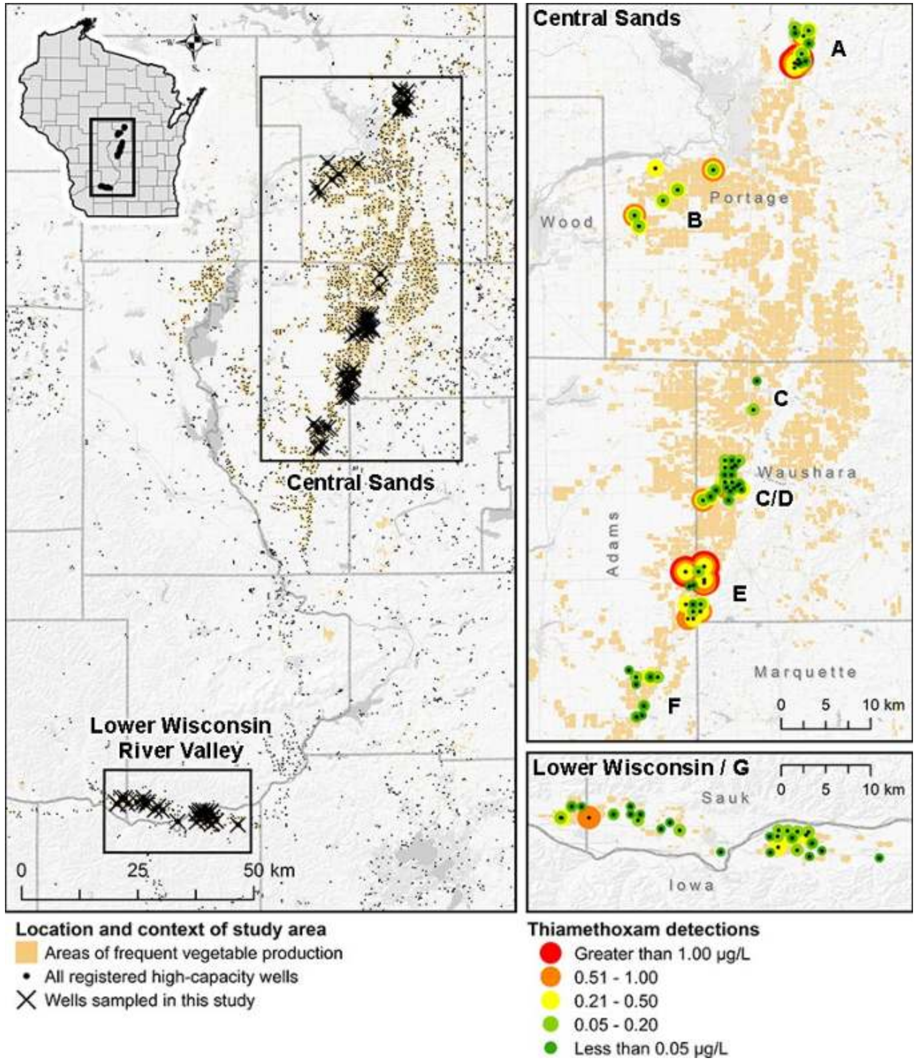
Past Research – Phenology of loss; lysimeter studies

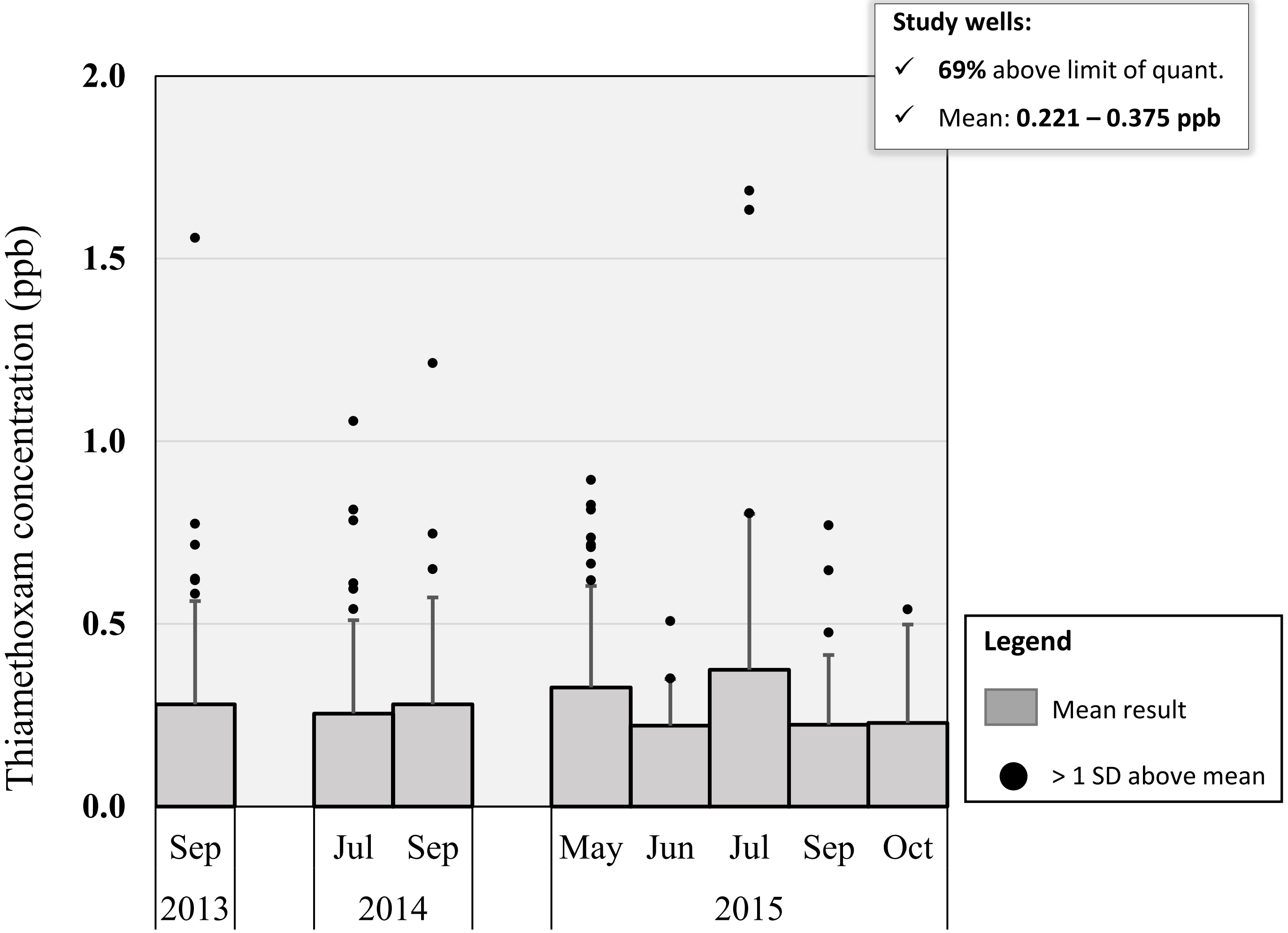




Huseth and Groves 2014, PLoS One
(https://doi: 10.1371/journal.pone.0097081)

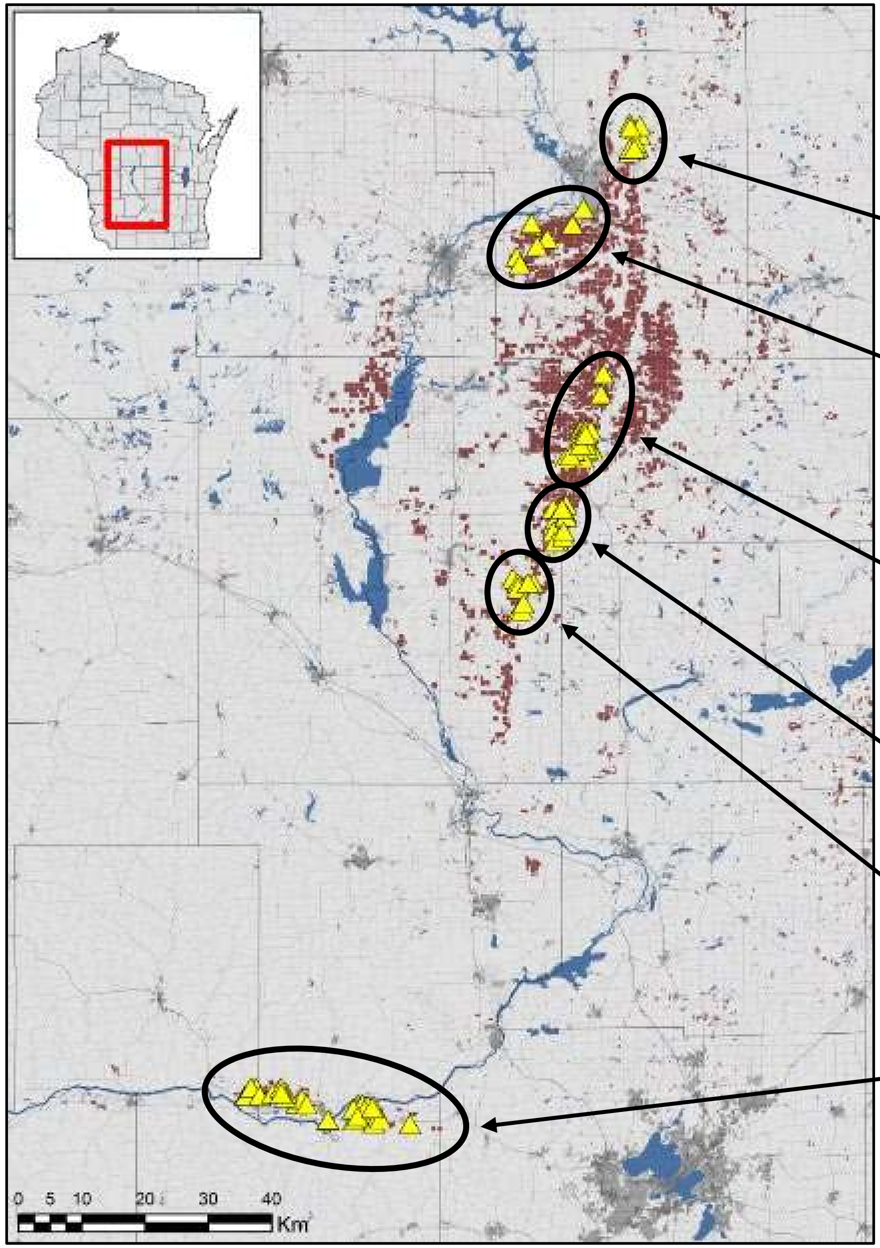
Past Research – High Capacity Well Sampling (2014-2016)

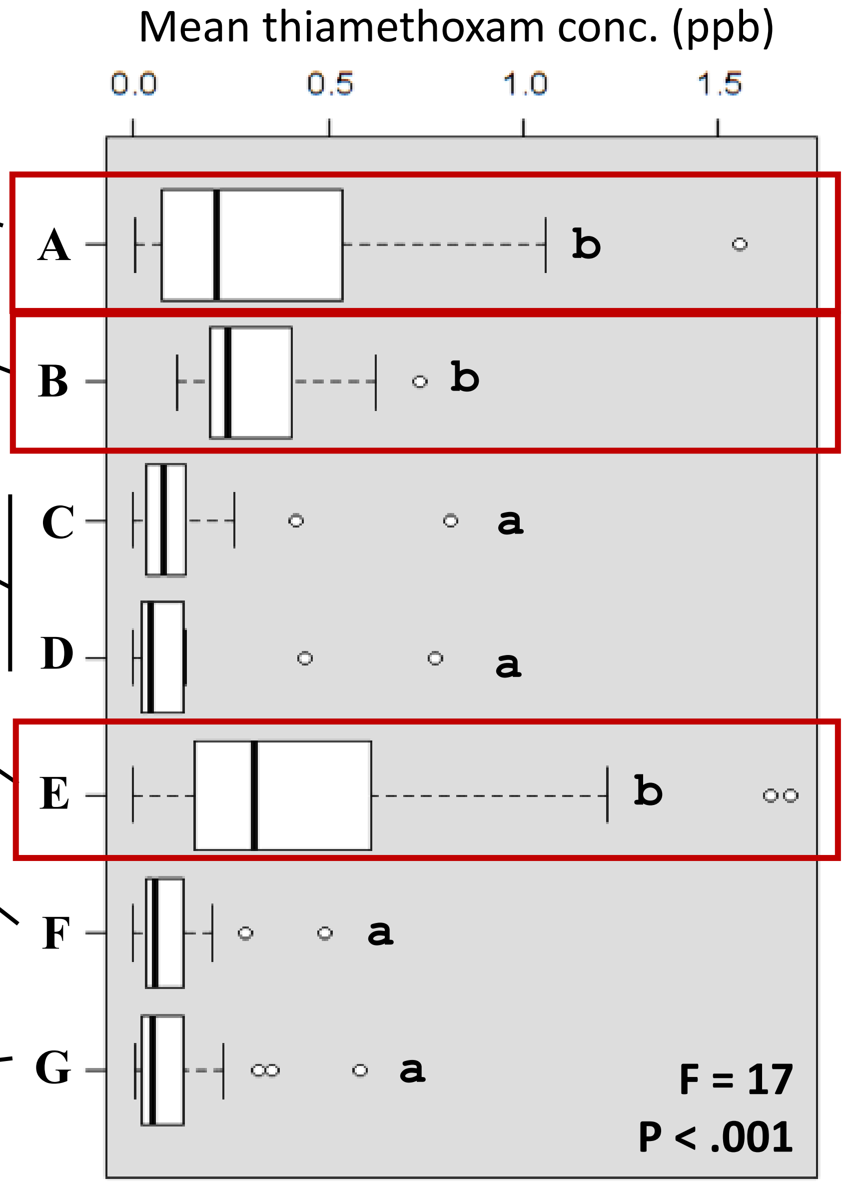




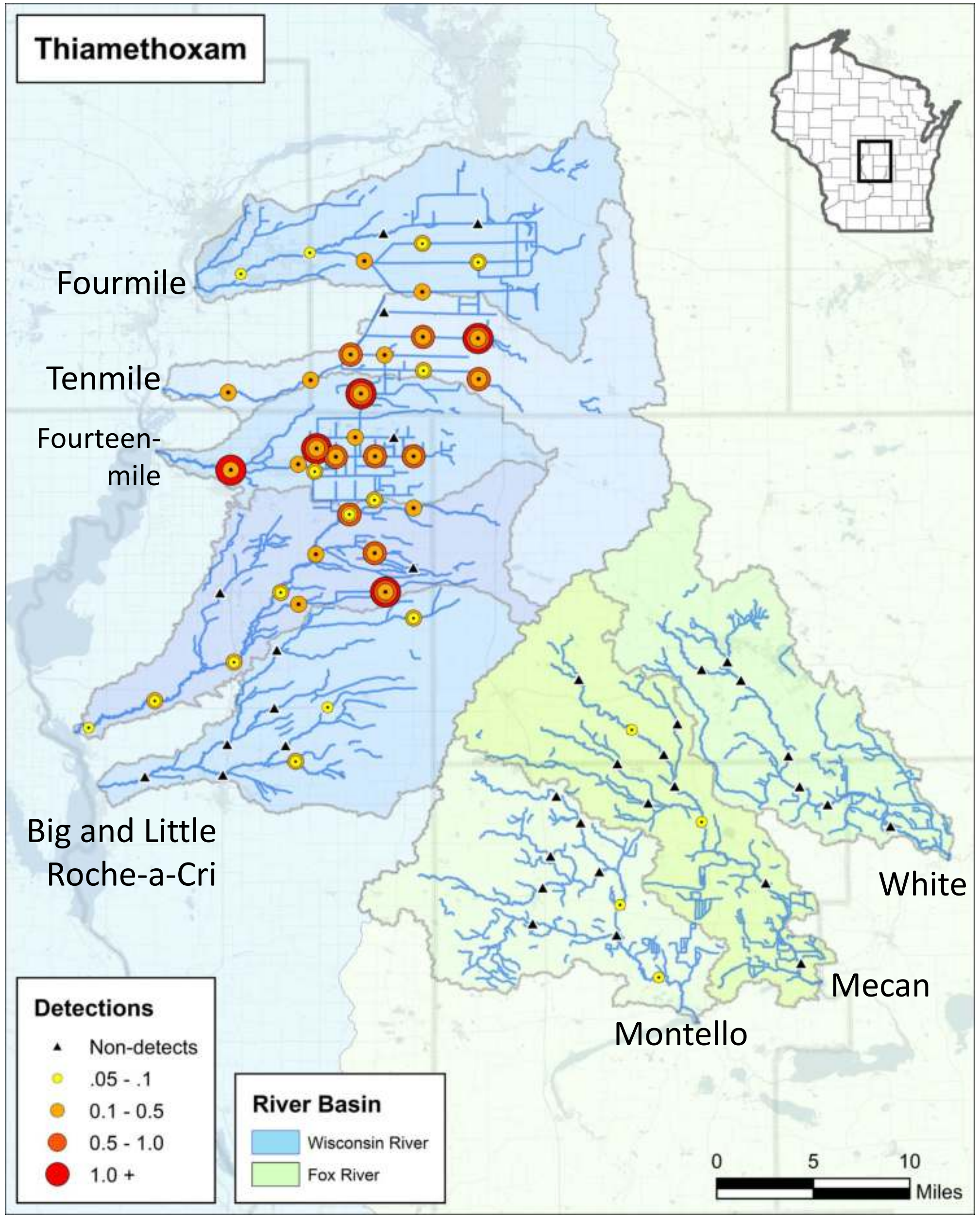
Bradford and Groves 2016. ***https://doi.org/10.1371/journal.pone.0201753***

Past Research – High Capacity Well Sampling; THMX well clusters (2014-2016)

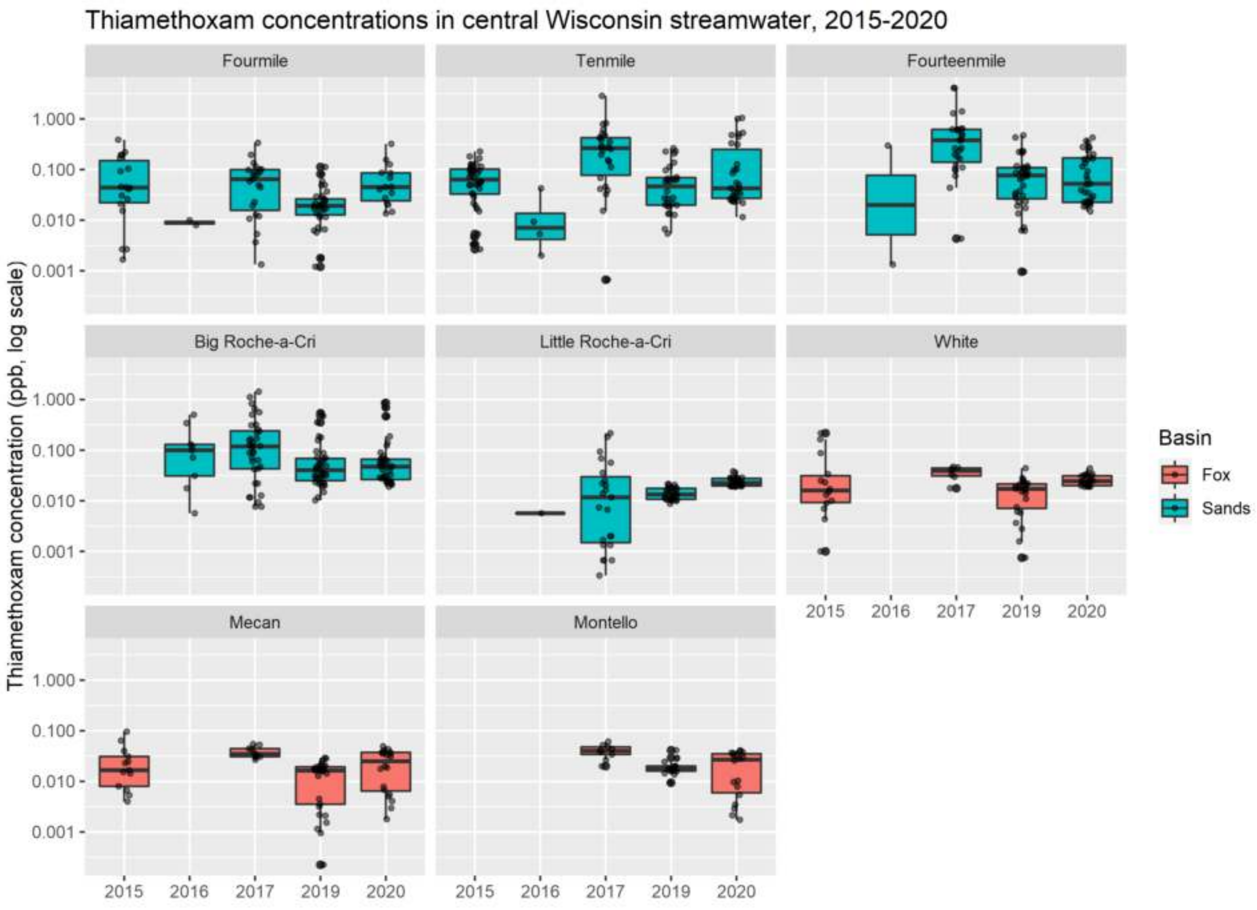




Bradford and Groves 2016. https://doi.org/10.1371/journal.pone.0201753



Earlier investigations: Regional neonicotinoid sampling (n=87)



Beyond annual/seasonal variation, how does landscape predict neonic concentration?

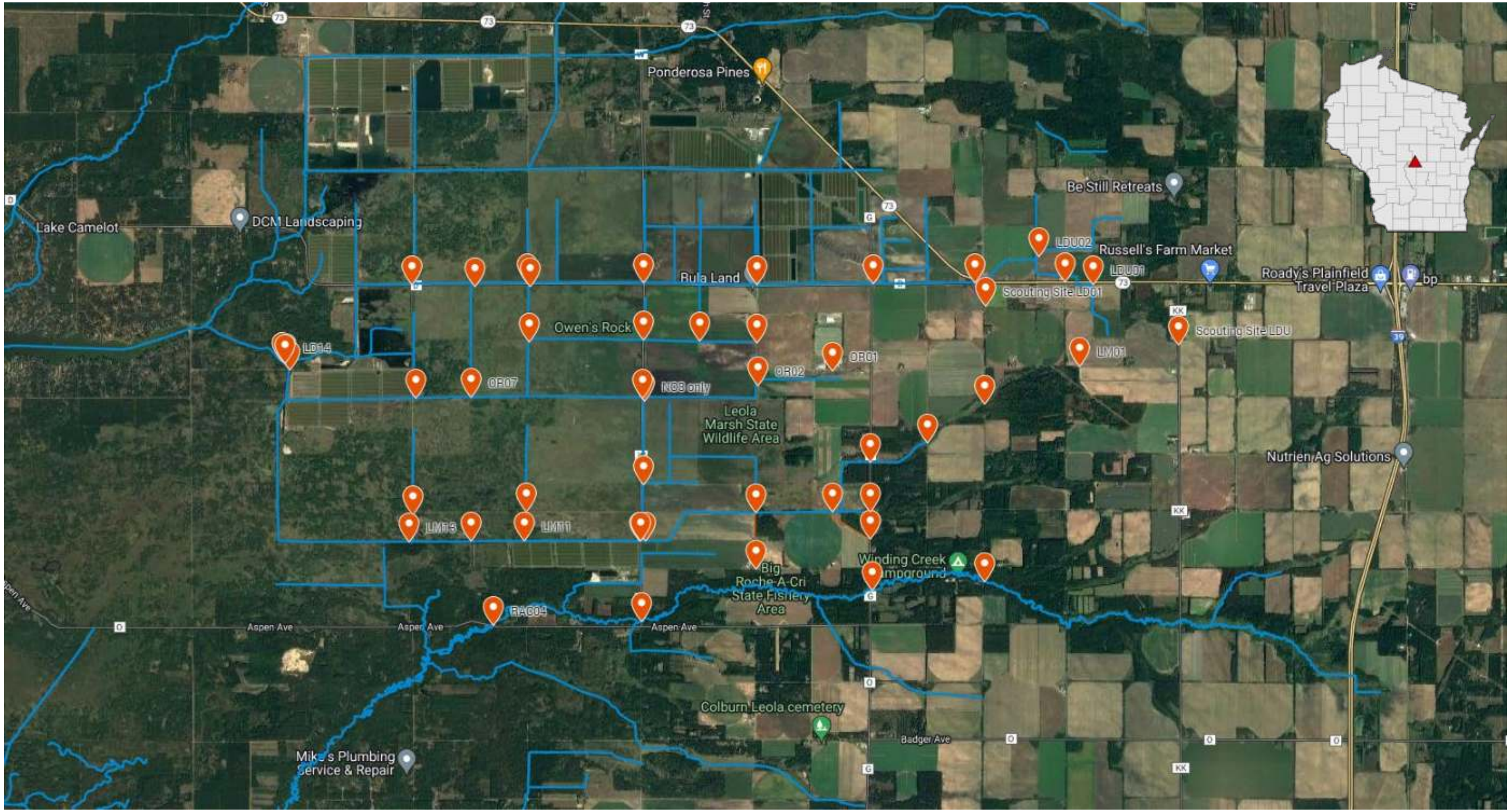
- Objective 1
  - Detection of neonicotinoids in
  - Hydrogeological characterization of ditch network
- Objective 2
  - Groundwater modeling (Vistas pckg)
  - Landscape analysis (NLCD + CDL)

Why Fourteen Mile?

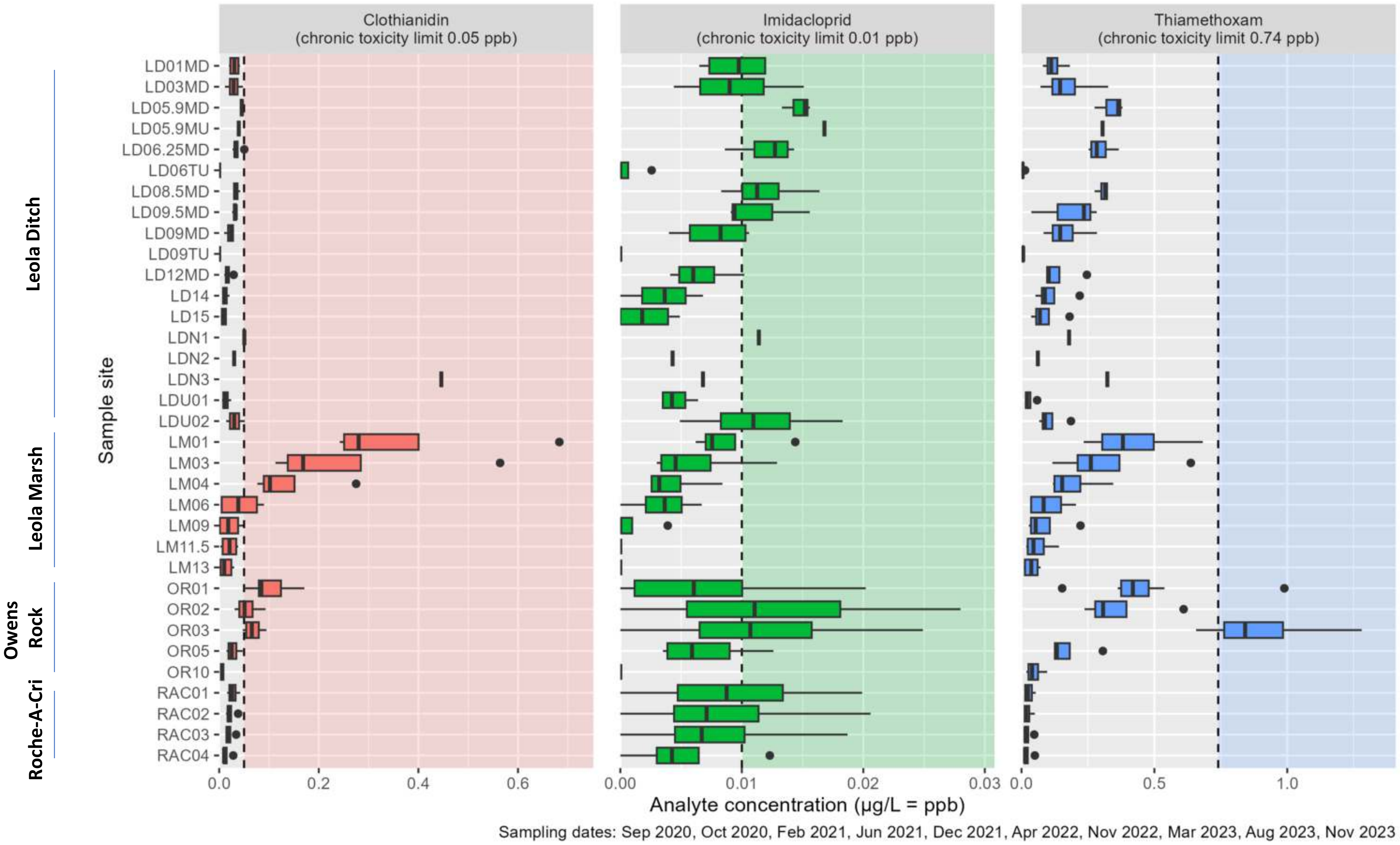
History of neonic detections

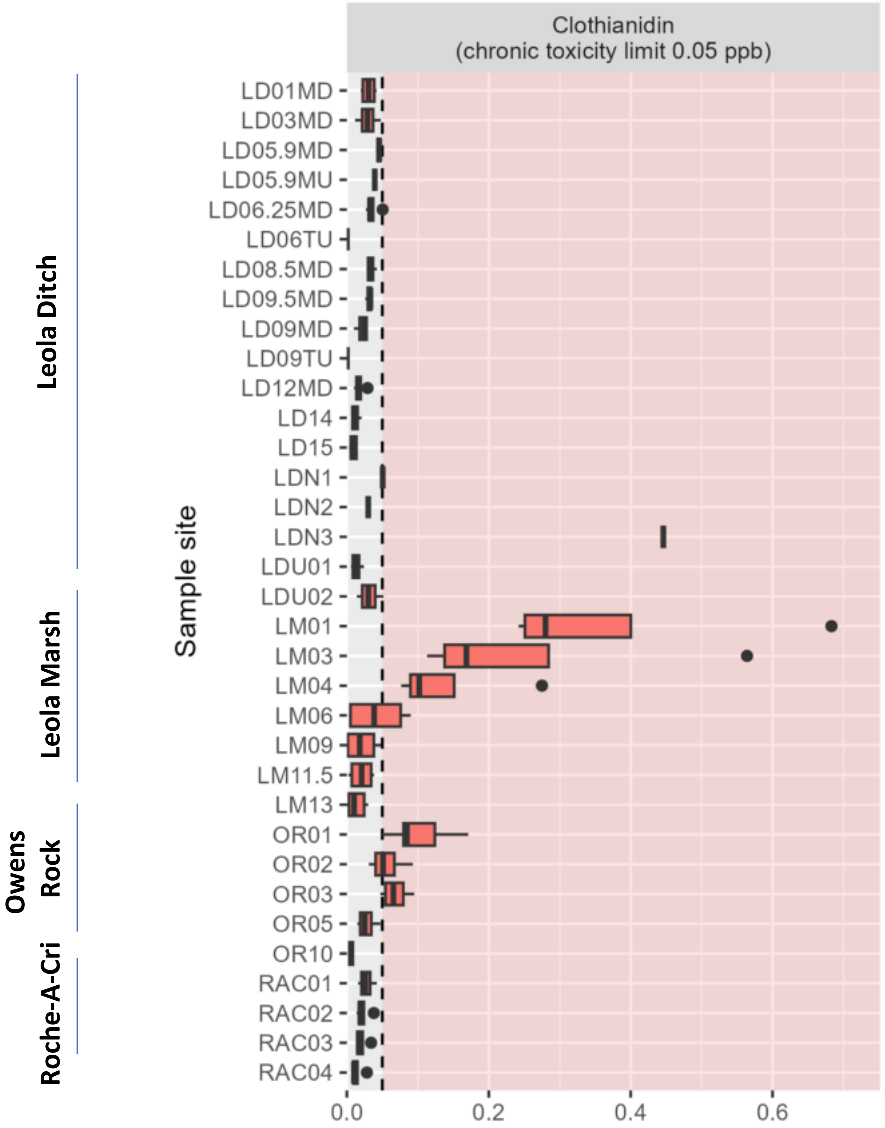
N-S gradient of channelized vs natural stream paths

E-W gradient of more intensive agriculture to more marsh and forest land



Ongoing Research – Neonicotinoid detections within/among streams



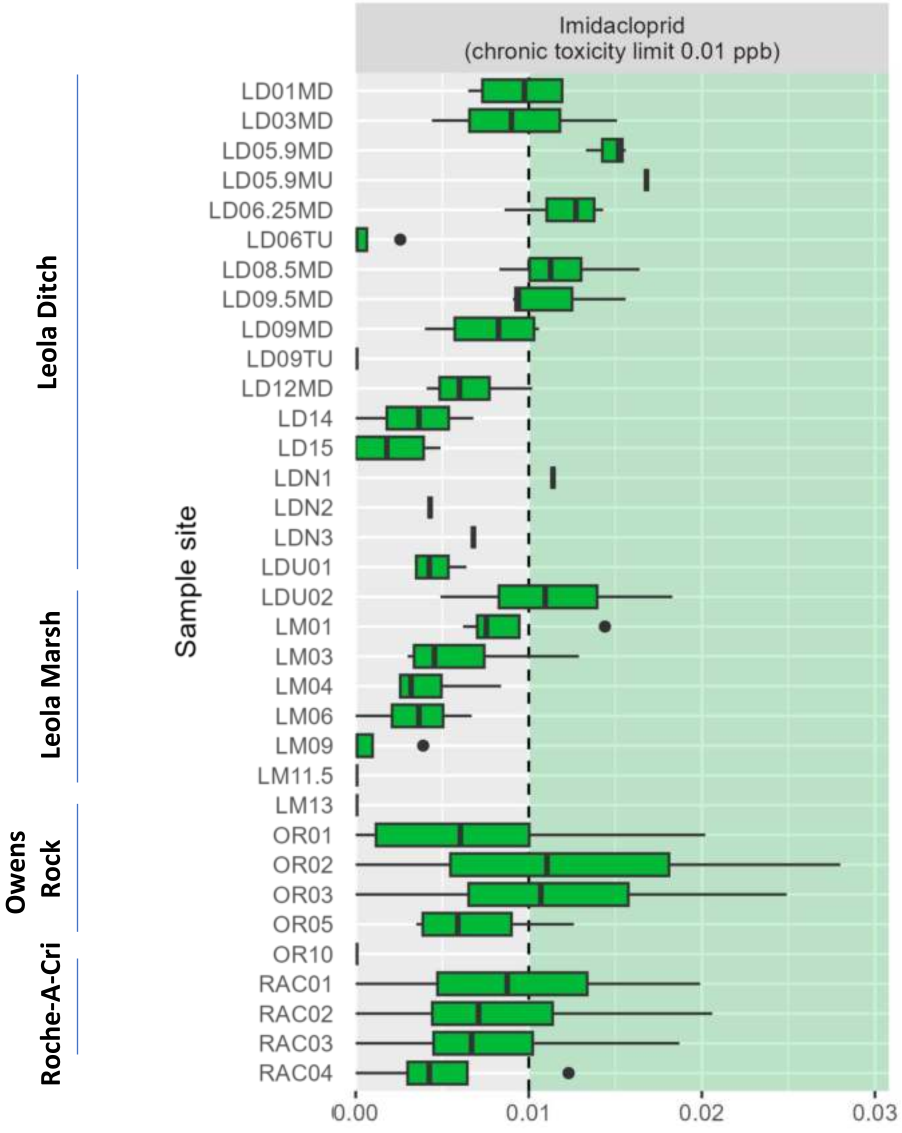


Poncho® 600

BELAY®
50 WDG INSECTICIDE

Clothianidin: (1st metabolite of THMX) - 0.327 g^{-1} L (20°C)

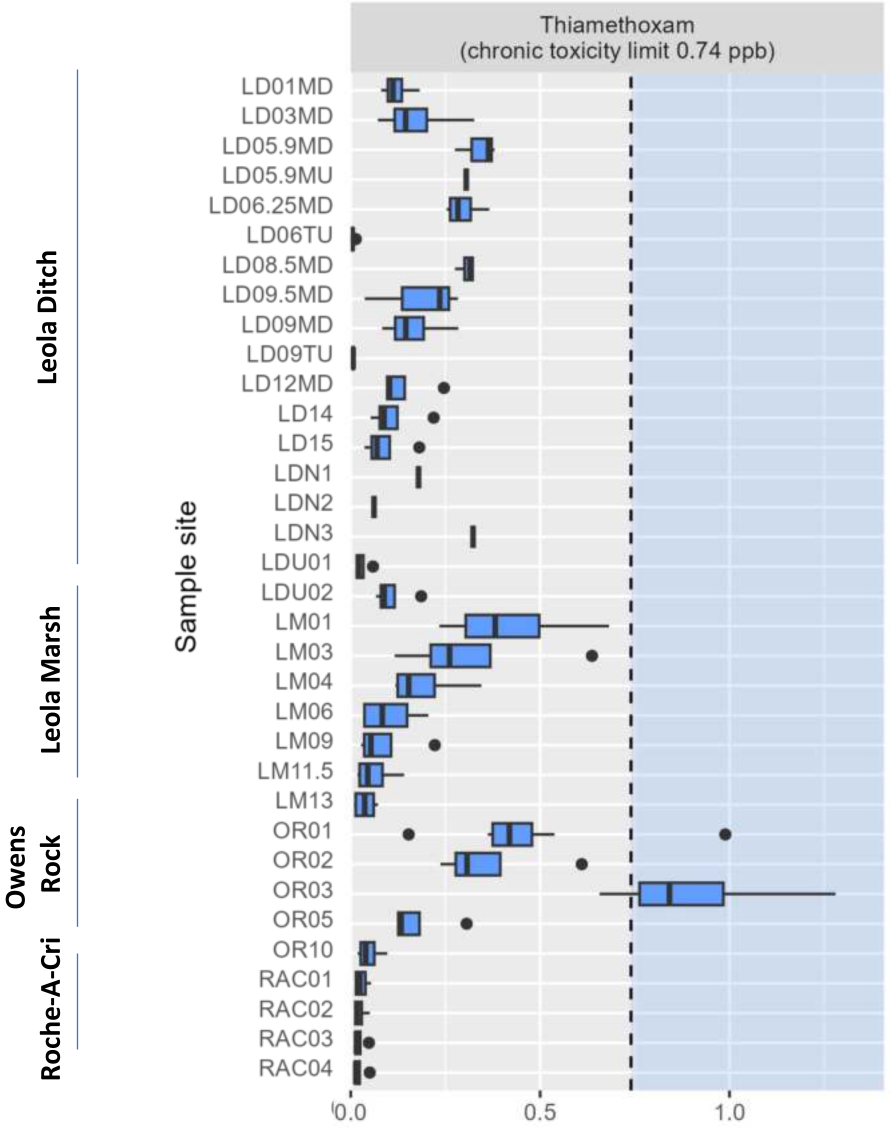
- EPA aquatic life chronic limit 0.05 ppb
- 29 / 126 (23%) samples > chronic limit
- 11 / 34 (32%) of sites with a sample > chronic limit



Imidacloprid: 0.61 g^{-1} L (20°C)

- EPA aquatic invertebrate chronic toxicity limit 0.01 ppb
- 35 / 125 (28%) of samples > chronic limit
- 21 / 34 (62%) of sites with a sample > chronic limit

Ongoing Research – Thiamethoxam detections among/within streams

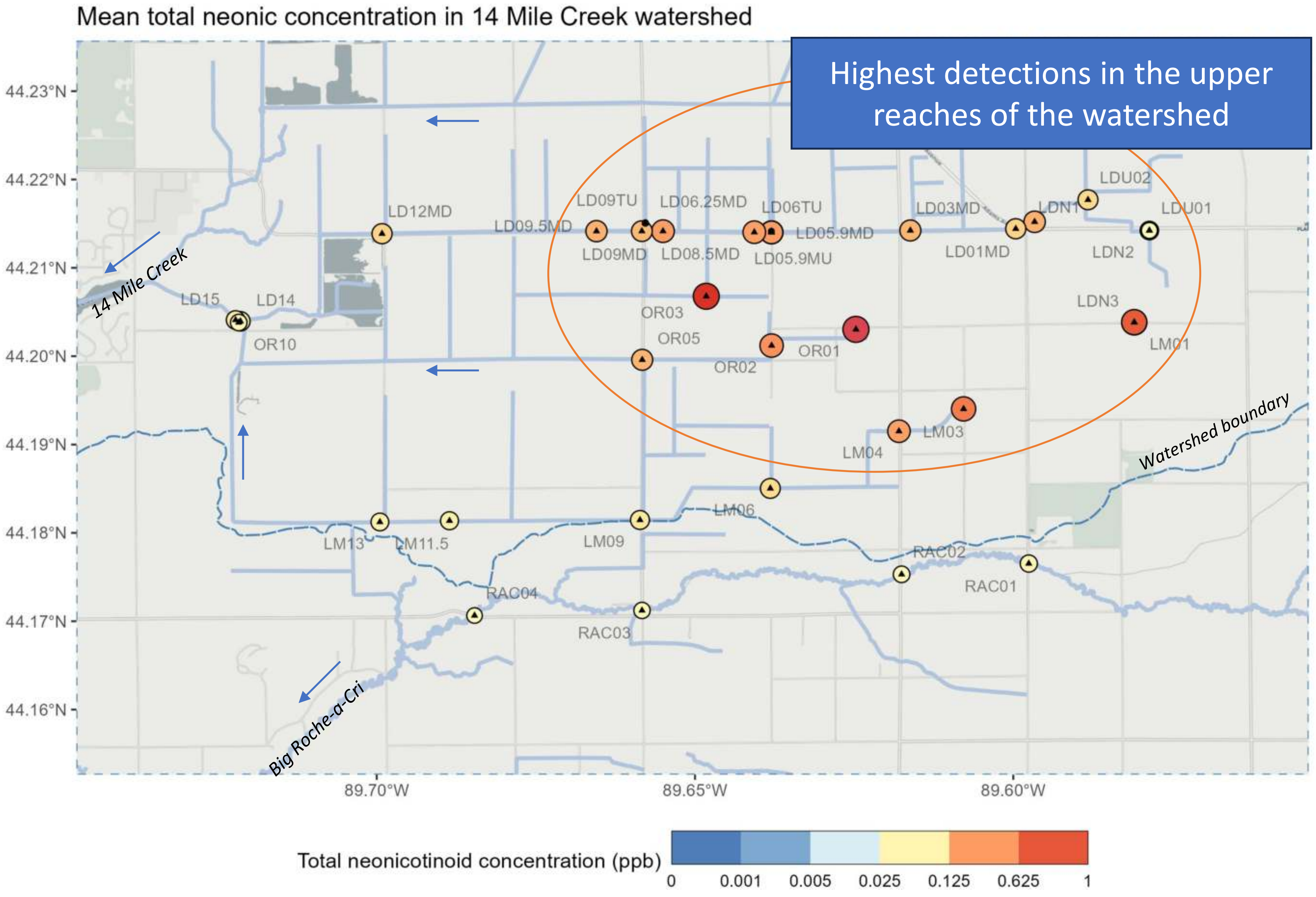


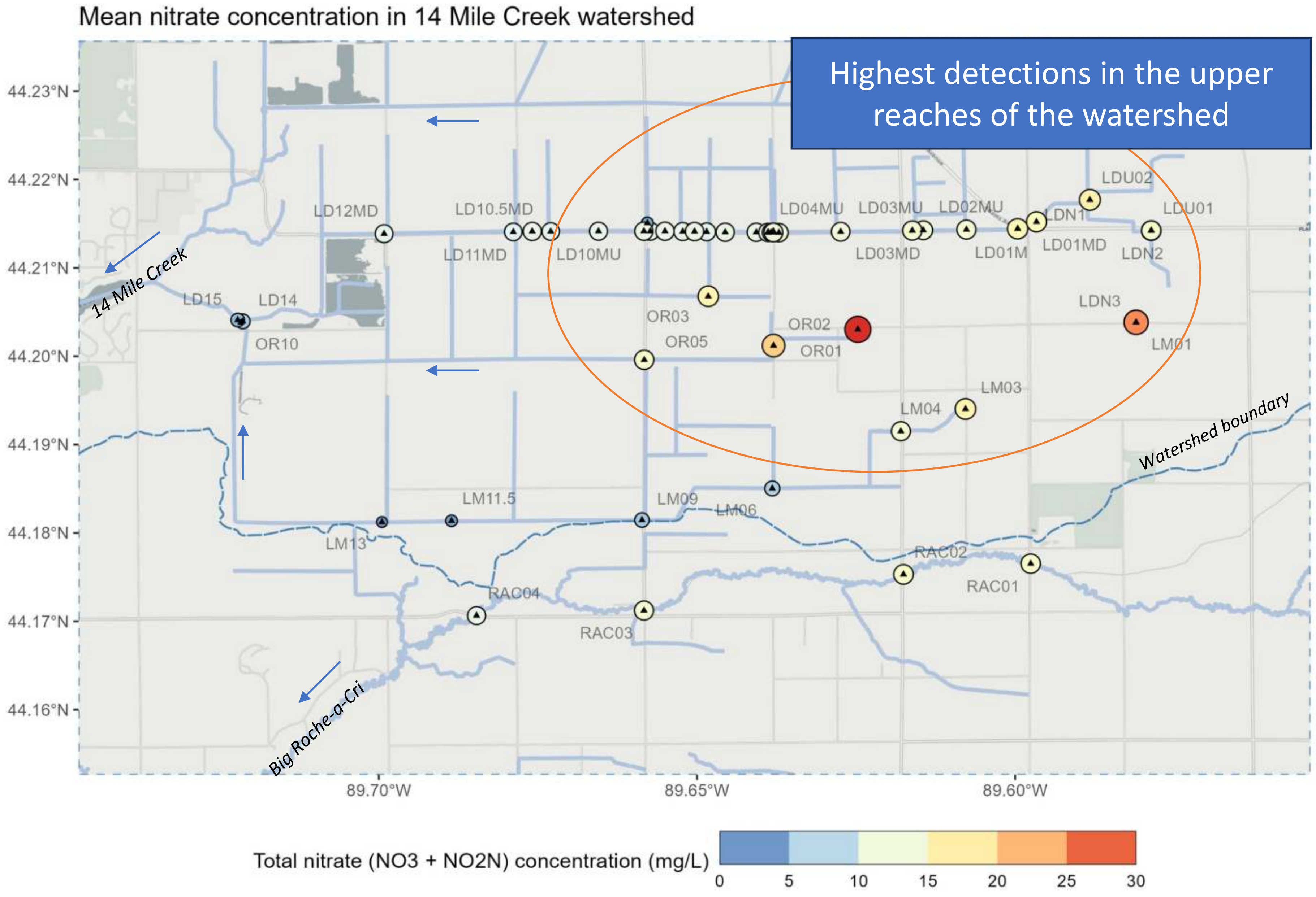
Actara®
Agri-Flex® Miticide/Insecticide
Platinum® Insecticide
Cruiser® 5FS
Endigo® ZC

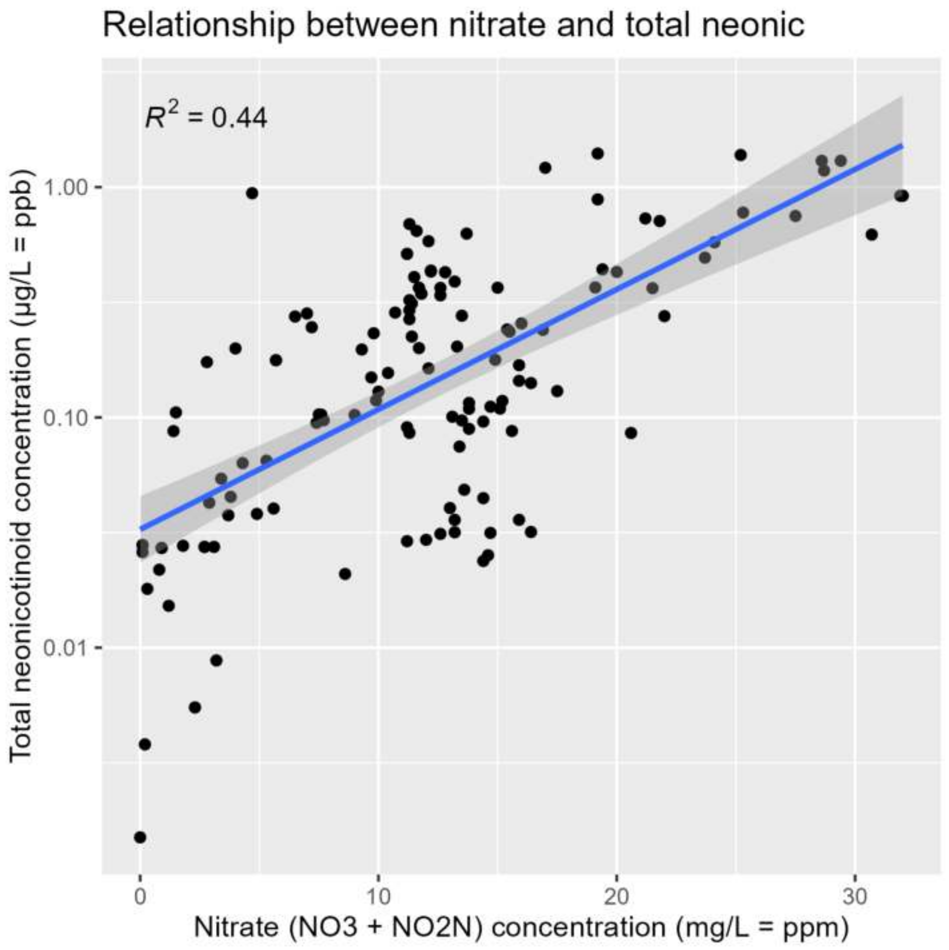
Thiamethoxam: 4.1 g^{-1} L (20°C)

- EPA aquatic invertebrate chronic toxicity limit 0.74 ppb
- 4 / 126 (3%) of samples > chronic limit
- 2 / 34 (6%) of sites with a sample > chronic limit

Ongoing Research – Where do we find the neonicotinoids?



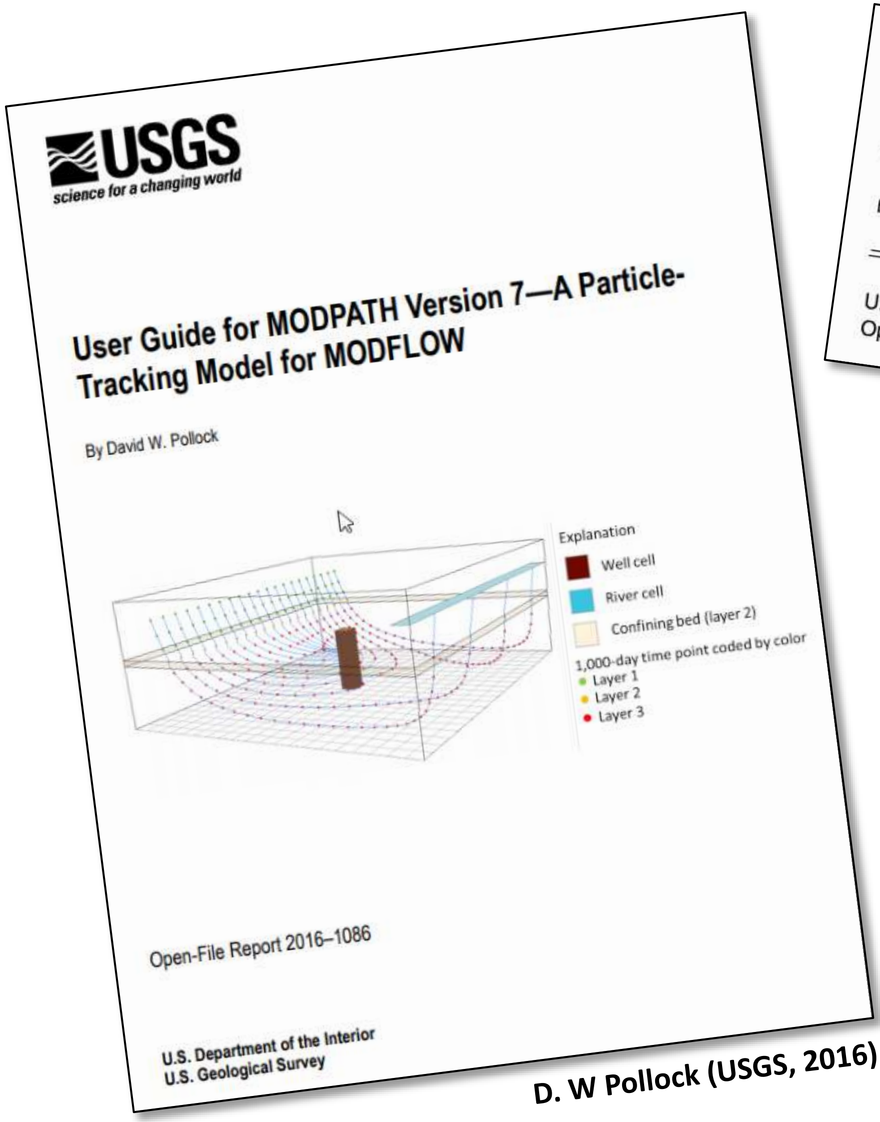

Mean nitrate concentration in 14 Mile Creek watershed
Highest detections in the upper reaches of the watershed
44.23°N
44.22°N
44.21°N
44.20°N
44.19°N
44.18°N
44.17°N
44.16°N
89.70°W
89.65°W
89.60°W
14 Mile Creek
Big Roche-a-Cri
Watershed boundary
LD12MD
LD10.5MD
LD11MD
LD10MU
LD04MU
LD03MU
LD02MU
LD03MD
LD01M
LD01MD
LDN1
LDU02
LDU01
LDN2
LDN3
LM01
LD15
LD14
OR10
OR03
OR05
OR02
OR01
LM03
LM04
LM11.5
LM09
LM06
LM13
RAC02
RAC01
RAC04
RAC03
Total nitrate (NO3 + NO2N) concentration (mg/L)
0
5
10
15
20
25
30



Similarities:

- Both contaminants are strongly correlated in water samples
- Both derive from agricultural activity
- Higher detections occur in the higher reaches of each stream
- Dilution is observed as we travel downstream

Particle tracking (MODPATH) & Endpoint analysis with Groundwater Vistas 8



USGS
science for a changing world

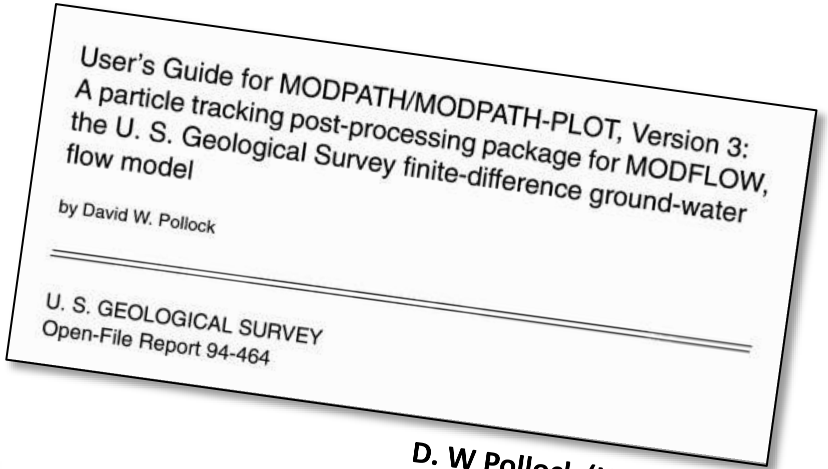
User Guide for MODPATH Version 7—A Particle-Tracking Model for MODFLOW

By David W. Pollock

Open-File Report 2016–1086

U.S. Department of the Interior
U.S. Geological Survey

D. W Pollock (USGS, 2016)

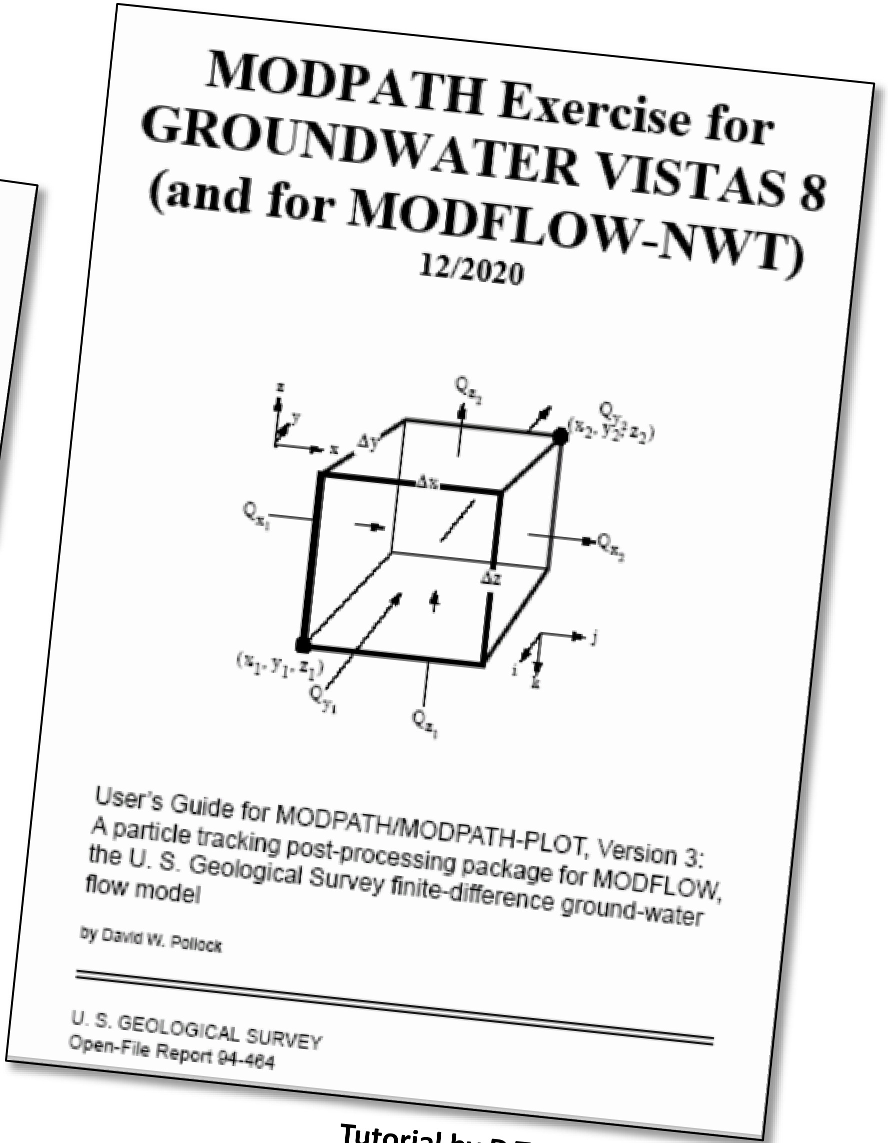


User's Guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking post-processing package for MODFLOW, the U. S. Geological Survey finite-difference ground-water flow model

by David W. Pollock

U. S. GEOLOGICAL SURVEY
Open-File Report 94-464

D. W Pollock (USGS, 1994)



MODPATH Exercise for GROUNDWATER VISTAS 8 (and for MODFLOW-NWT)
12/2020

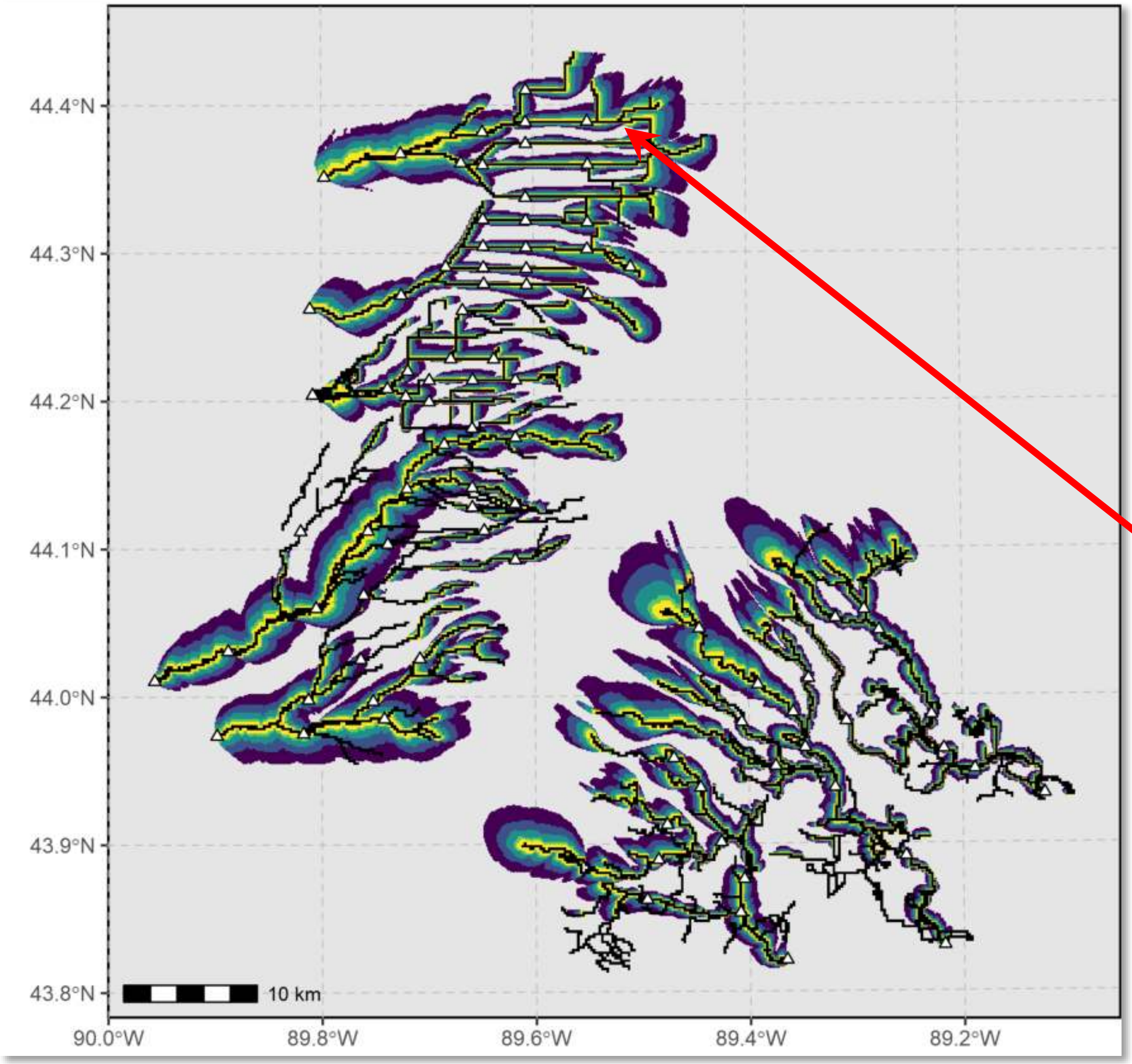
User's Guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking post-processing package for MODFLOW, the U. S. Geological Survey finite-difference ground-water flow model

by David W. Pollock

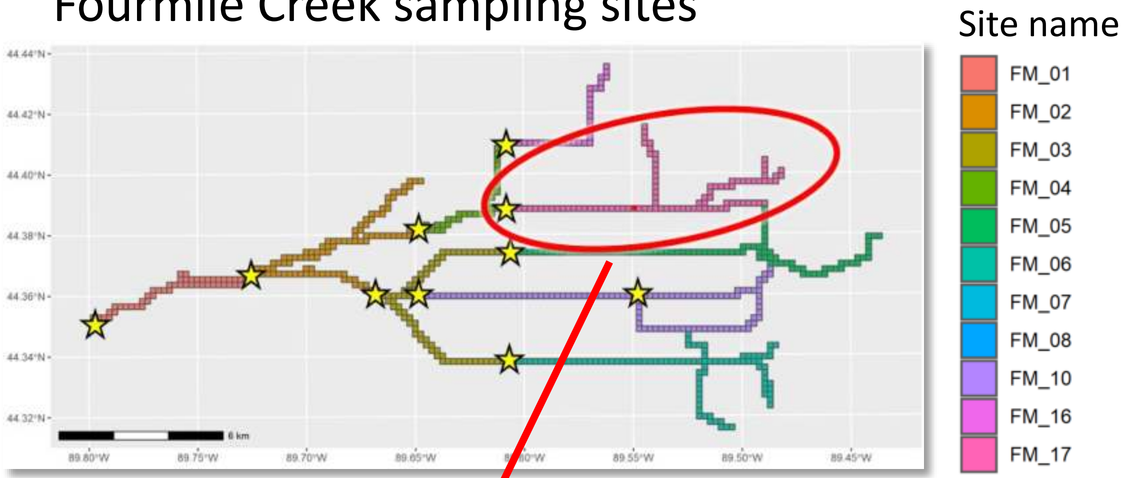
U. S. GEOLOGICAL SURVEY
Open-File Report 94-464

Tutorial by D.T. Feinstein (USGS)

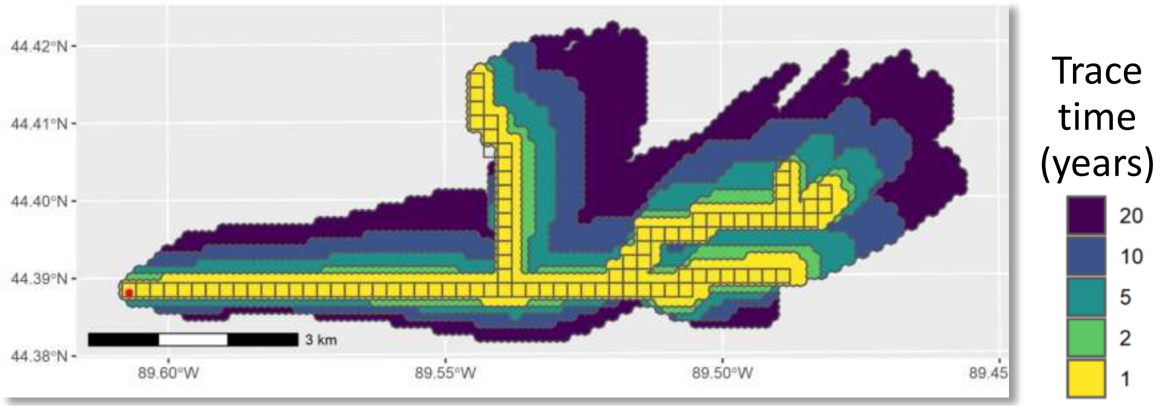
Generate contributing areas for all 87 sites



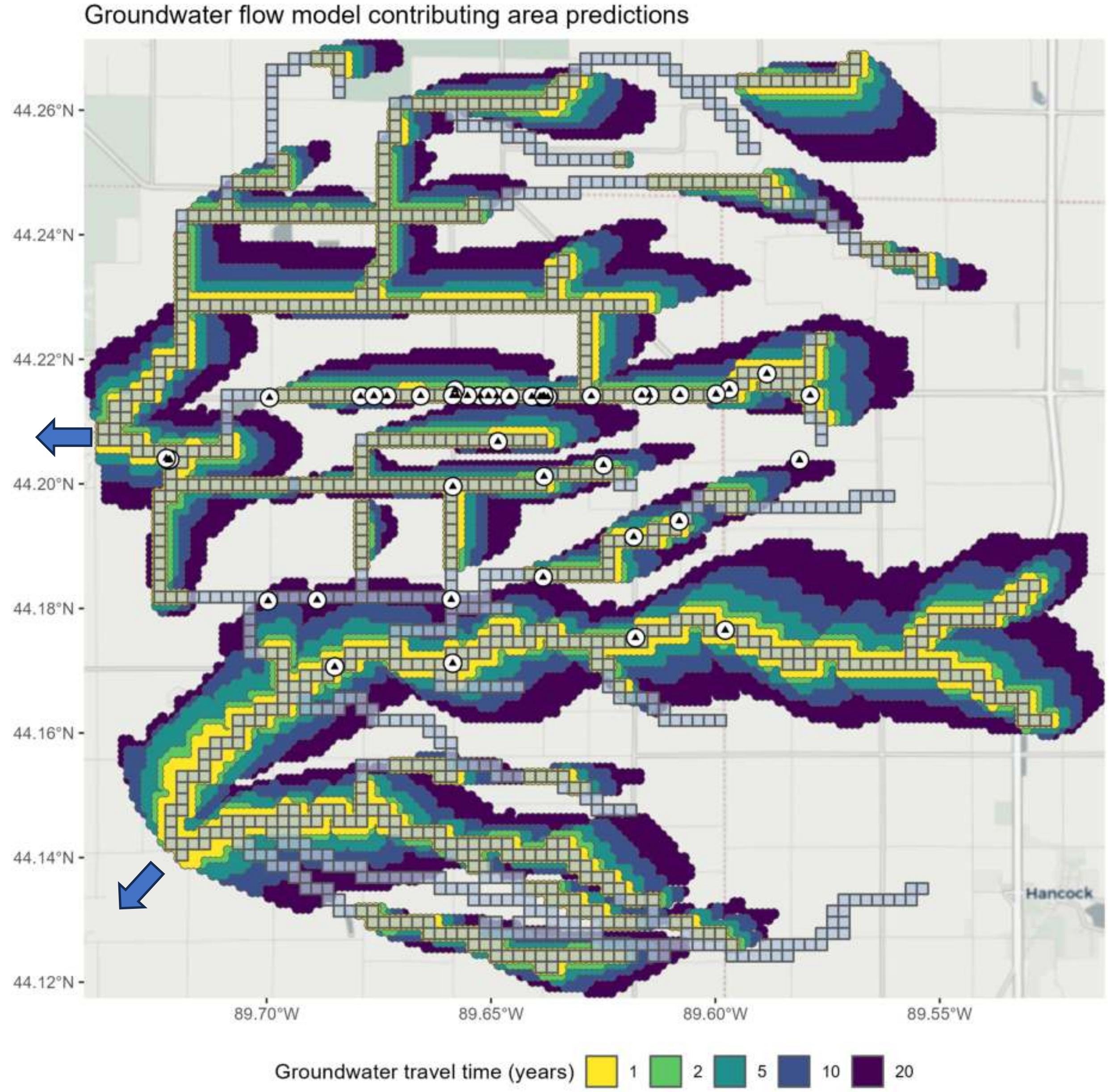
Fourmile Creek sampling sites



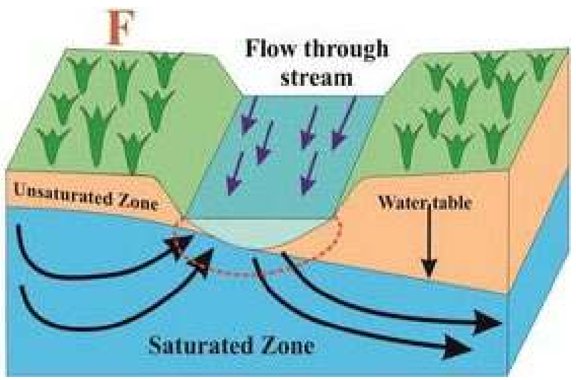
Fourmile Creek contributing areas



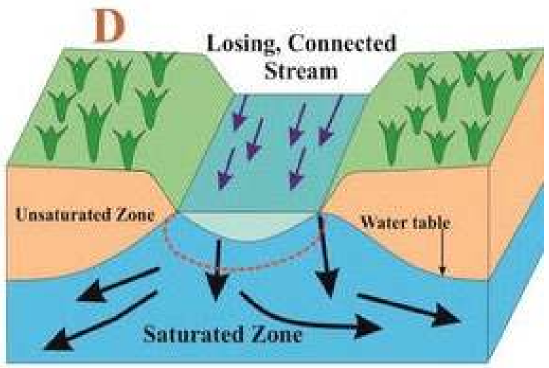
- *Contributing areas vary from >125 km^2 to just a few km^2*



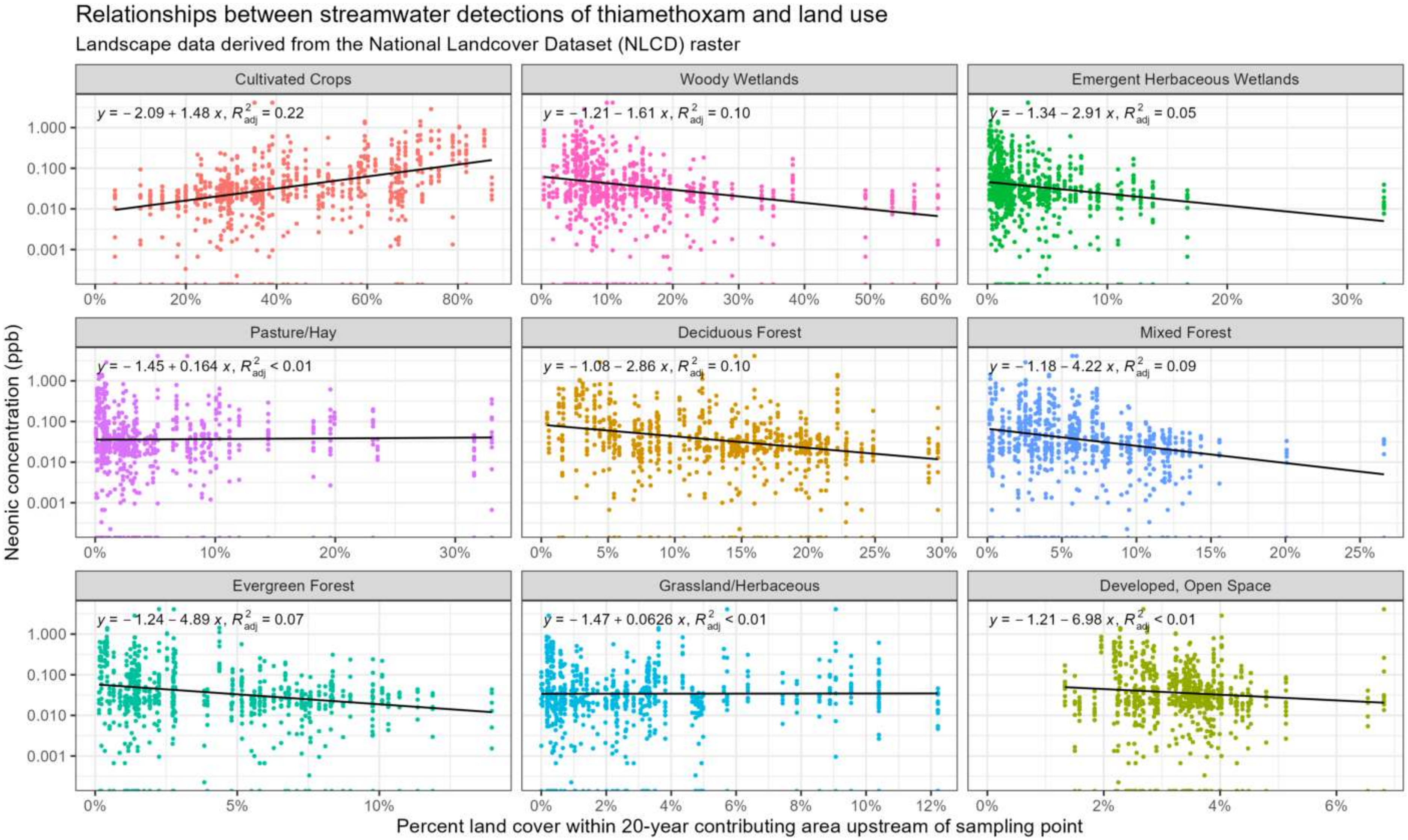
"Gaining" section



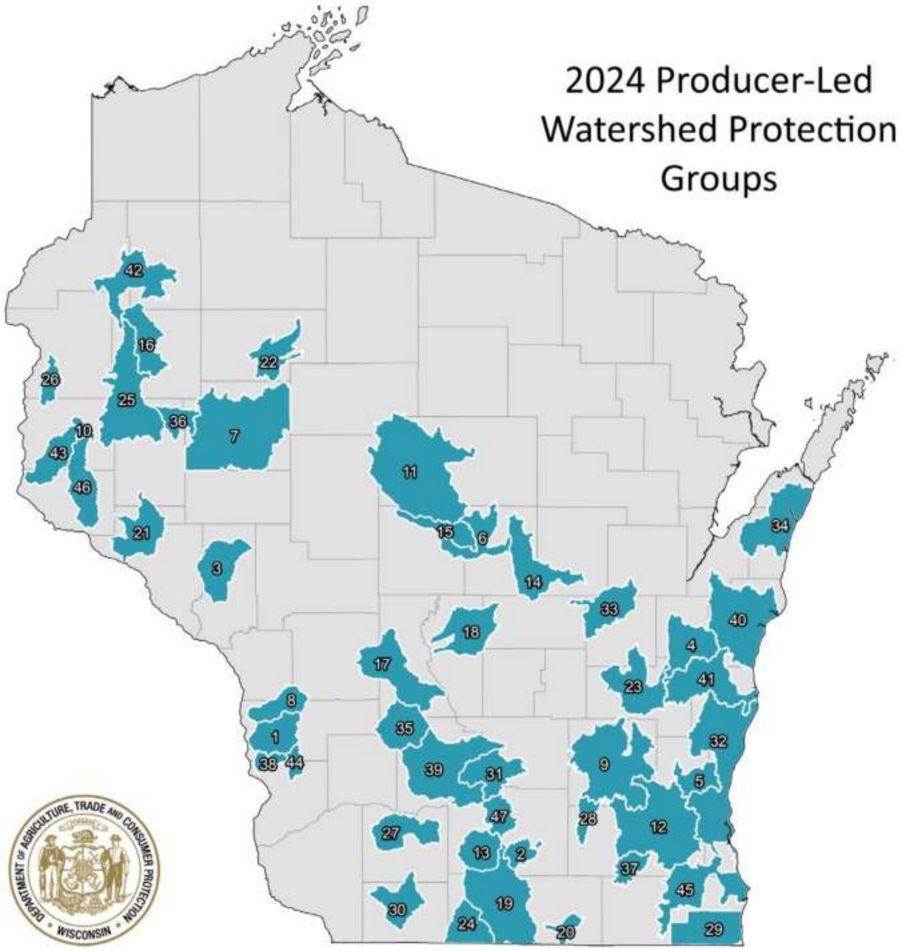
"Losing" section



Generating contributing areas – groundwater flow processes and adjacent agricultural use



Solutions for the future



Choices:

- Use only the minimum product necessary for acceptable yield and pest control
- Explore new reduced-risk pesticide chemistries
- Practice nutrient recovery/ remediation

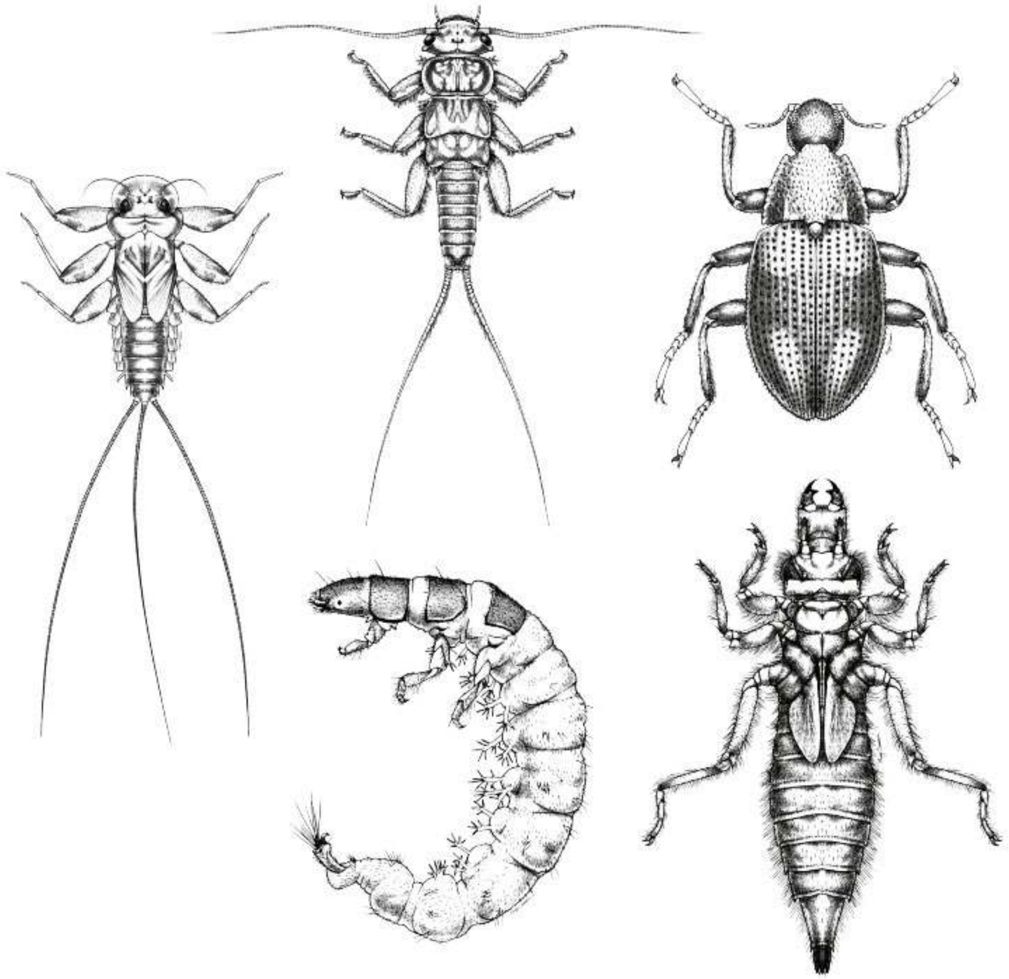
Remediation?

- Understand the landscape – some areas at higher risk for runoff and contamination than others
- Restore marshlands that can naturally pull these contaminants out of the water

Funding:

- DATCP funds grants that can support watershed remediation efforts

Why do we care??



Human health: (mitochondrial oxidative stress)

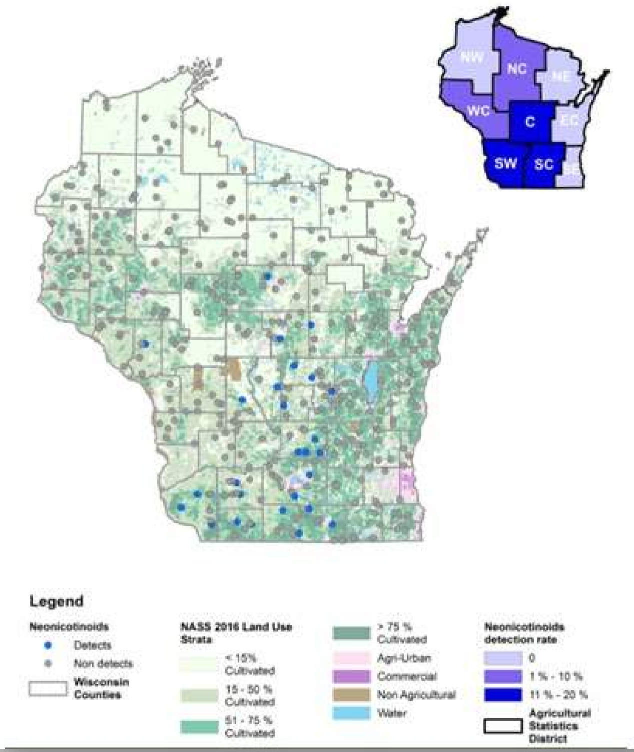
- Drinking water sources must be filtered to comply with local regulations for nitrates and pesticides

Ecosystem health:

- Aquatic macroinvertebrates are highly sensitive to pesticides and poor water quality
- They form the cornerstone of aquatic ecosystems
- EPA has established acute and chronic exposure thresholds for clothianidin, imidacloprid, and thiamethoxam
- No macros… No fish.

FIGURE 5

2023 SURVEY RESULTS FOR CLOTHIANIDIN, IMIDACLOPRID, AND THIAMETHOXAM (NEONICOTINOIDS)



AGRICULTURAL CHEMICALS IN WISCONSIN GROUNDWATER

FINAL REPORT
March 2024

TABLE 5

ESTIMATED STATEWIDE MEAN CONCENTRATIONS AND 95% CONFIDENCE INTERVALS FOR EIGHT COMPOUNDS DETECTED IN THE 2023 SURVEY

Compound	Estimated Statewide Mean Concentration (µg/l)	95% Confidence Interval (µg/l)[6]	Health Standard (µg/l)[7]
Metolachlor ESA	0.76	0.55 - 0.97	1,300
Alachlor ESA	0.36	0.15 - 0.57	20
Atrazine TCR	0.2	0.16 - 0.24	3
Atrazine	0.05	0.03 - 0.07	3
Clothianidin	0.09	0 - 0.23	1,000
Imidacloprid	0.07	0 - 3.77	0.2
Thiamethoxam	0.04	**	120
Nitrate	5.22 mg/l	4.7 - 5.74 mg/l	10 mg/l

[6] Calculated range of values where there is a 95% probability that the percent of reported detections will fall within that range.

[7] Wis. Admin. Code, ch. NR 140 Enforcement Standard or Wisconsin Department of Health Services Drinking Water Health Advisory

**Not enough data points to calculate a confidence interval

Emerging Regulatory Changes

January 3, 2024; https://www.ncelenviro.org/articles/new-york-enacts-nations-first-neonicotinoid-treated-seed-ban/

June 28, 2024: https://environmentamerica.org/colorado/updates/victory-new-law-protecting-pollinators-goes-into-effect/

May 14, 2024; https://www.ncelenviro.org/articles/washington-becomes-the-11th-state-legislature-to-restrict-neonicotinoids/#:~:text=Vermont%20and%20Illinois%20are%20seeking,most%20non-commercial

November 3, 2024: https://beyondpesticides.org/dailynewsblog/2023/11/states-step-in-to-restrict-bee-toxic-pesticides-california-the-latest-in-absence-of-epa-action/