

An overview of neonicotinoid contaminants in Wisconsin

Wisconsin Agribusiness Classic
Madison, WI
Jan 15, 2019



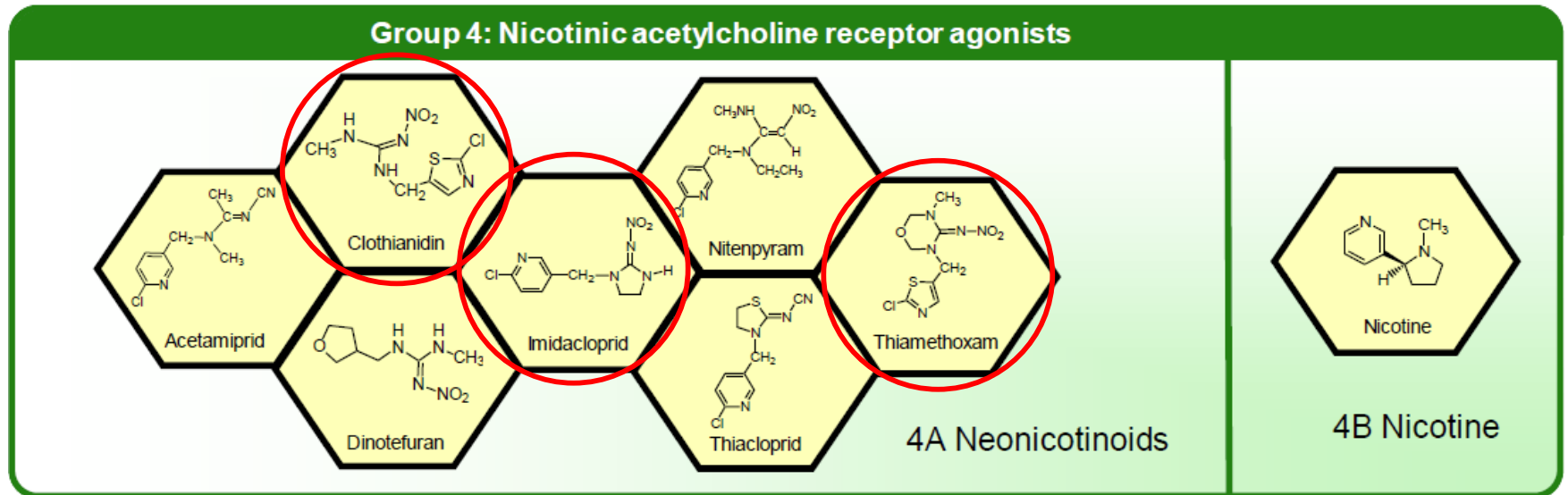
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What are neonicotinoid insecticides?



Insecticide Resistance Action Committee

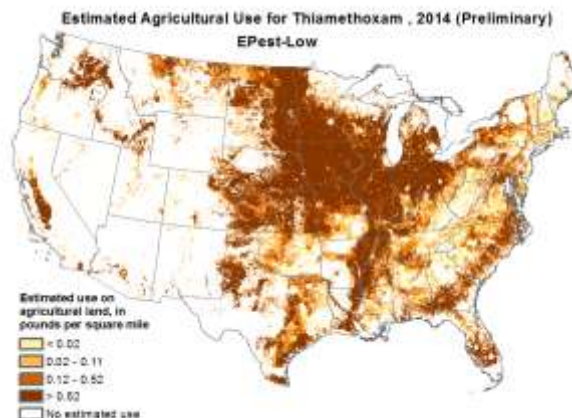
- Developed in early 90's as a safer alternative to older, toxic classes
- Versatile: May be applied to seed, soil, or as a foliar
- Systemic activity grants long field persistence
- Currently make up 25% of the global pesticide market
- Imidacloprid, thiamethoxam, clothianidin = big three

Widespread utilization of neonicotinoids

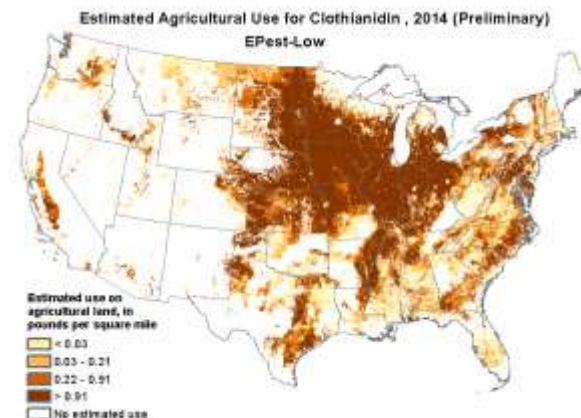
Imidacloprid



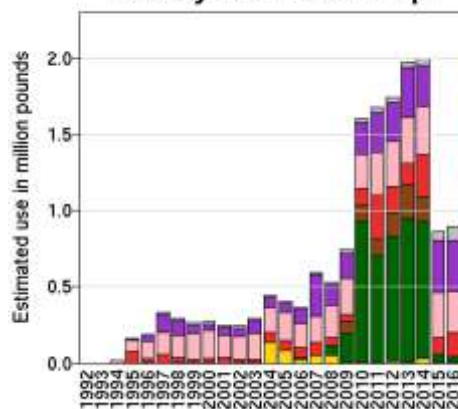
Thiamethoxam



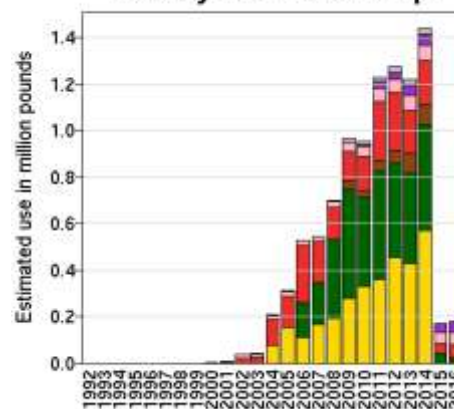
Clothianidin



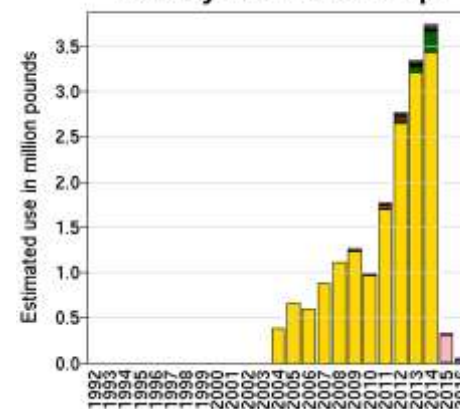
Use by Year and Crop



Use by Year and Crop



Use by Year and Crop

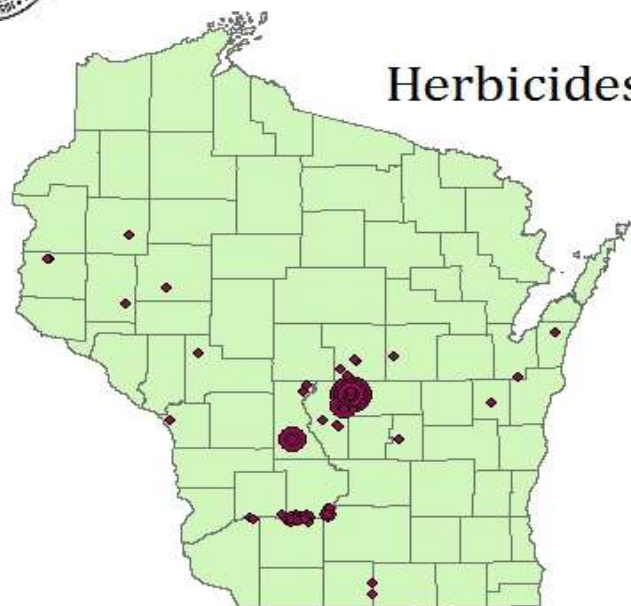


Over 6.7 million pounds now applied annually in US
140 different registered crop uses



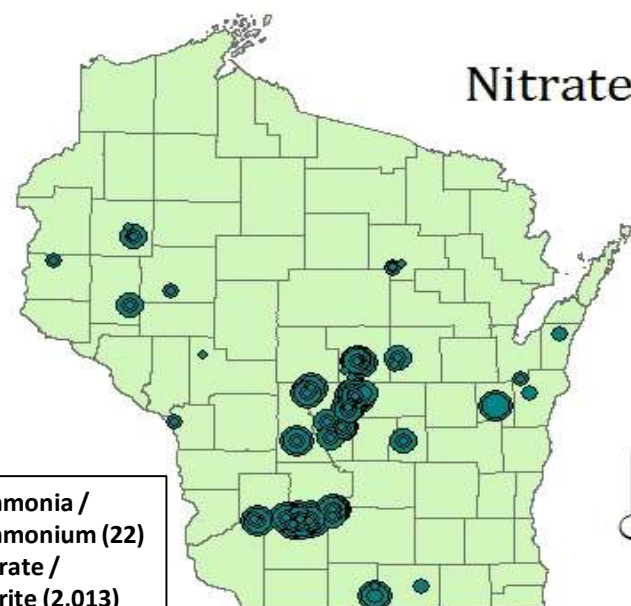
DATCP groundwater surveys 1985-2012

Herbicides



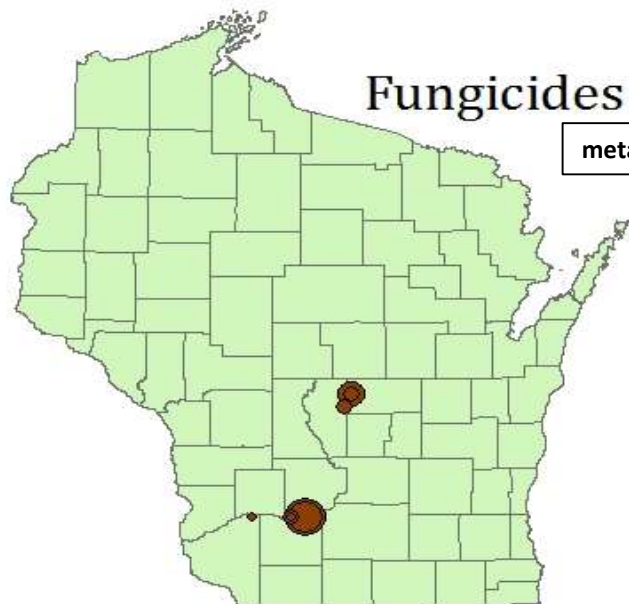
2,4-D (7)
acetochlor (105)
alachlor (730)
atrazine (2,421)
bentazon (5)
cyanazine (14)
diphenylamine (2)
mesotrione (1)
metolachlor (1,013)
metribuzin (757)
picloram (32)
simazine (22)

Nitrates



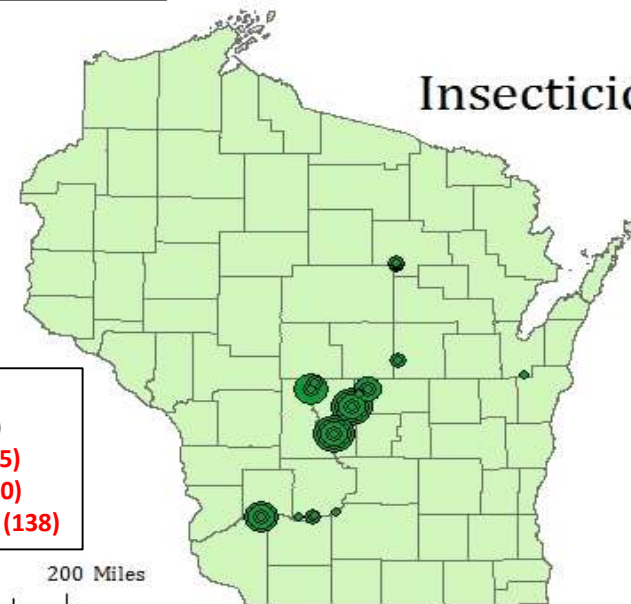
ammonia /
ammonium (22)
nitrate /
nitrite (2,013)

Fungicides



metalaxyl (11)

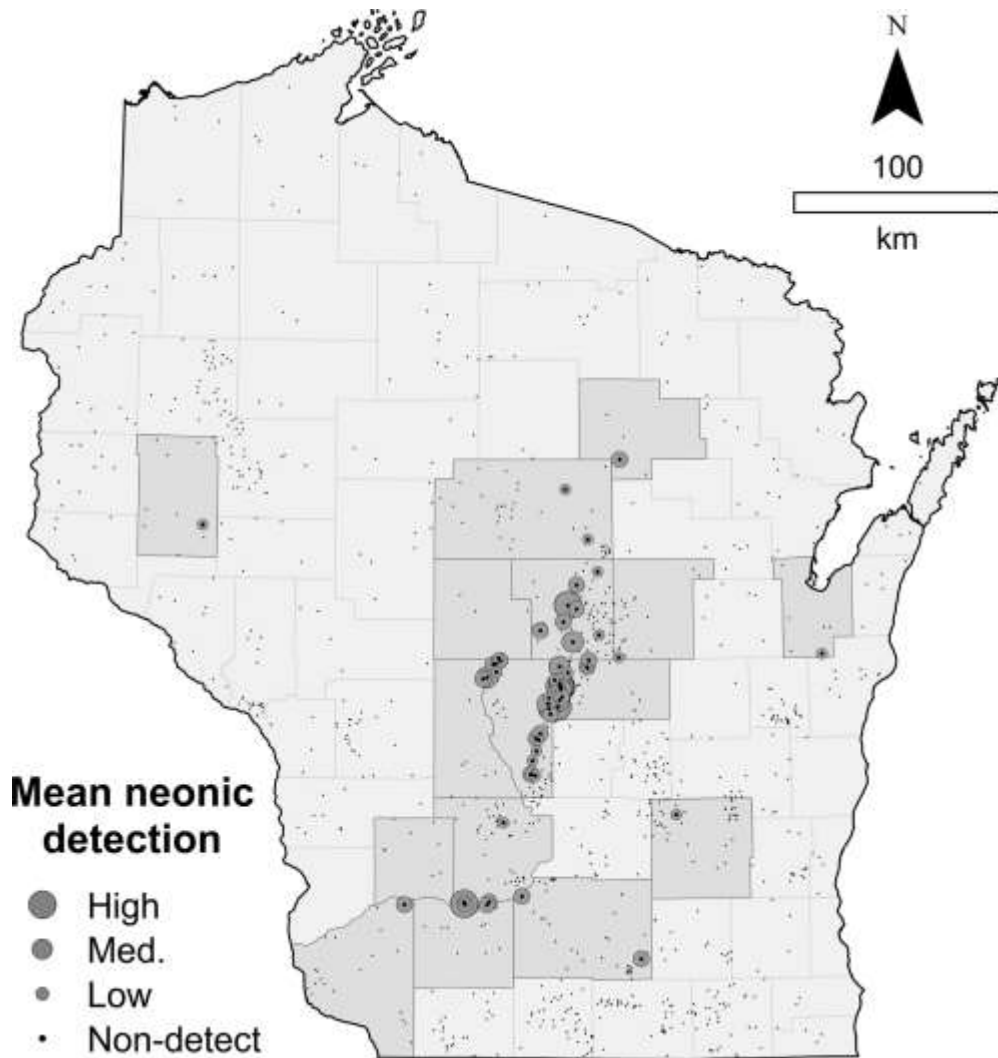
Insecticides



aldicarb (172)
chlorpyrifos (6)
clothianadin (45)
imidacloprid (90)
thiamethoxam (138)

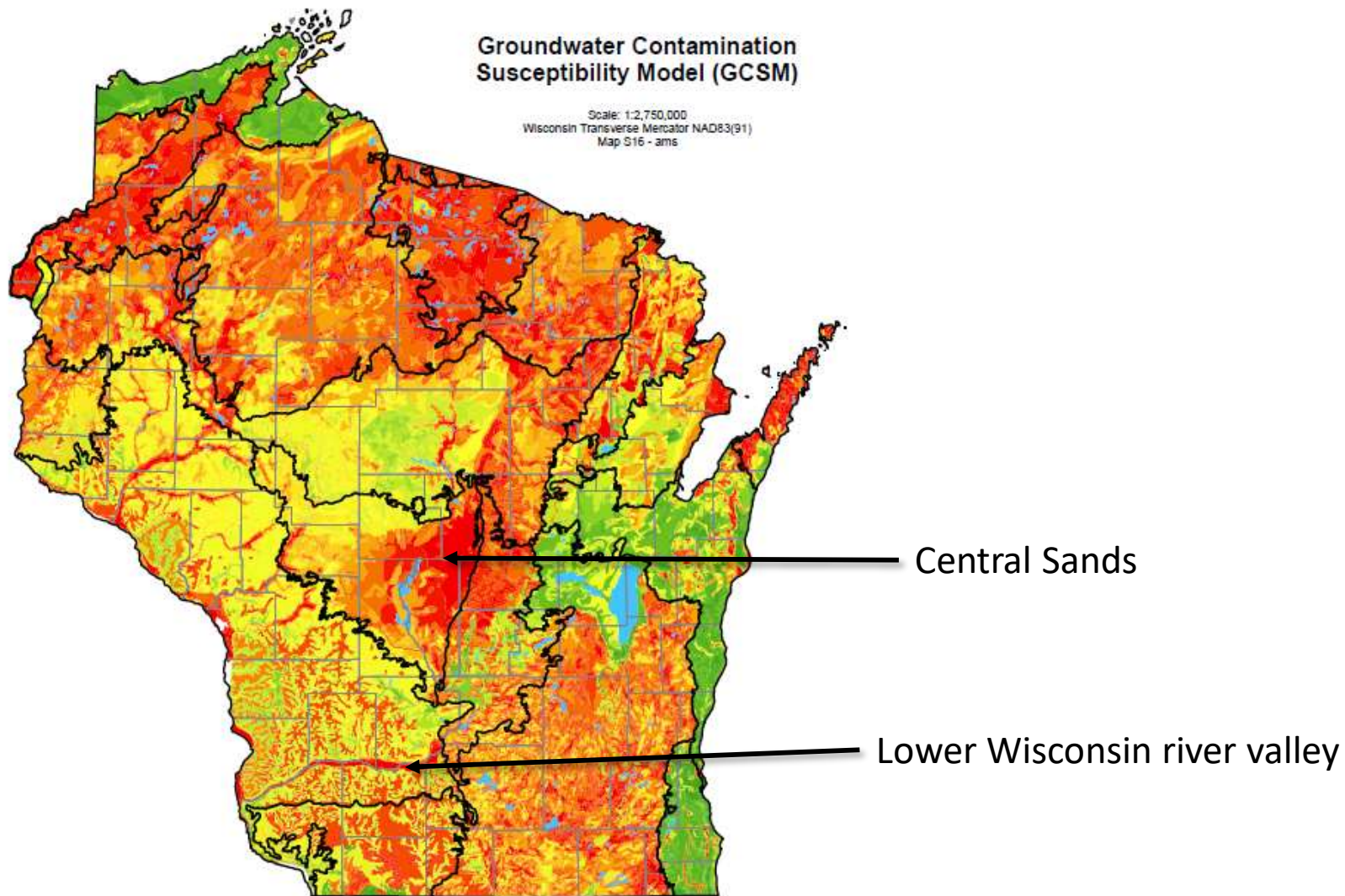
0 50 100 200 Miles

DATCP: Neonicotinoid detections 2008-2017



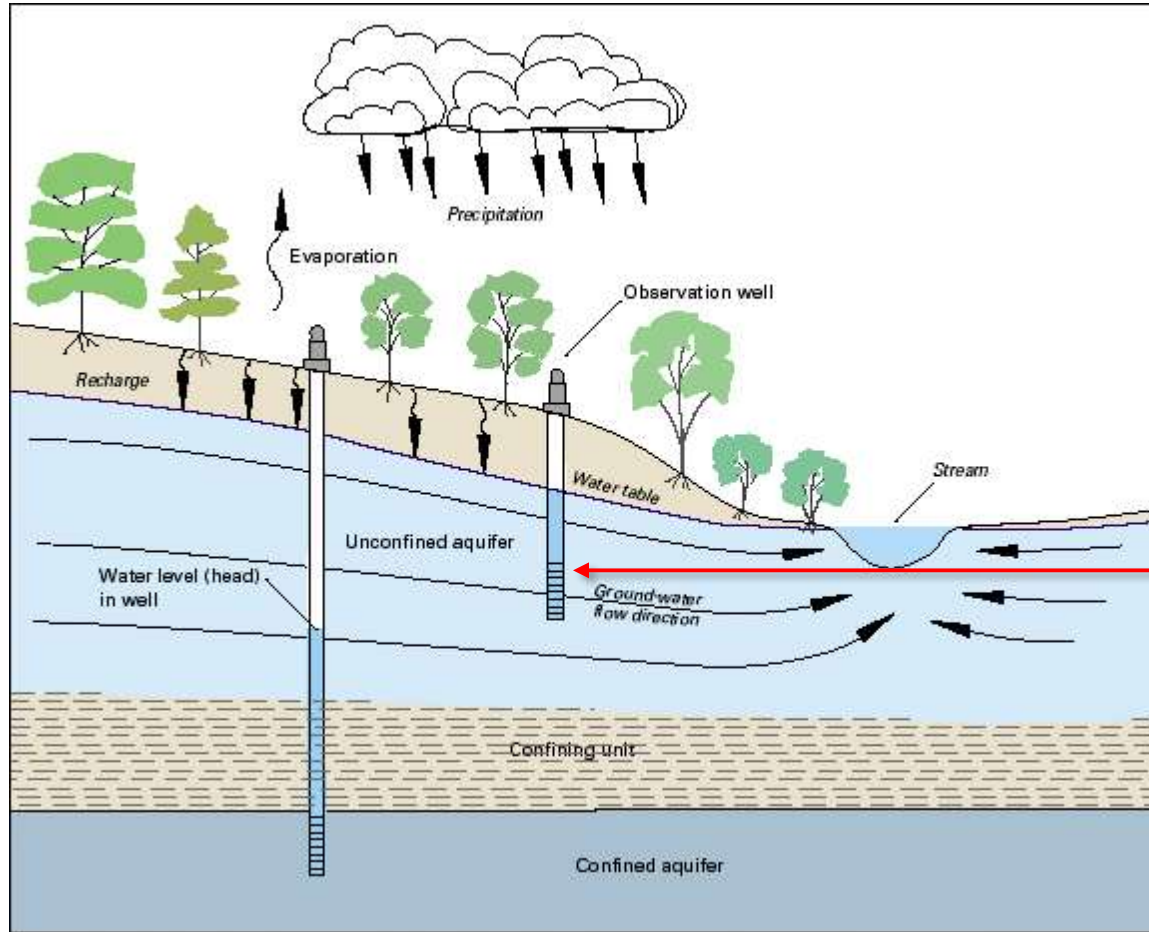
- Shallow groundwater monitoring wells ('11-'17)
 - 53 locations / 527 samples
 - 47% positive for 1+ neonic
- Private potable wells ('11-'17)
 - 1120 wells / 1313 samples
 - 4% positive for 1+ neonic
- Detections largely restricted to **Central Sands** and **lower Wisconsin river valley**

Groundwater contamination susceptibility in Wis.



Model published in 1987 by
DNR/USGS/WGNHS/UW

Why are these areas susceptible to contamination?



Contamination risk factors:

- Sandy, fast-draining soils
- Unconfined aquifers close to surface

DATCP monitoring wells: shallow groundwater

USGS

High-capacity wells in Wisconsin

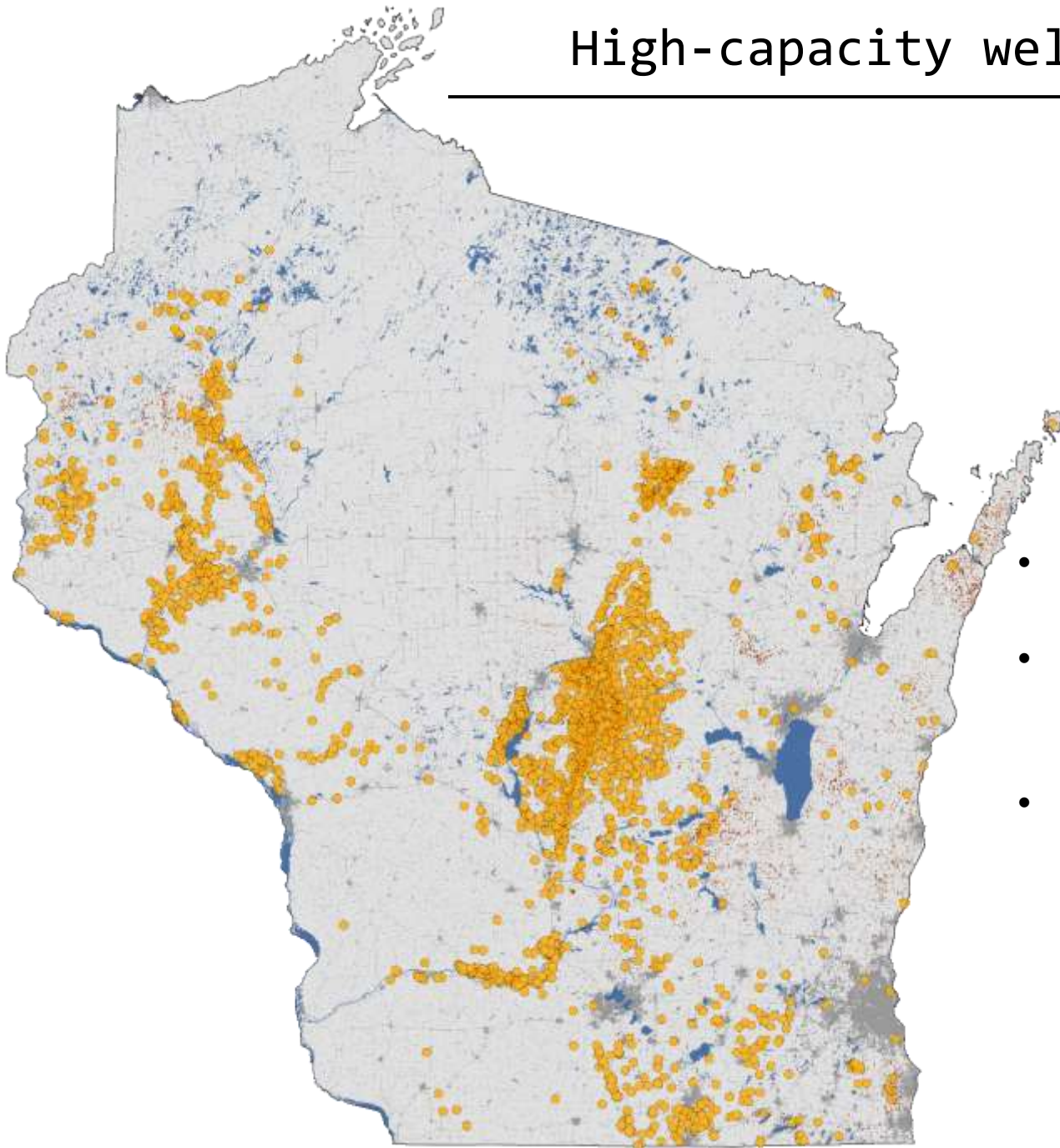
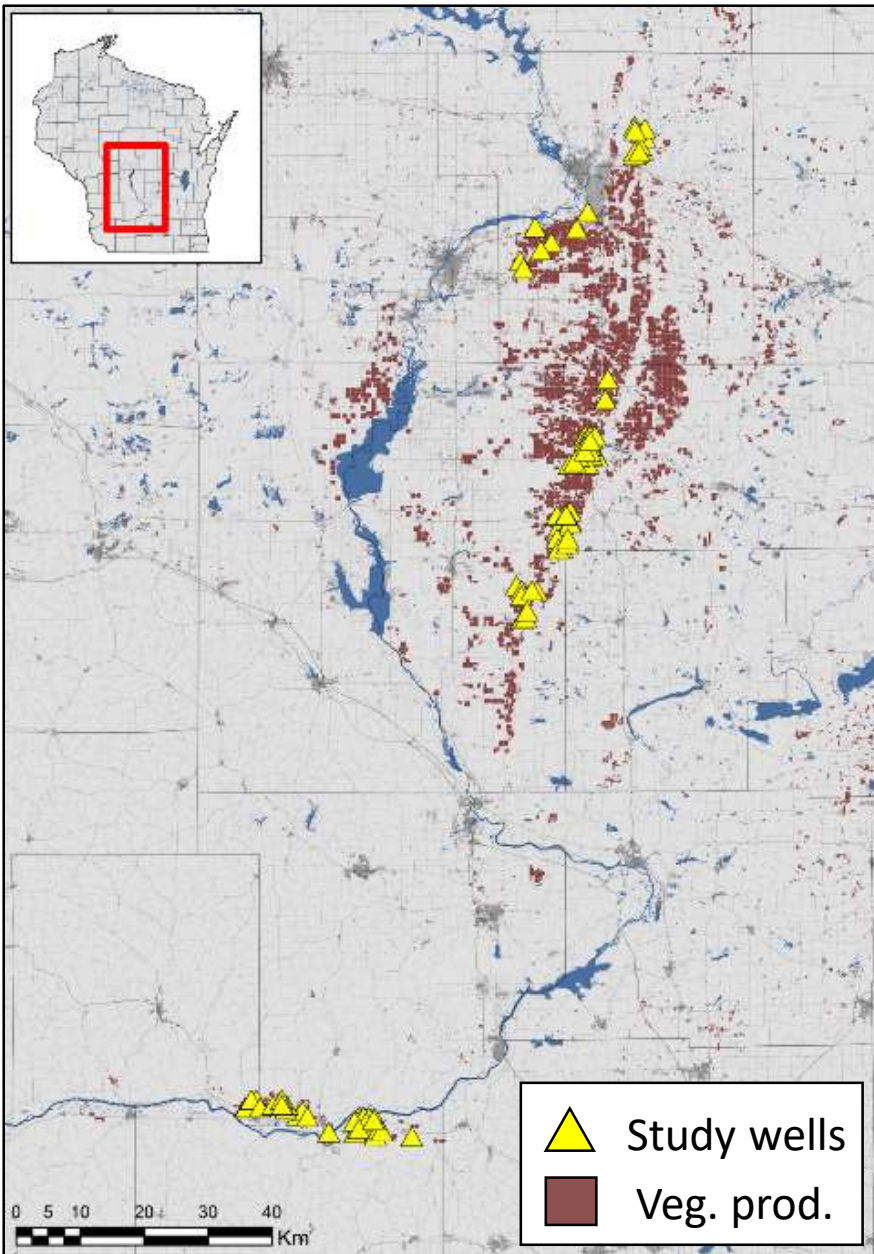


photo: Atlantis Engineering

- Nearly 8000 total wells
- Largely concentrated in vegetable producing areas
- **Window into deeper groundwater quality**

Hicap well study

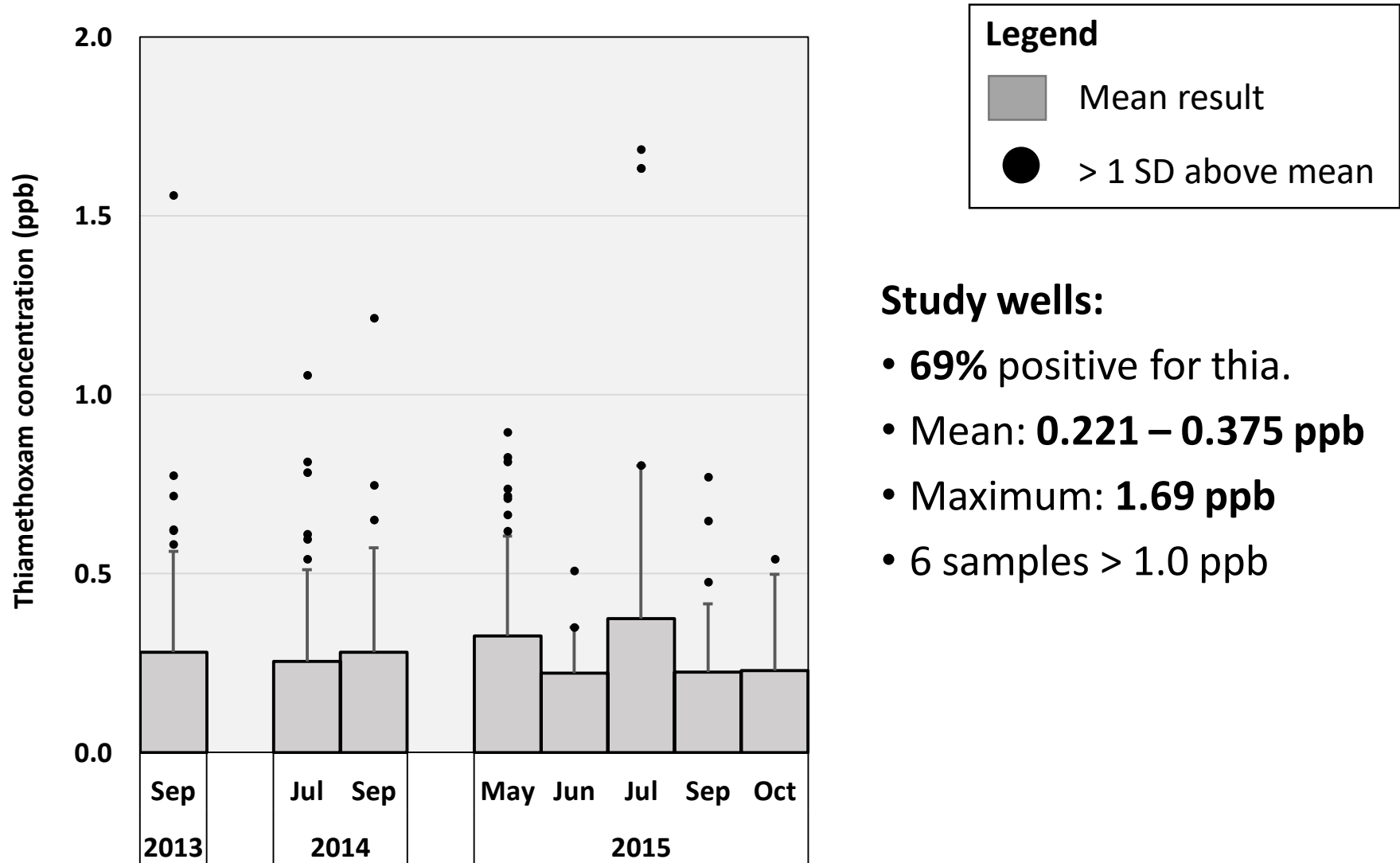


No. unique wells tested

Year	May	Jun	Jul	Sep	Oct	Total
2013	-	-	-	48	-	48
2014	-	-	53	26	-	53
2015	38	16	52	36	4	56

- 91 unique wells
- 312 total samples
- Each well sampled 1 – 6 times over 3 years
- Tested for thiamethoxam only

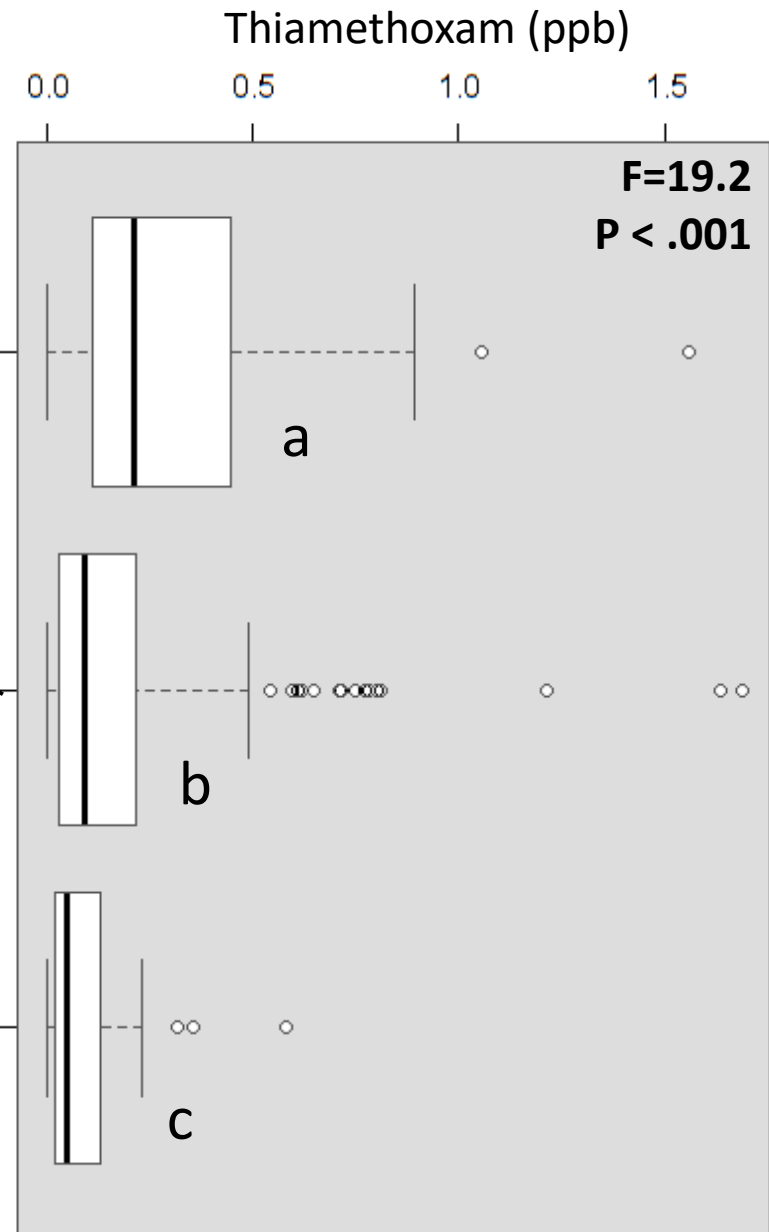
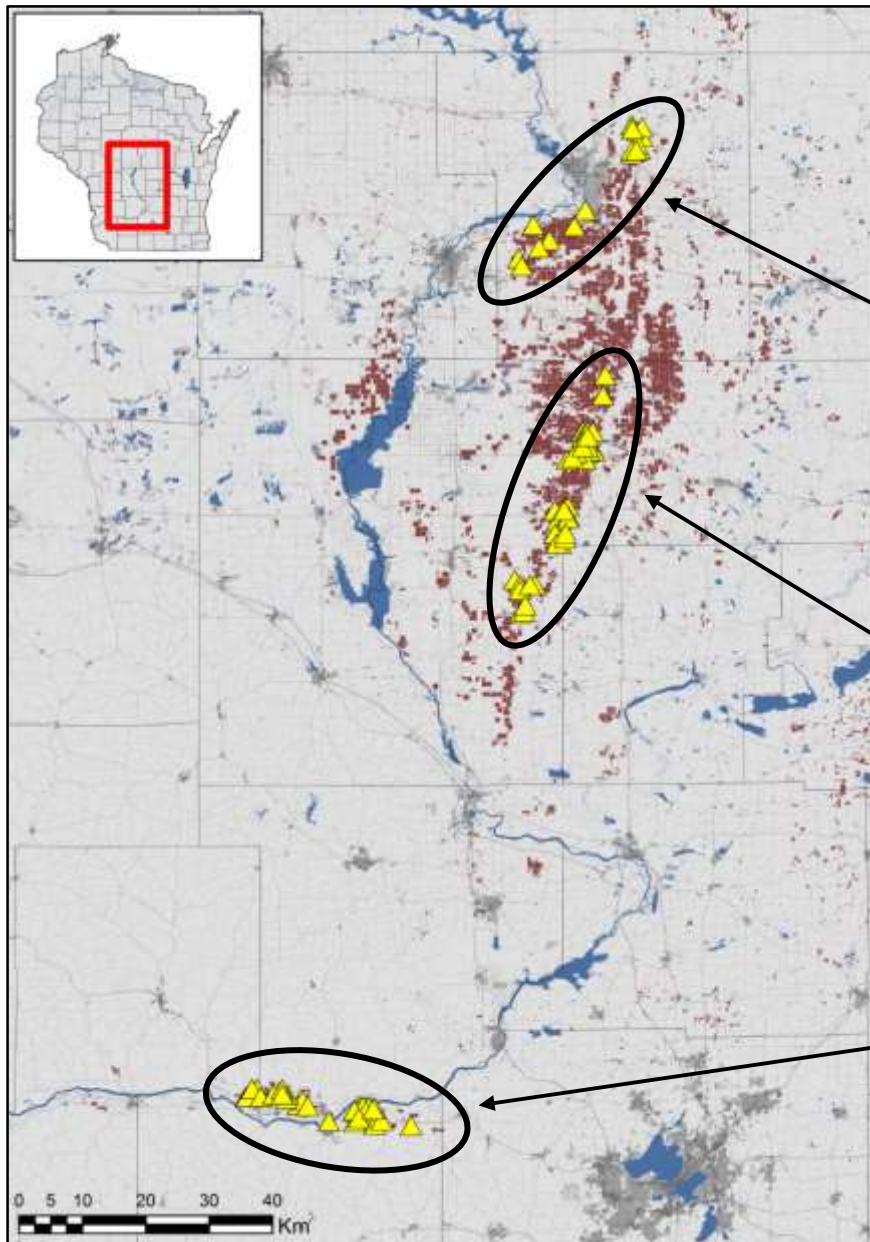
Hicap wells: Summary of detections



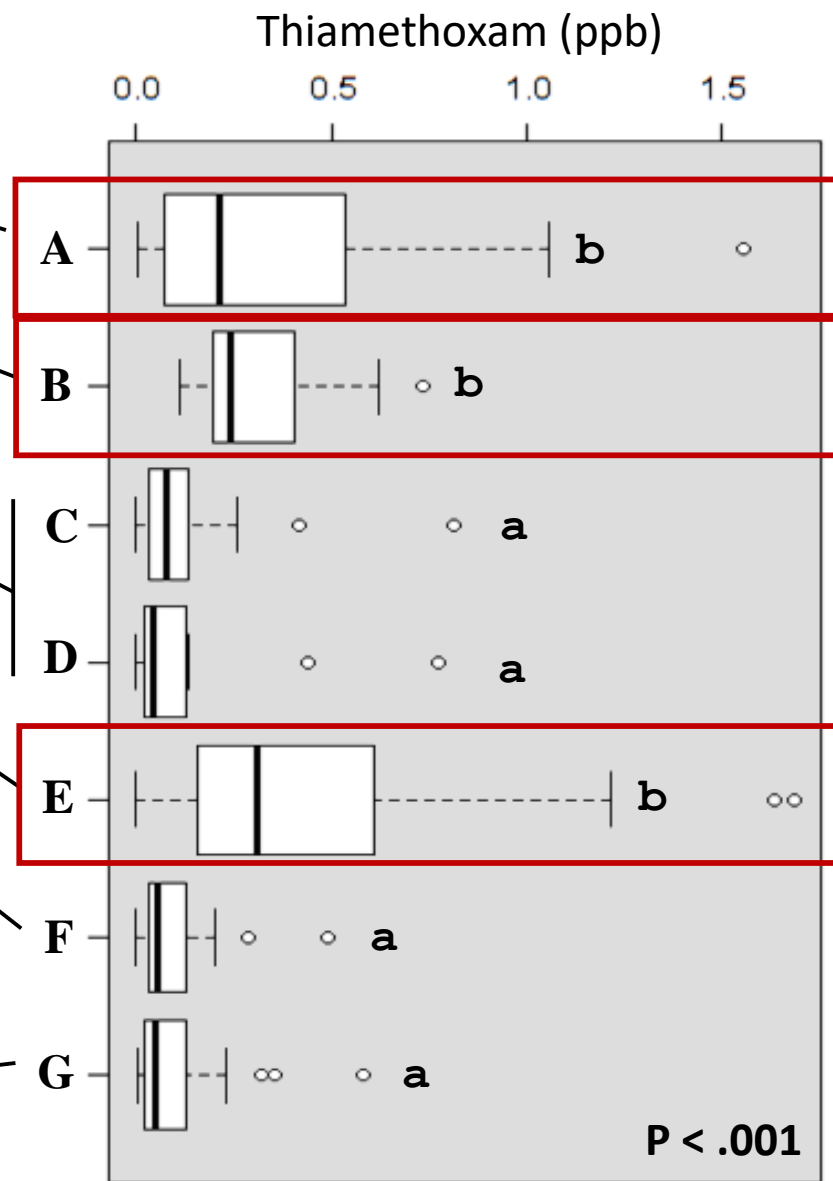
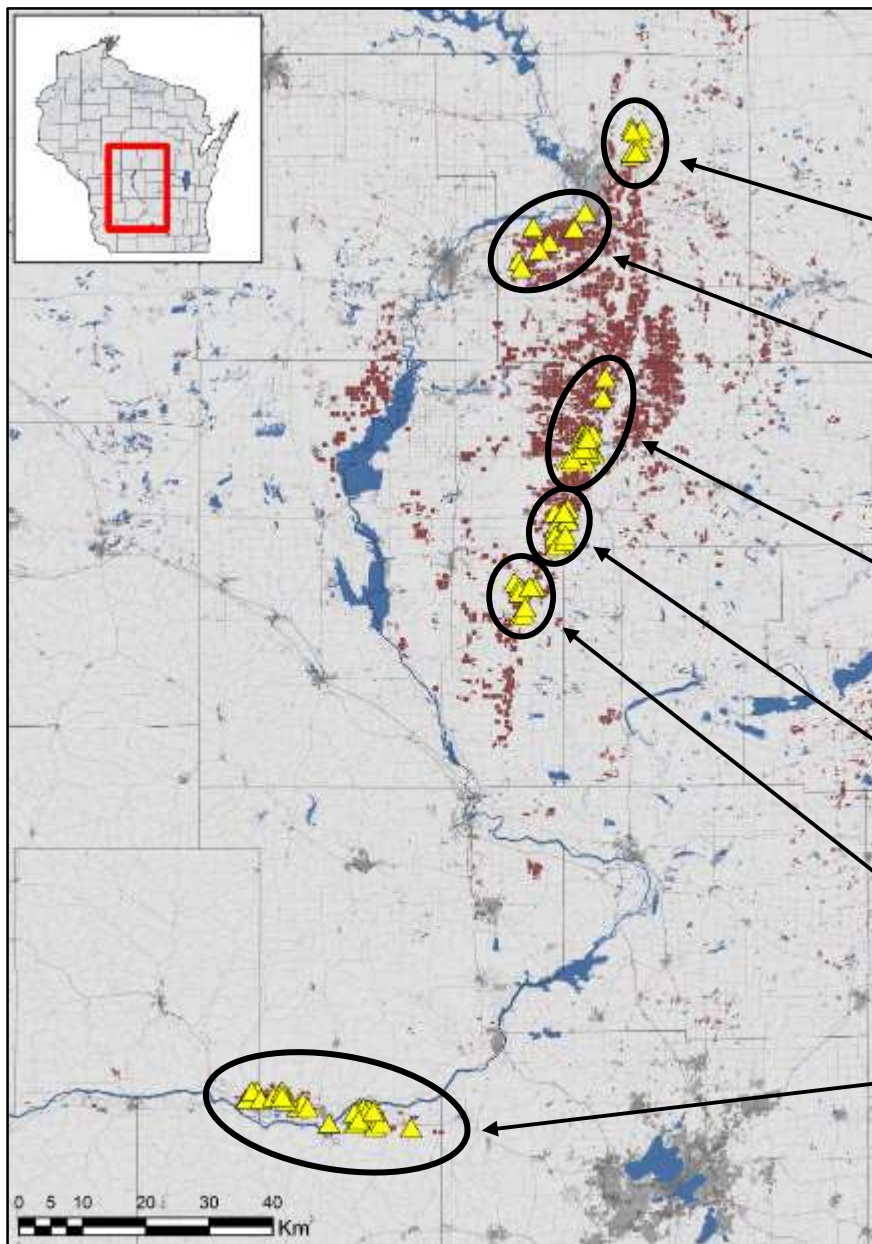
Study wells:

- **69%** positive for thia.
- Mean: **0.221 – 0.375 ppb**
- Maximum: **1.69 ppb**
- 6 samples > 1.0 ppb

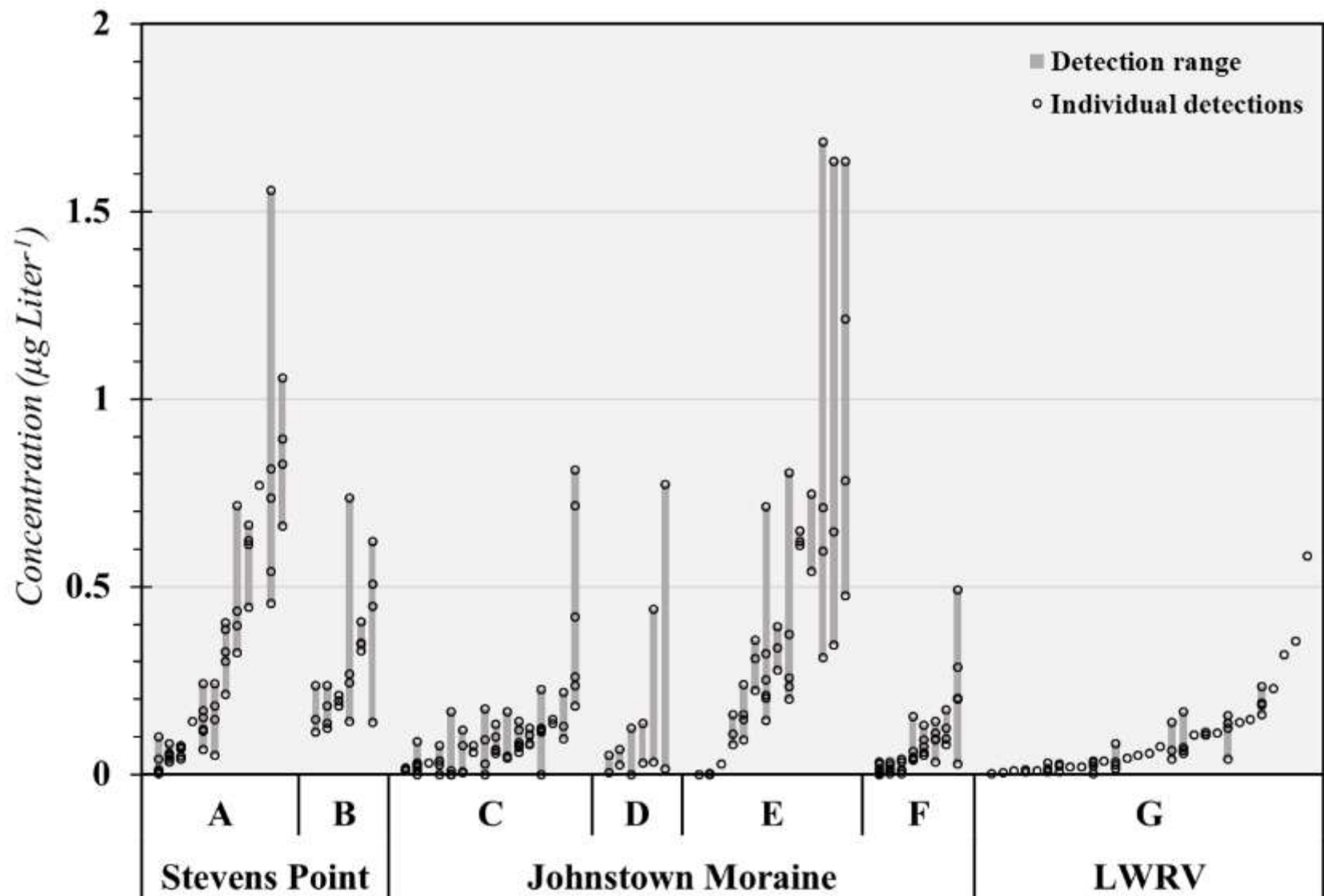
Hicap wells: Regional differences



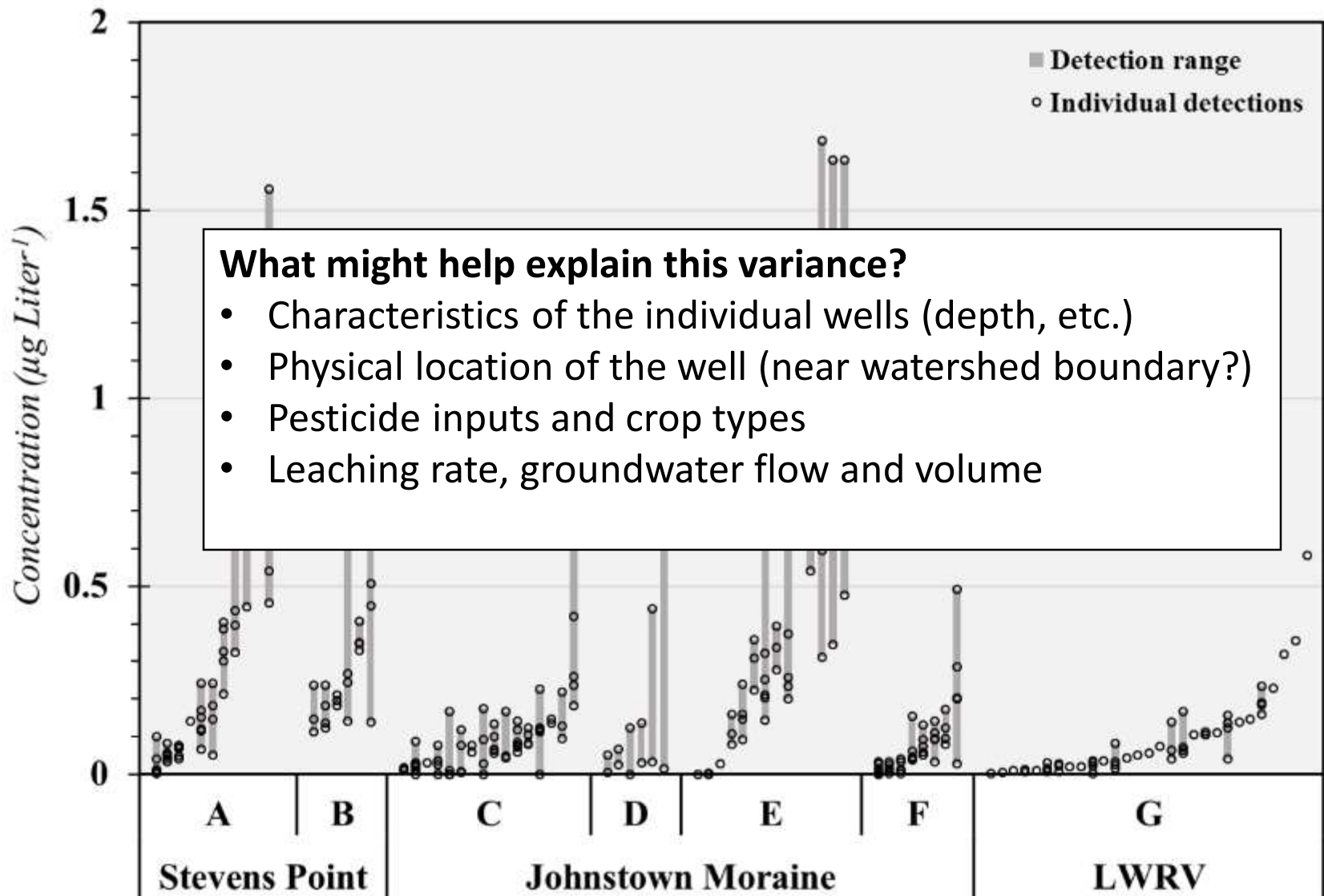
Hicap wells: Farm-level differences



Hicap wells: High variation observed



Hicap wells: High variation observed



Proposed Enforcement Standard & Preventive Action Limit



Wisconsin Groundwater Protection Standard

Section 160.13 – Methodology to establish enforcement standard

Section 160.15 – Establishment of preventive actions limits

Enforcement Standard (ES) – Determine Acceptable Daily Intake (ADI) and assume intake of 1 L water/day for 10 kg body mass

ADI = 0.012 mg/kg bw/day (June 2007, EPA HED review)

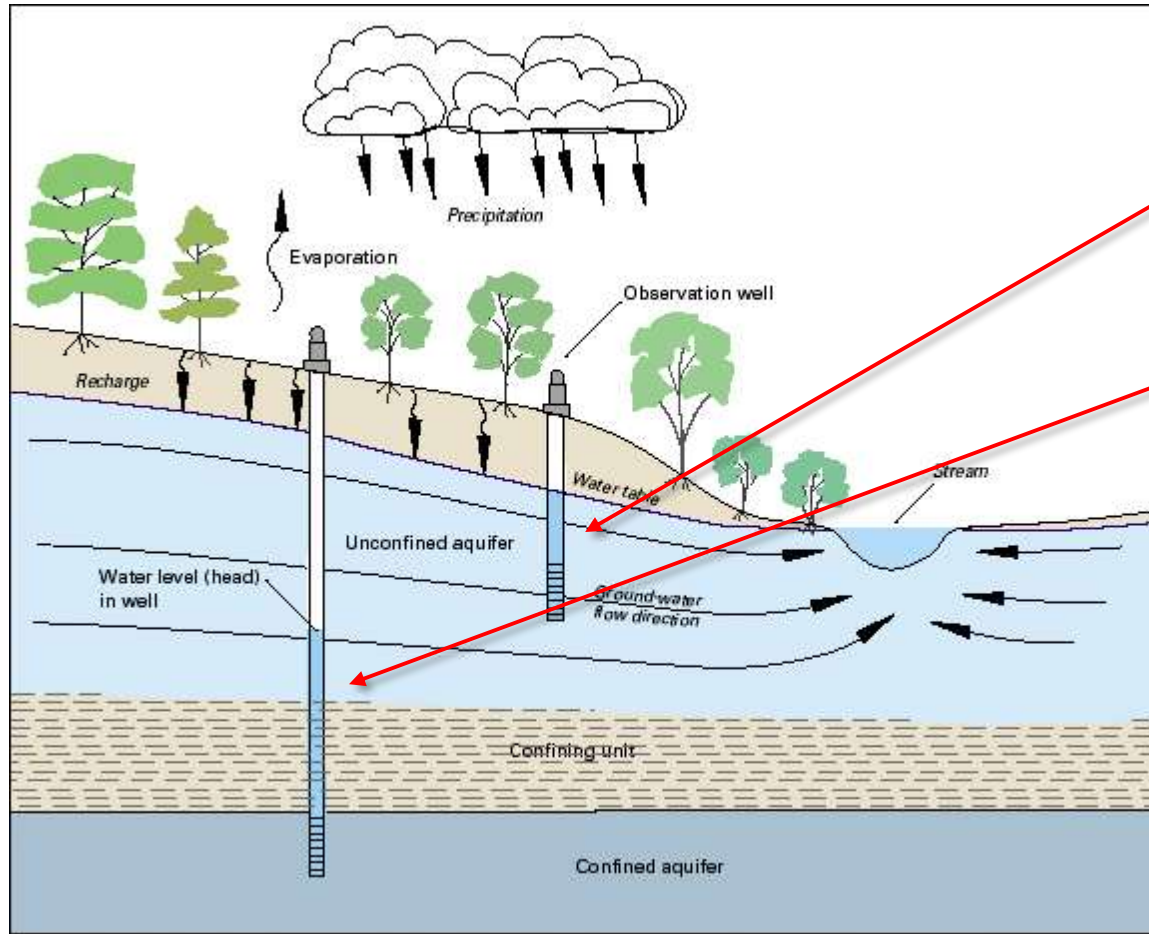
ES = 120 ppb for thiamethoxam

Preventive Action Limit (PAL)- 20% of the concentration established as the ES

PAL = 120 ppb x 20% = 24 ppb for thiamethoxam

Well above current detections in groundwater
No human health concern at currently observed levels

Hicap wells: window into deep groundwater quality



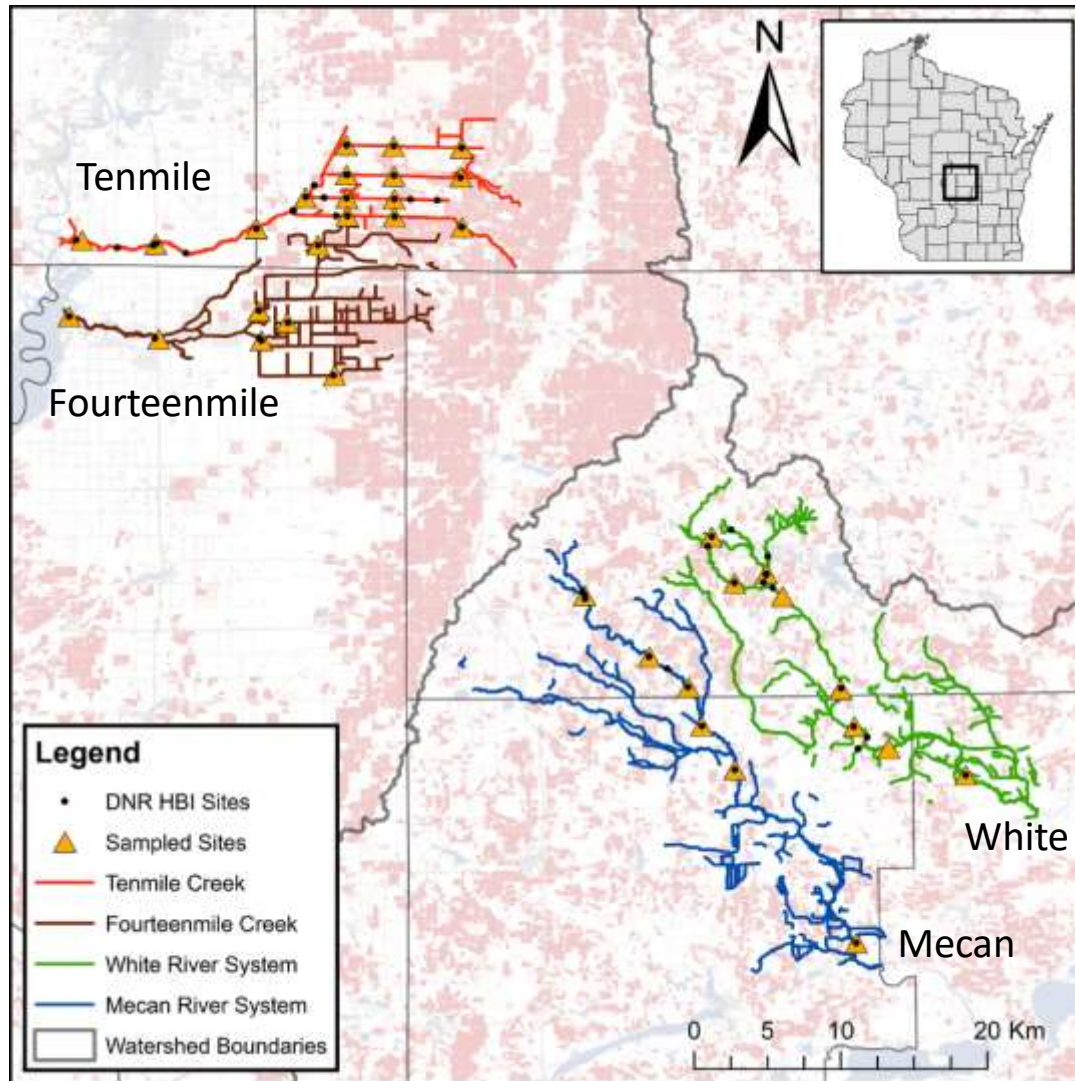
DATCP monitoring wells

High-capacity wells

Will monitoring well and high-capacity well detects translate into stream water detections?

USGS

Stream water collections: 2015



Wisconsin River watershed

- > 30% ag land use

Fox River watershed

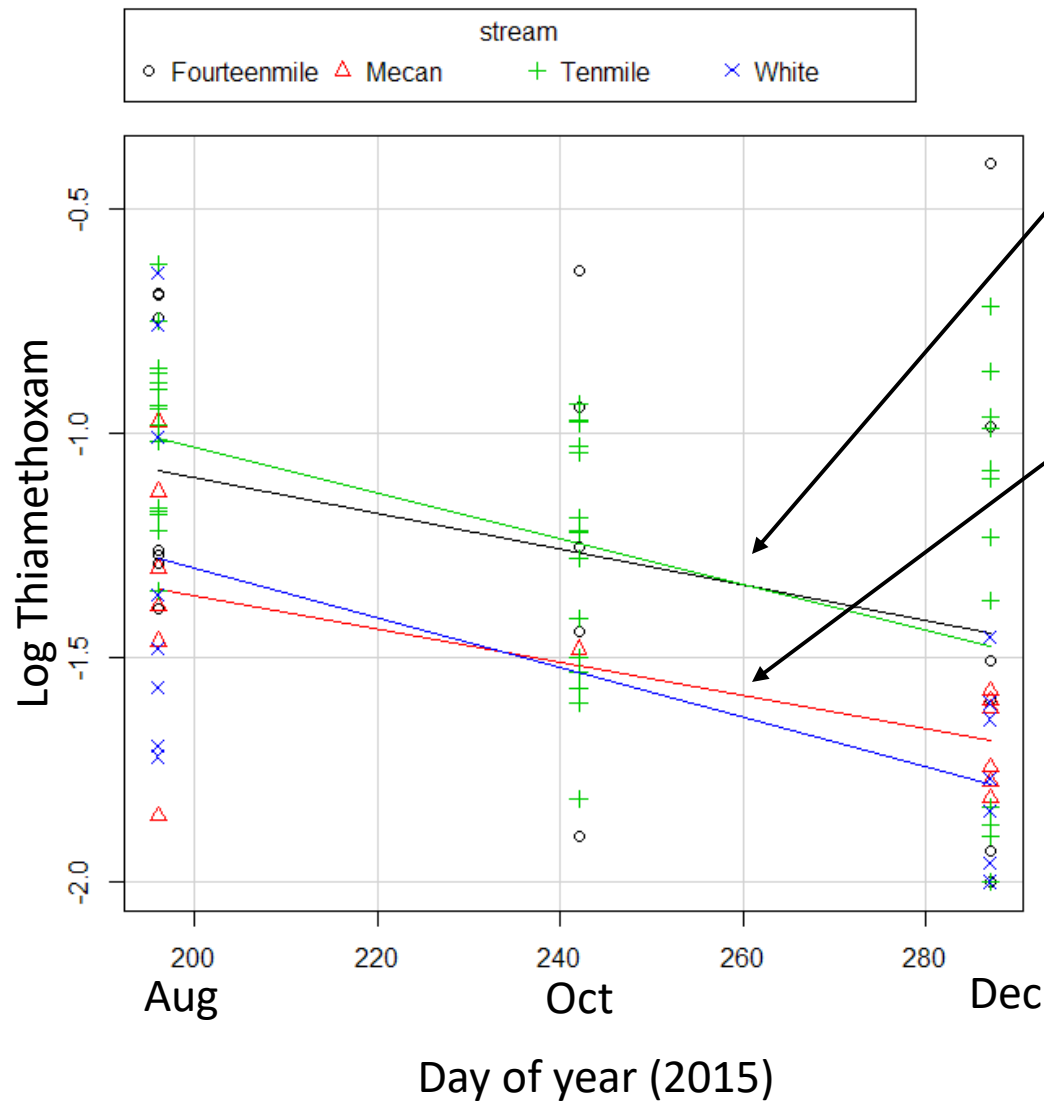
- < 30% ag land use

Sites selected near existing
DNR biodiversity data

Hypothesis:

*Higher detects associated
with higher ag land use*

Stream water collections: 2015



Wisconsin watershed

- 22 sites / 65 samples
- Max: 0.388 $\mu\text{g/L}$
- Mean: 0.073 $\mu\text{g/L}$

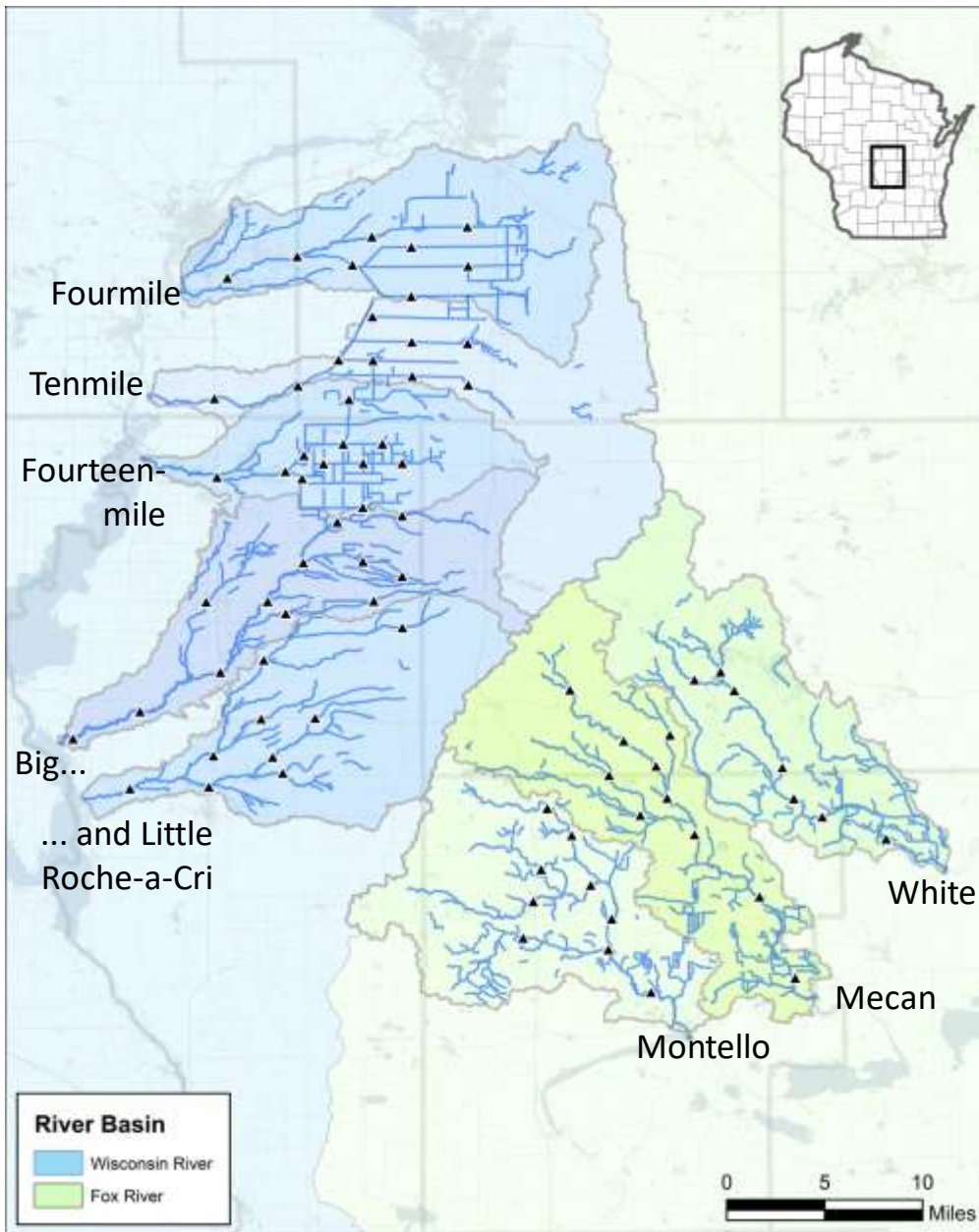
Fox watershed

- 14 sites / 29 samples
- Max: 0.217 $\mu\text{g/L}$
- Mean: 0.034 $\mu\text{g/L}$

Observations:

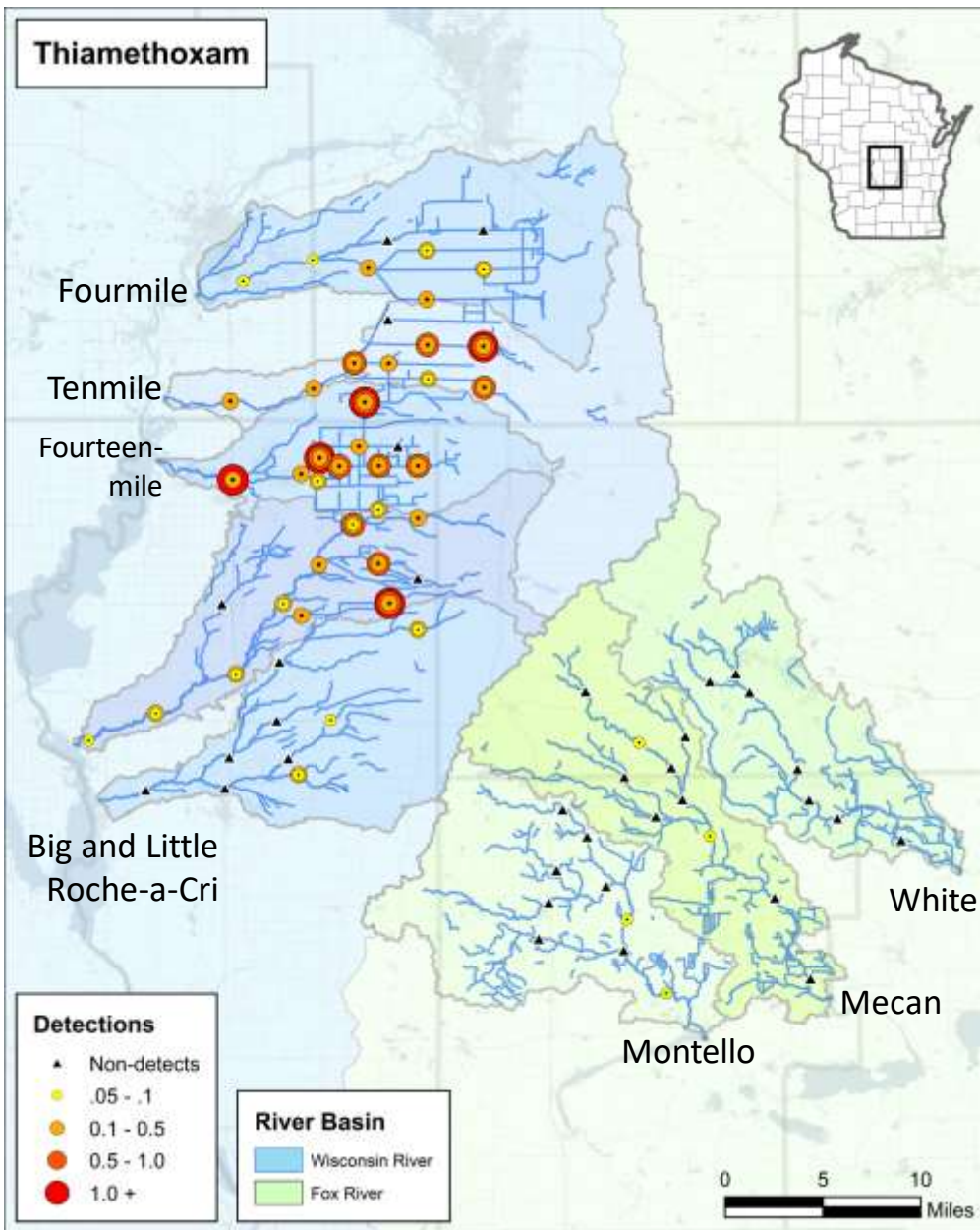
- Wisconsin > Fox
- Mean detection decreased each date

Stream water collections: 2016-2017



- Wisconsin River
 - Five stream systems
 - 53 sites
 - Four dates
- Fox River
 - Three stream systems
 - 27 sites
 - One date

Stream water: Thiamethoxam detections 2016-17

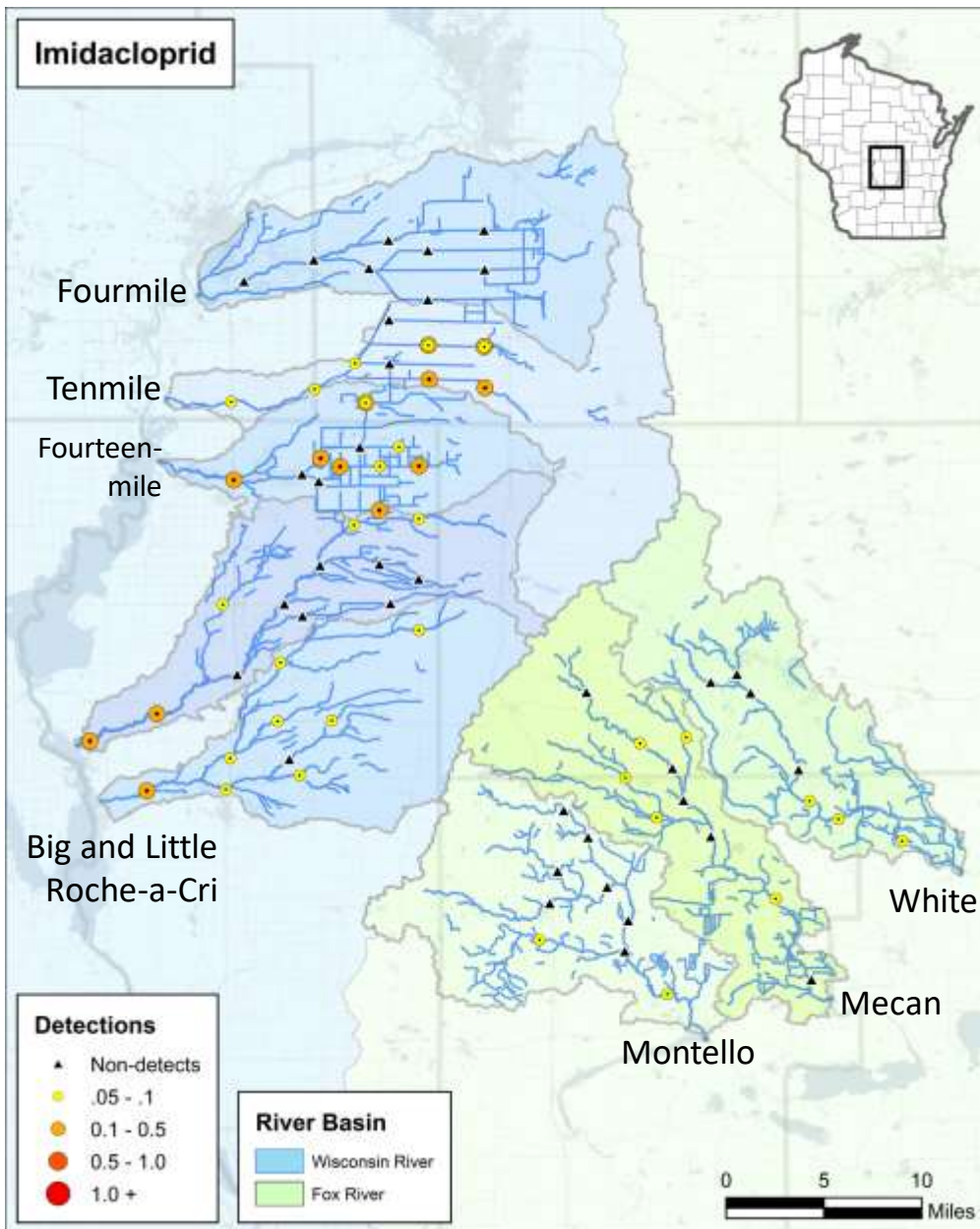


Wisconsin	N	% Pos.	Max ppb
Fourmile	32	41%	0.337
Tenmile	36	56%	2.851
14-mile	35	74%	4.110
Big RaC	48	65%	1.432
Little RaC	36	14%	0.216
	187	51%	4.110

Fox	N	% Pos.	Max ppb
White	7	0%	0.047
Mecan	10	20%	0.055
Montello	9	22%	0.061
	26	15%	0.061

Positive detection: > 0.05 ppb

Stream water: Imidacloprid detections 2016/17



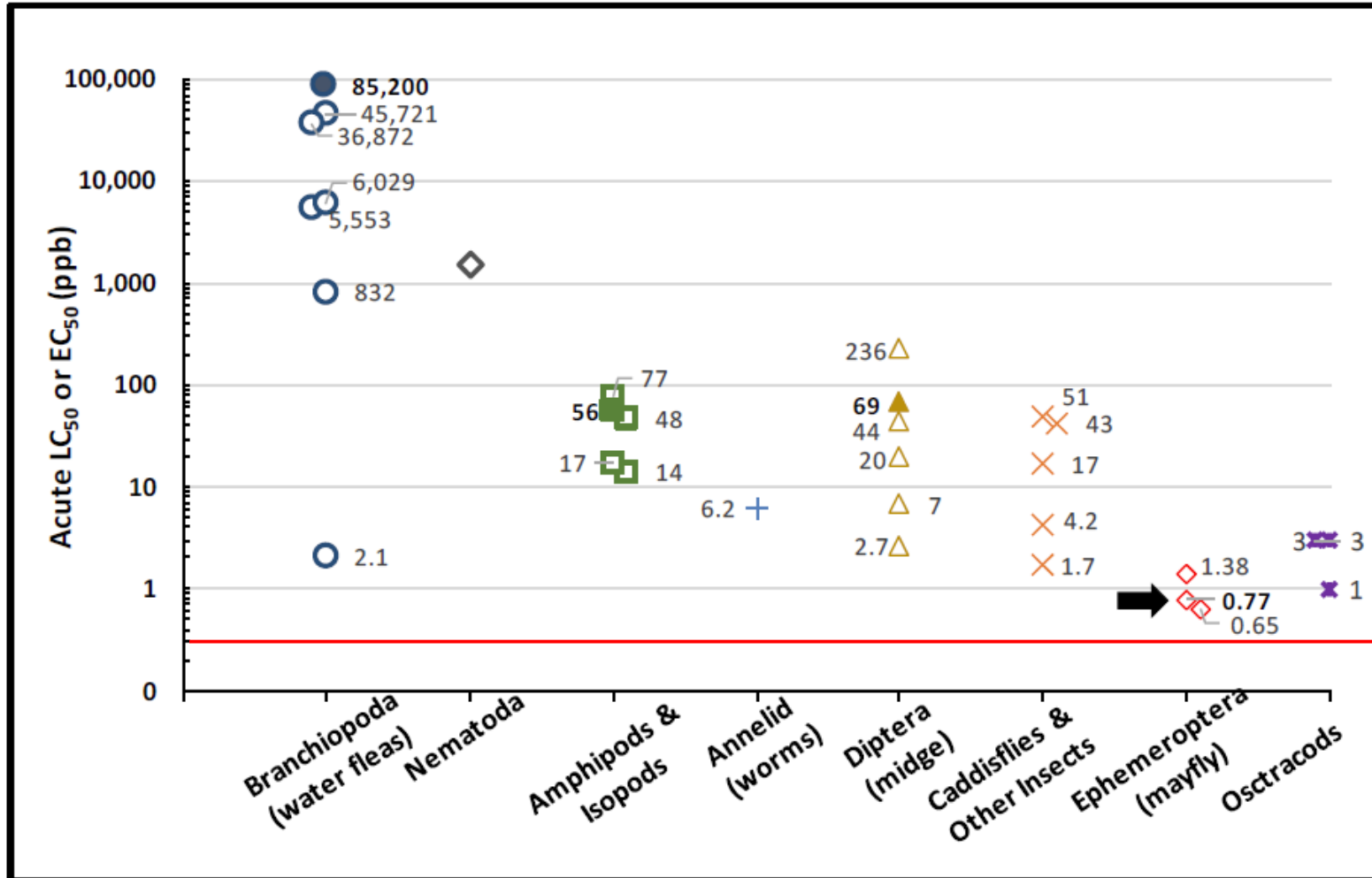
Wisconsin	N	% Pos.	Max ppb
Fourmile	32	0%	.042
Tenmile	36	25%	.213
14-mile	35	26%	.192
BRC	48	13%	.135
LRC	36	31%	.193
	187	19%	0.213

Fox	N	% Pos.	Max ppb
White	7	43%	.059
Mecan	10	50%	.070
Montello	9	22%	.081
	26	38%	.081

Positive: > 0.05 ppb

EPA aquatic life benchmarks: Imidacloprid

Imidacloprid acute tolerance by organism



This study:
0.213 ppb
max

Figure 4-1. Acute Toxicity of Imidacloprid to Freshwater Invertebrates (most sensitive value for each species; open symbols = open literature; solid symbols = registrant data; solid arrow = endpoint used for risk estimation).

EPA aquatic life benchmarks: Imidacloprid

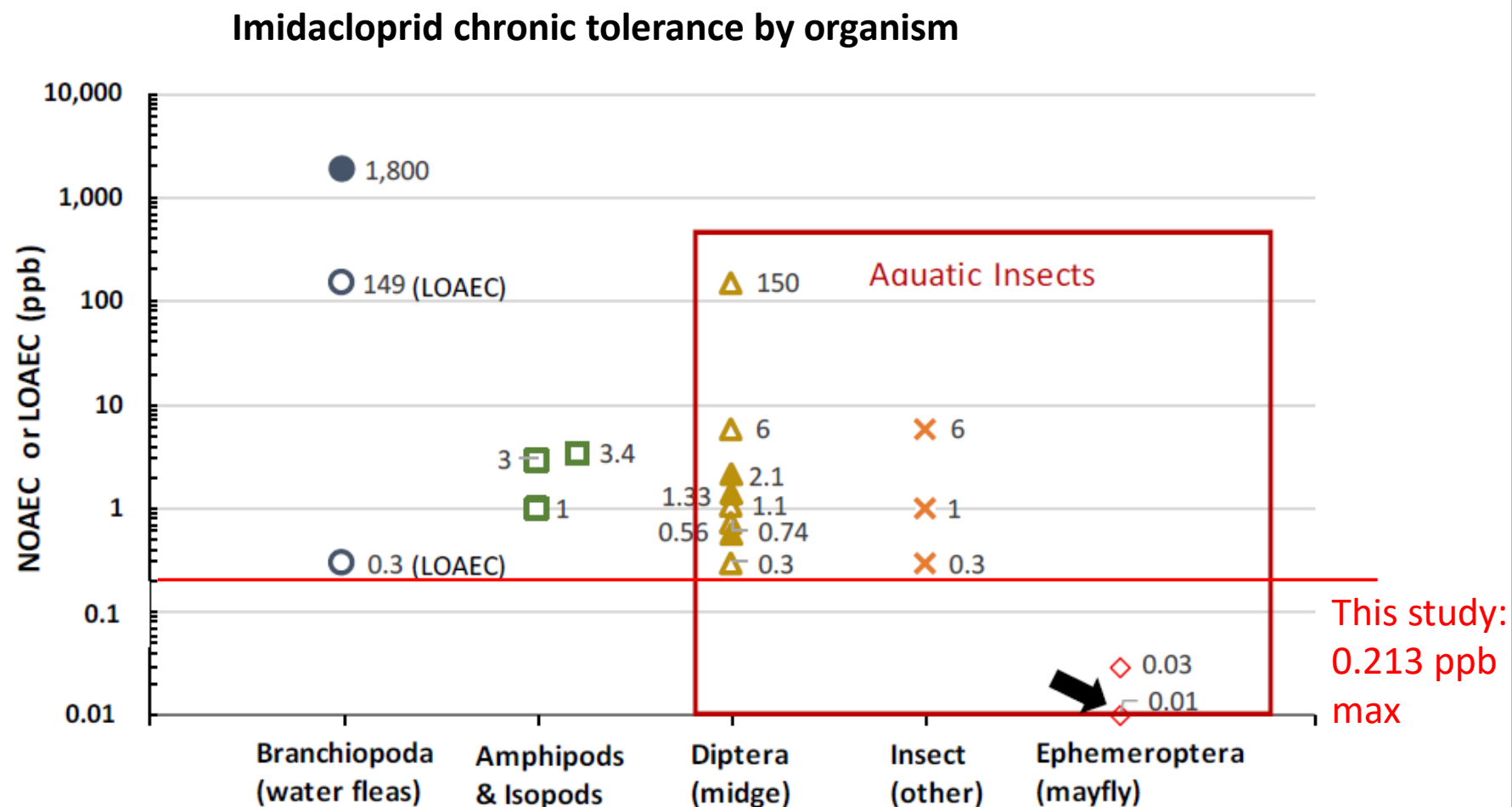


Figure 4-3. Most Sensitive Chronic Toxicity Values on the Effects of Imidacloprid on Freshwater Invertebrates (most sensitive value for each species; open symbols = open lit., closed symbols = registrant data; solid arrow = endpoint used for risk estimation).

Stream water (2016-17): Aquatic life benchmarks

- **EPA imidacloprid benchmarks**
 - Acute (0.385 ppb): 0 samples exceed
 - Chronic (0.01 ppb): 127 samples exceed (60%)
- **EPA thiamethoxam benchmarks**
 - Acute (17.5 ppb): 0 samples exceed
 - Chronic: no benchmark established
- **Proposed total neonic exposure benchmarks from the scientific literature (Morrissey *et al.* 2015)**
 - Acute (0.2 ppb): 53 samples exceed (25%)
 - Chronic (0.035 ppb): 156 samples exceed (73%)



Next steps: Hatch proposal funded to continue these stream water investigations

Summary and next steps

Summary of results

- DATCP surveys reveal neonicotinoid contaminants in shallow groundwater, particularly in the Central Sands and lower Wisconsin
- High-capacity well surveys show contamination in the lower reaches of these same aquifers
- Groundwater-fed streams in the Central Sands frequently test positive for neonicotinoids at concentrations potentially harmful to aquatic insects

Future directions

- What characteristics help explain the presence of and changes over time in neonicotinoid detections in stream water?
- What are the impacts of these contaminants on the prevalence and diversity of aquatic organisms in impacted streams?
- A recent Hatch grant should help us work towards these goals

Acknowledgements

- WPVGA and cooperating growers
- Wisconsin DATCP
- Wisconsin DNR
- Groves Lab
- Funding sources
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 - HATCH Formula 142 Funds (UW)
 - USDA SCRI Specialty Crop Block Grants Program



Questions?

