



LAND & WATER  
RESOURCES  
DEPARTMENT

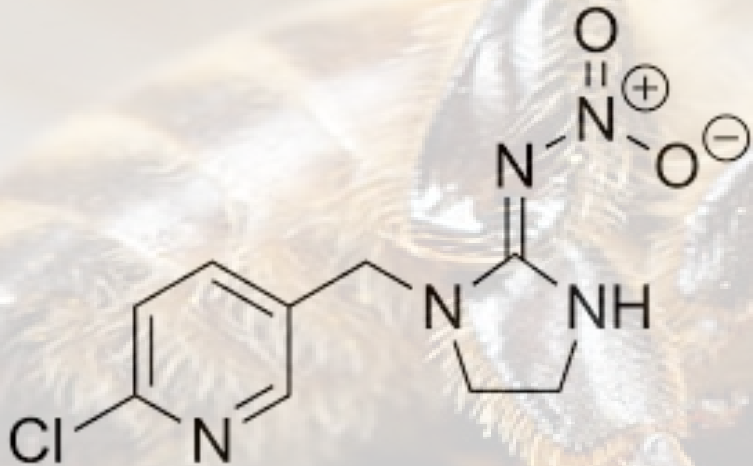
# An Introduction to Neonicotinoid Insecticides

James Brodzeller, Watershed Coordinator  
April 15, 2026

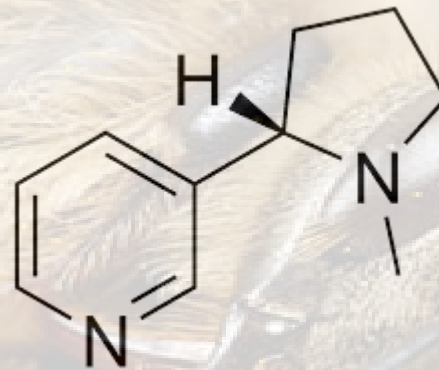


# Mode of Action

- Systemic neurotoxins
- Chemically similar to nicotine



Imidacloprid



Nicotine

# Primary Applications



Seed Dressings



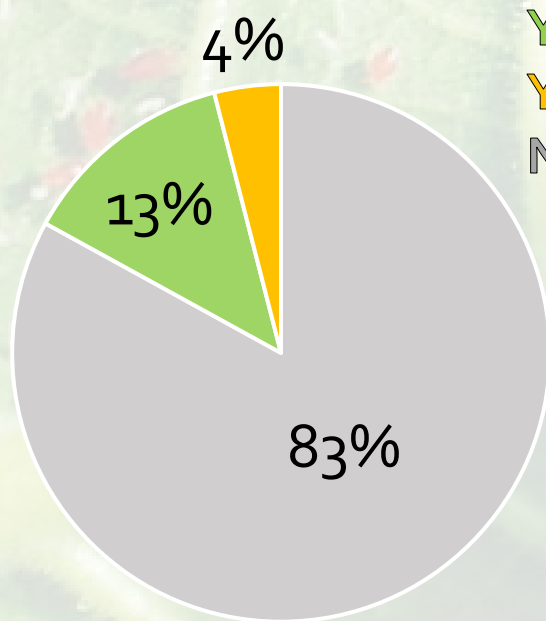
Foliar Sprays



Urban

# Efficacy

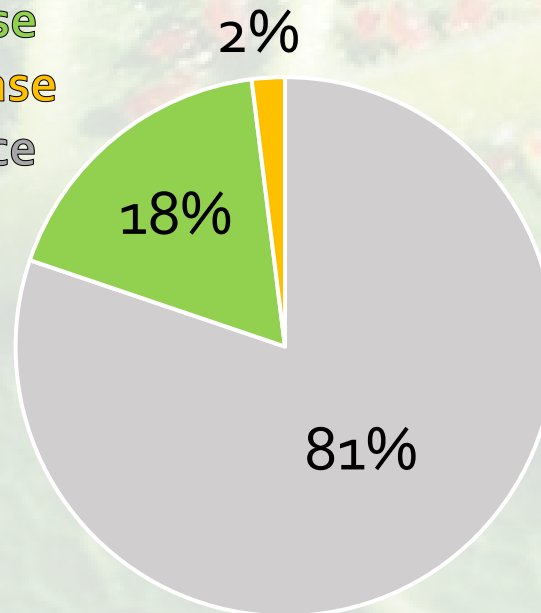
- Estimated annual pesticide use in WI is 20 million pounds (USGS)
- Nearly 100% of seed corn sold in the U.S. is dressed with neonics, ≈ 60% of soybeans
- WI corn & soybean producers spend \$20-\$60 million annually on dressed seed



**Corn**

Yield Increase  
Yield Decrease  
No Difference

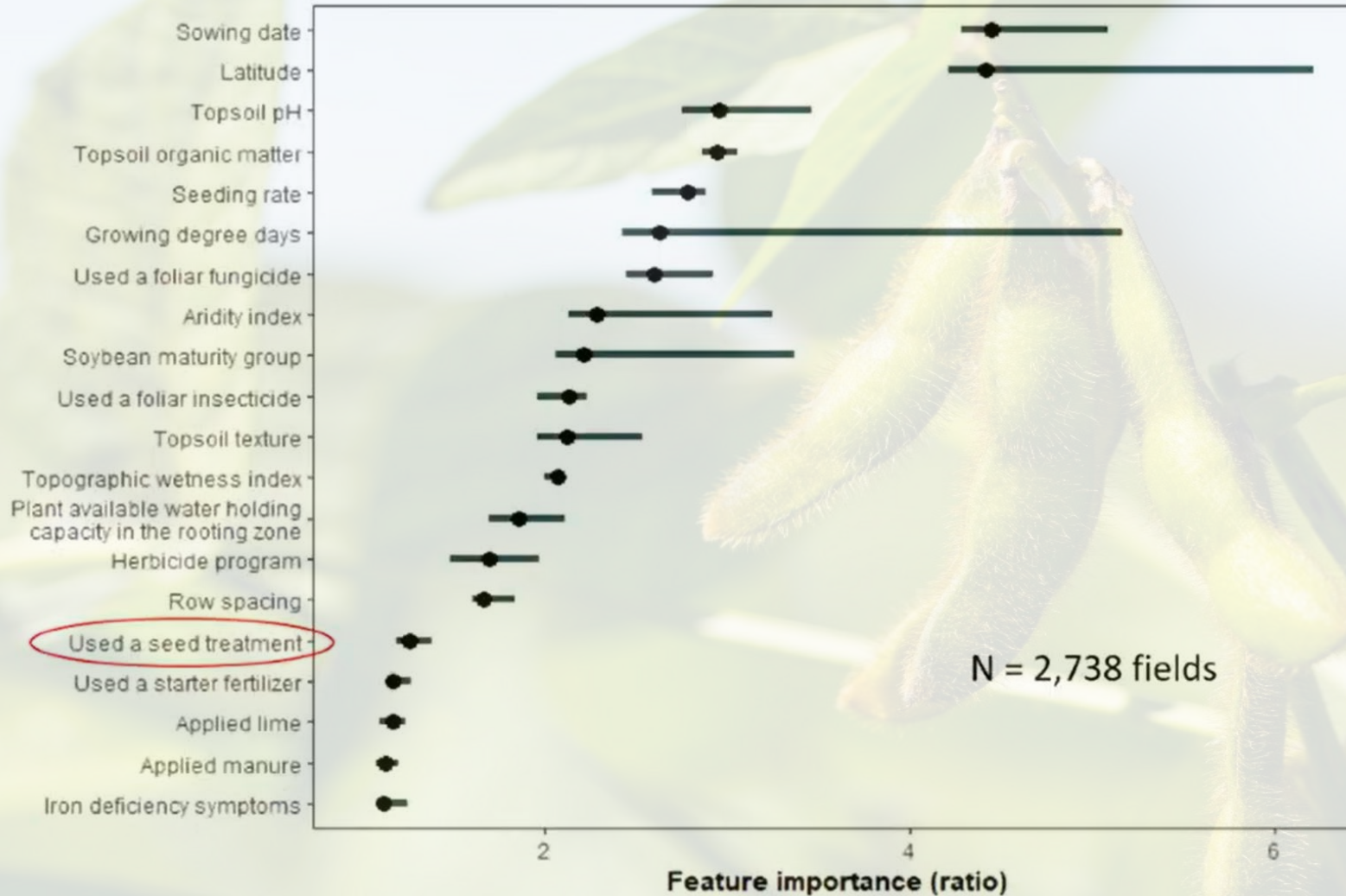
Cornell University  
Grout et al 2020



**Soybean**

**678** Field Trials  
22 States, 2 Provinces

# What Drives Soybean Yield?



- Seed dressing has minimal effect on yields
  - 1/2 bushel/acre/year
- Sowing date & latitude are much more influential
  - 2-3 bushel/acre/week

Shah et al 2021

# Environmental Concerns

- Adversely affects non-target species (pollinators, macroinvertebrates)
- Bioaccumulation in animals higher in the food web



# Human Health

- WI Department of Agriculture 2024
- Tested 380 private wells, 40% had detectable levels of pesticides
- 1/2 of these compounds aren't regulated
- Center for Disease Control 2019
- 1/2 of Americans exposed to neonics daily
- Pregnancy exposure linked to potential:
  - Birth defects in heart & brain
  - Autism-like symptoms
  - Cognitive impairment



# Toxicity

- Oral LD<sub>50</sub> in honeybees is approximately 4 billionths of a gram (Godfray et al 2015)



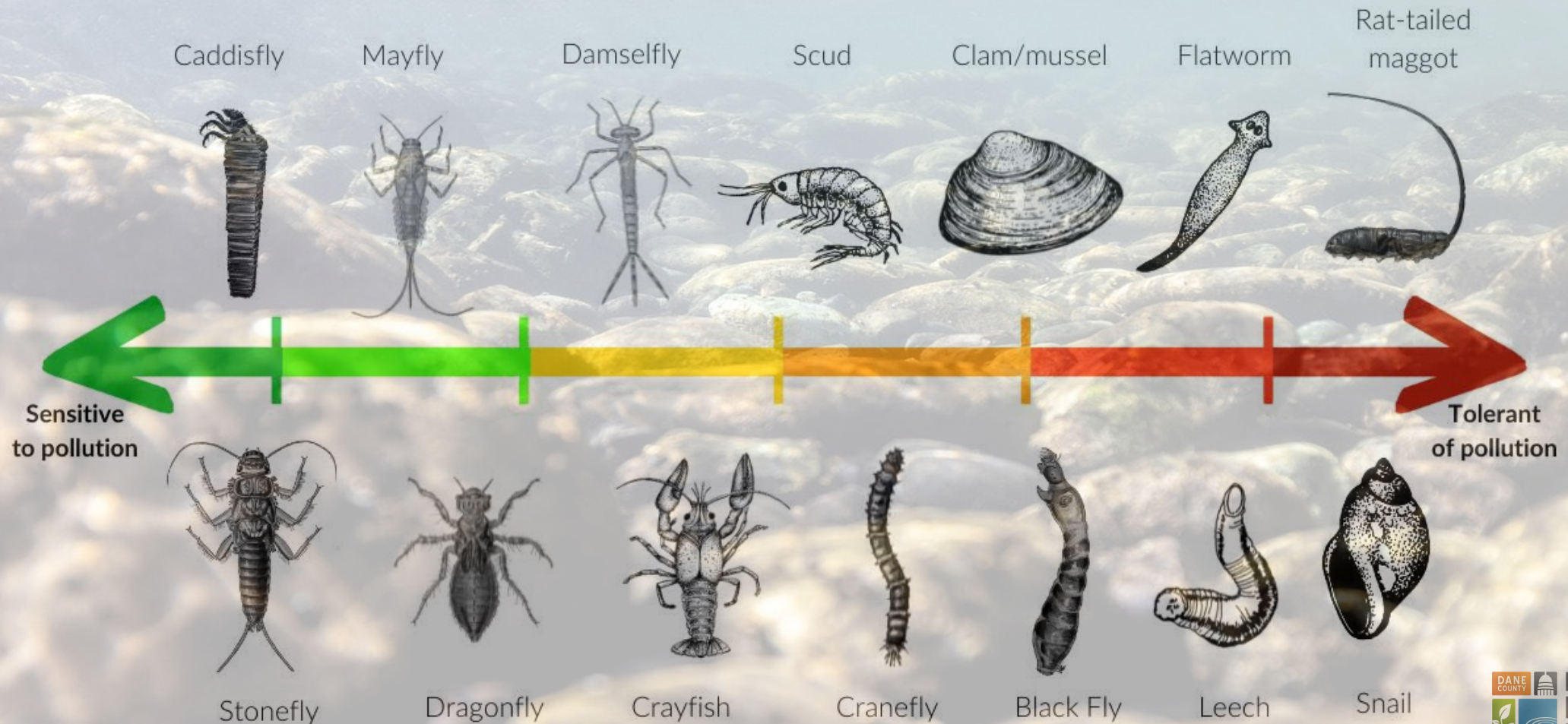
→ One treated corn seed can kill up to 250,000 honeybees, one songbird



→ Salt packet provides LD<sub>50</sub> to 250 million honeybees (50 metric tonnes)

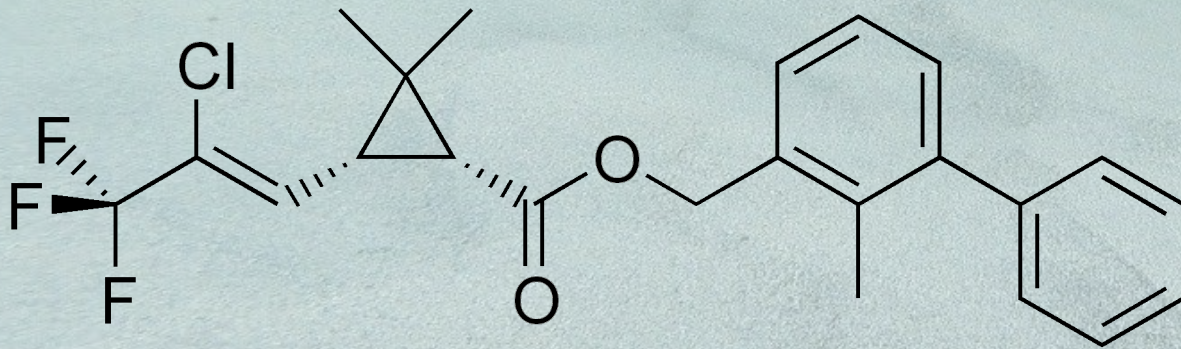
# Aquatic Mobility

- Predominately hydrophilic compounds (highly water-soluble)



# Sediment Contamination

- Some insecticides are hydrophobic, partition into sediment
- Classified as Category C by EPA (possible human carcinogen)
- Found in toxic levels in WI rivers & streams



Bifenthrin

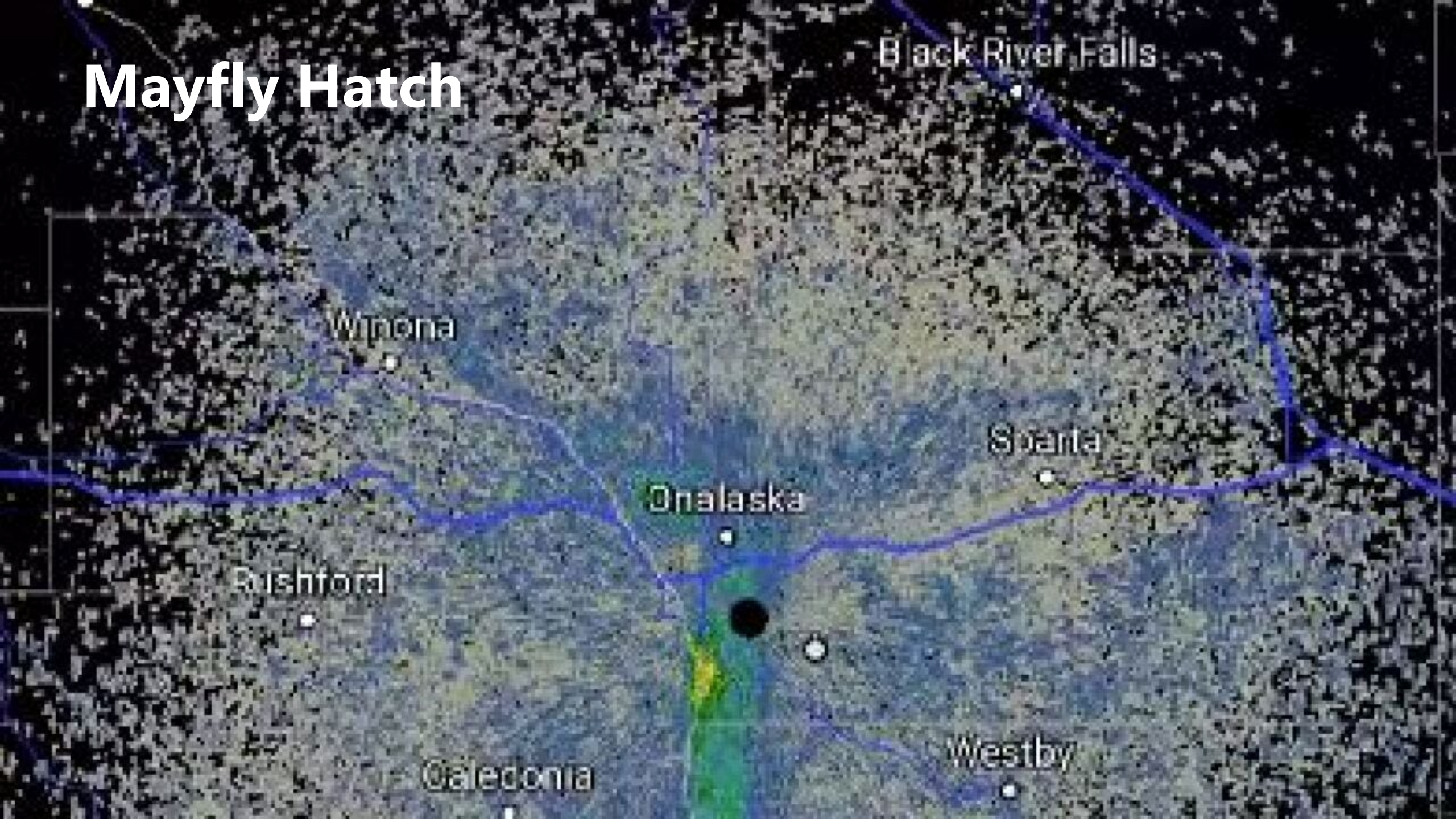


# Surface Water Impacts

- Macroinvertebrate decrease in streams, rivers and lakes can negatively effect fisheries, waterfowl & ecological balance

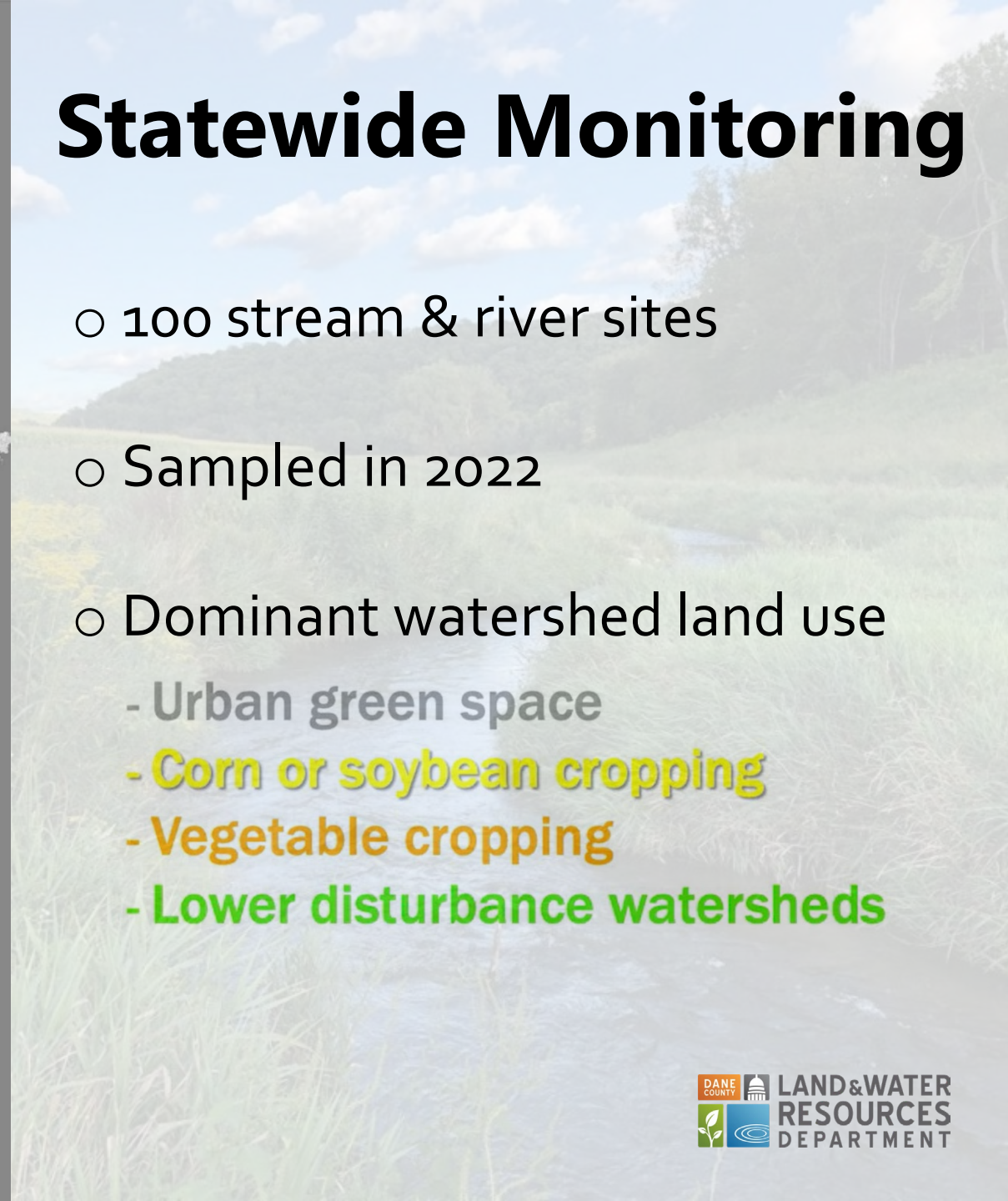
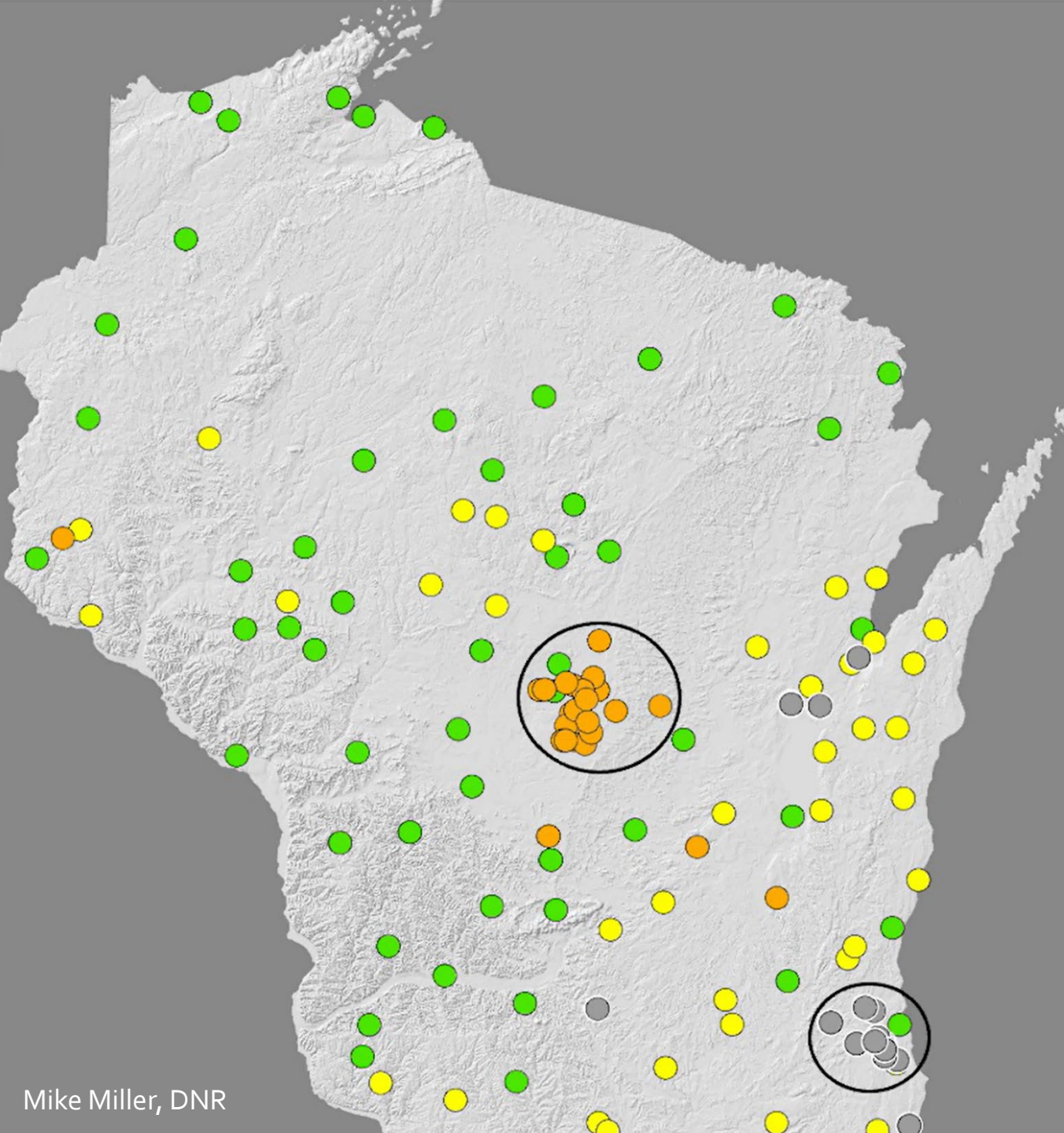


# Mayfly Hatch

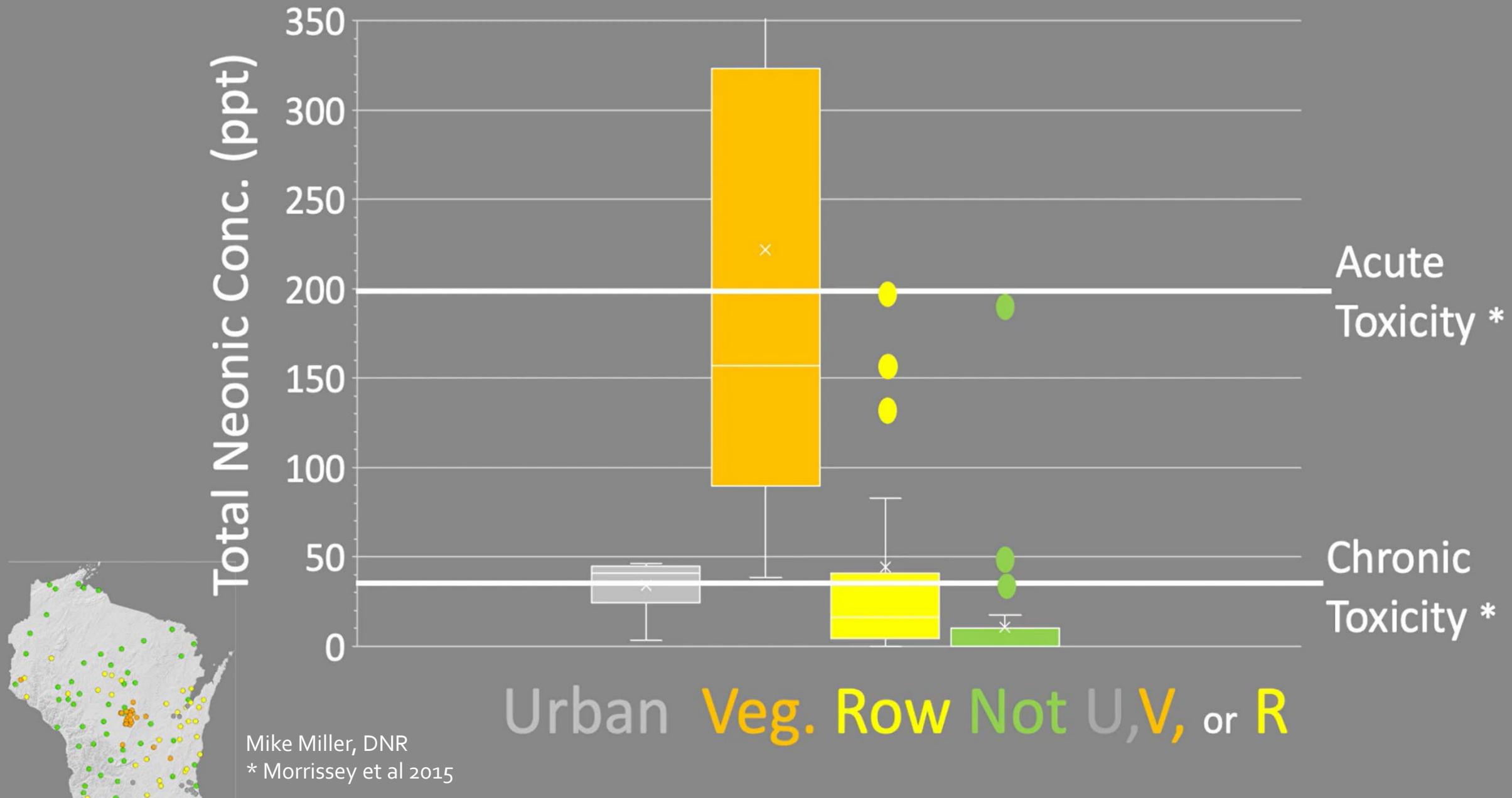


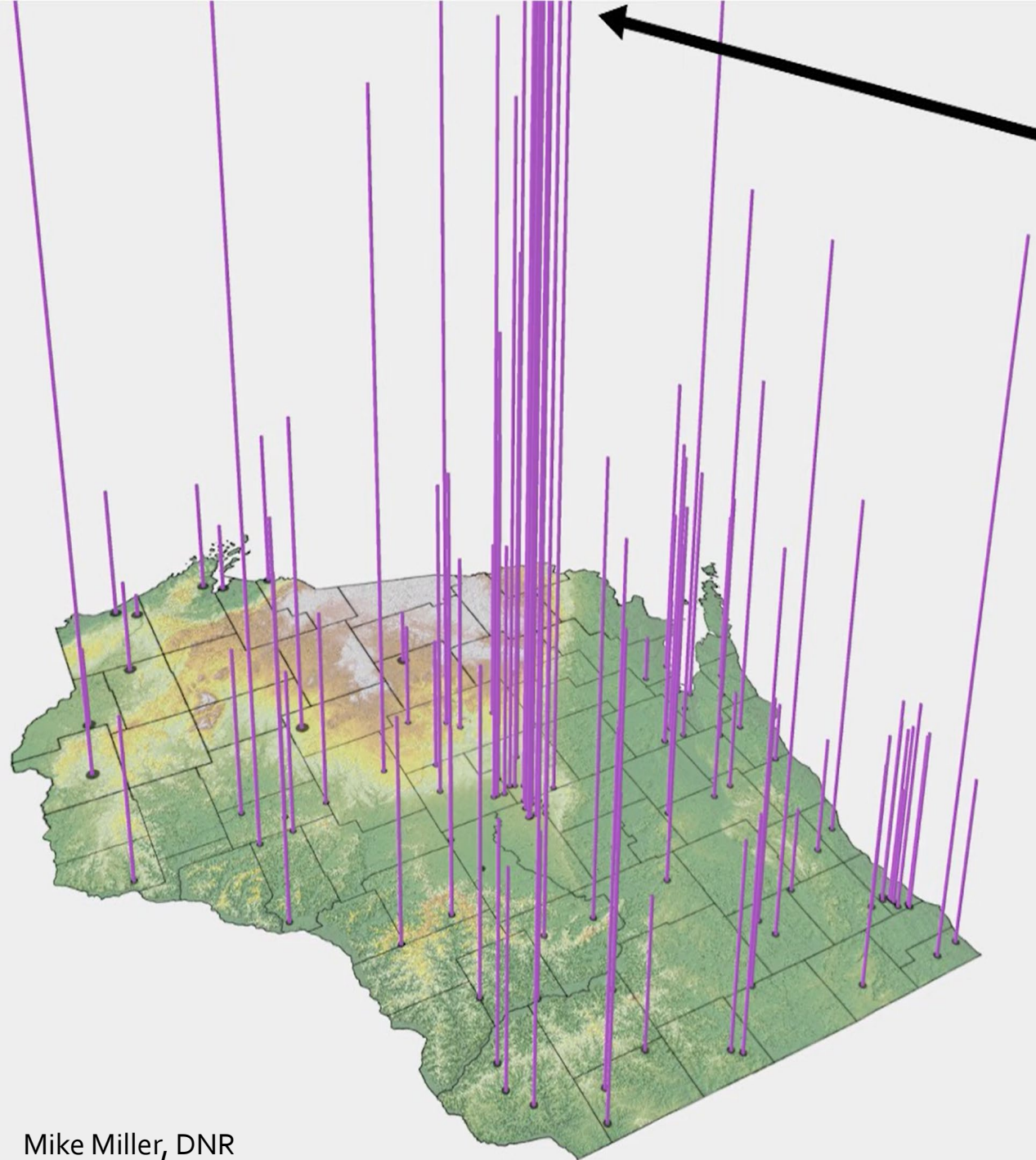
# Statewide Monitoring

- 100 stream & river sites
- Sampled in 2022
- Dominant watershed land use
  - Urban green space
  - **Corn or soybean cropping**
  - **Vegetable cropping**
  - **Lower disturbance watersheds**

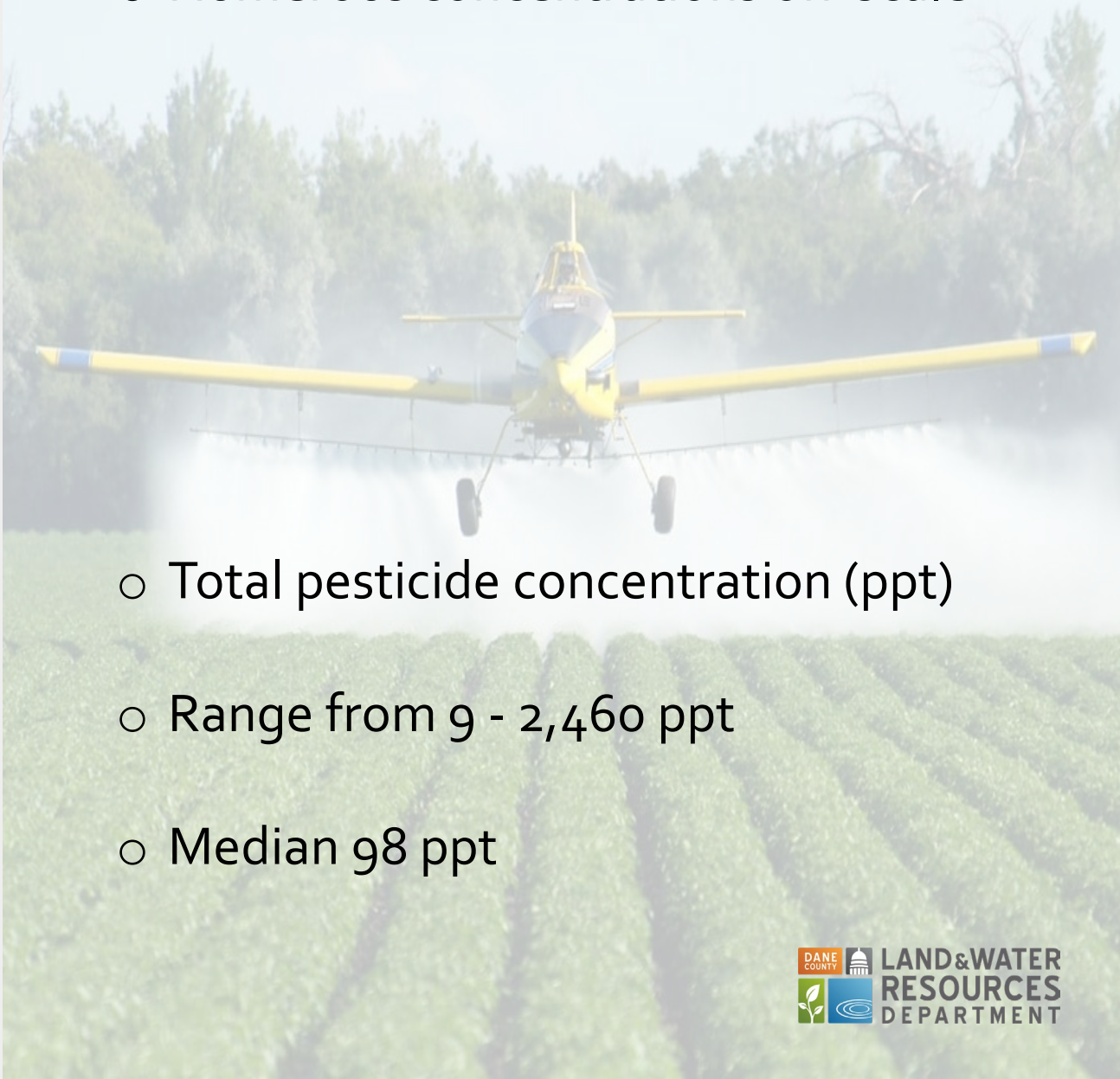


# Neonicotinoid Concentrations by Land Use





- Numerous concentrations off-scale



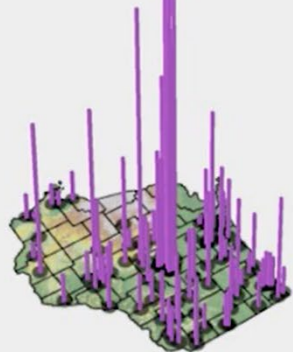
- Total pesticide concentration (ppt)

- Range from 9 - 2,460 ppt

- Median 98 ppt

## What's going on in the Central Sands?

- Heavy pesticide use (vegetable cropping)
- Low soil organic matter
- Highly permeable soils
- Shallow water table
- Irrigation, groundwater recirculation



# Pesticides & Transformation Compounds Found in Wisconsin Streams & Rivers (n = 135)

- |                      |                      |                     |                    |                    |                     |                    |
|----------------------|----------------------|---------------------|--------------------|--------------------|---------------------|--------------------|
| Acetachlor           | Azoxystrobin         | Flutriafol          | Norflurazon        | Methoprotryne      | Phenmediphama       | Methabenzthiazuron |
| Alachlor             | Biphenyl             | Halofenozide        | Fluoxastrobin      | Siduron            | Zoximide            | Methamidophos      |
| Metolachlor          | Sulfentrazone        | Metribuzin          | Dimethomorph       | Monocrotophos      | Carfentrazone ethyl | Monolinuron        |
| Metalaxyl            | Aldicarb sulfoximide | Fenarimol           | Fenhexamid         | Cymoxanil          | Aldicarb sulfone    | Nitenpyram         |
| Tetrhydrophthalimide | Bifenthrin           | Flusilazole         | Methoxyfenozide    | Iprovalicarb       | Bifenazate          | Propham            |
| Aldrin               | Chlorantraniliprole  | Penconazole         | Bromuconazole      | Simetryn           | Bitertanol          | Spirotetramat      |
| Dimethachlor         | Terbutylazine        | Mesotrione          | Nuarimol           | Difenoconazole     | Carbofuran          | Teflubenzuron      |
| Atrazine             | Meviphos             | Tebuconazole        | Tebufenozide       | Chloroxuron        | Chlorotoluron       | Thiobencarb        |
| Propachlor           | <b>Imidacloprid</b>  | <b>Thiamethoxam</b> | Triadimefon        | Cycluron           | Clethodim           |                    |
| Procymidone          | Flutolanil           | BHC, delta-         | Terbacil           | Forchlorfenuron    | Diethofencarb       |                    |
| <b>Clothianidin</b>  | Terbutryn            | Tetraconazole       | Benalaxyl          | Furalaxyl          | Dimethoate          |                    |
| Diphenylamine        | Thiabendazole        | Cyromazine          | Diclobutrazol      | Isoproturon        | Diuron              |                    |
|                      | Transfluthrin        | Pacllobutrazol      | Dimoxystrobin      | Fenuron            | Fluometuron         |                    |
|                      | Propiconazole        | Aminacarb           | Epoxiconazole      | Metobromuron       | Fuberidazole        |                    |
|                      | Boscalid             | Cyproconazole       | Flufenacet         | Oxadixyl           |                     |                    |
|                      | Prothioconazole      | Pymetrozine         | Hexaconazole       | Piperonyl butoxide |                     |                    |
|                      | Promenton            | Linuron             | Mepronil           | Trifloxystrobin    |                     |                    |
|                      |                      | Tetrachloroaniline  | Pirimicarb         | Acetamiprid        |                     |                    |
|                      |                      | 2,3,5,6-Ethiprole   | Tebuthiuron        | Clofentezine       |                     |                    |
|                      |                      | Thiofanox           | Mandipropamid      | Ethirimol          |                     |                    |
|                      |                      | Tricyclozole        | Mefenacet          |                    |                     |                    |
|                      |                      | Dicrotophos         | Triticonazole      |                    |                     |                    |
|                      |                      | Etaconazole         | Prometryne         |                    |                     |                    |
|                      |                      | Flonicamid          | Propoxur           |                    |                     |                    |
|                      |                      | Mycloburtanil       | Pentachlorobenzene |                    |                     |                    |
|                      |                      | Propamocarb         | Acephate           |                    |                     |                    |
|                      |                      | Metconazole         | Mepanipyrim        |                    |                     |                    |
|                      |                      | Picoxystrobin       | Methiocarb         |                    |                     |                    |
|                      |                      |                     | Methomyl           |                    |                     |                    |

In order of decreasing frequency of occurrence, (top to bottom, left to right)



# Monitoring and Analysis of Neonicotinoid Insecticides in Wisconsin Groundwater: Distribution, Trends, and Influential Factors

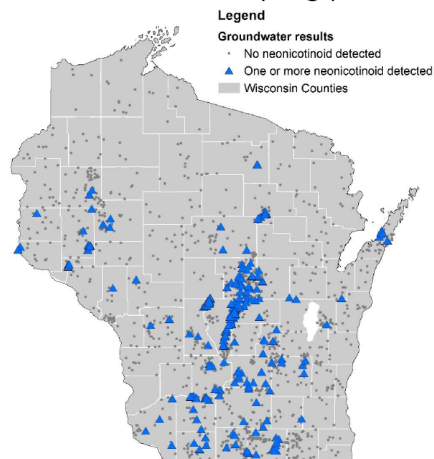
Brockschmidt S.<sup>1</sup>, Potrykus K.<sup>1</sup>, Romano C.<sup>2</sup>, Cook C.<sup>1</sup>, McColloch M.<sup>1</sup>, Blanchard D.<sup>1</sup>, Engelhardt A.<sup>1</sup>, Gramse M.<sup>1</sup>, Kelley G.<sup>1</sup>

<sup>1</sup> Wisconsin Department of Agriculture, Trade, and Consumer Protection; <sup>2</sup> Wisconsin Department of Natural Resources

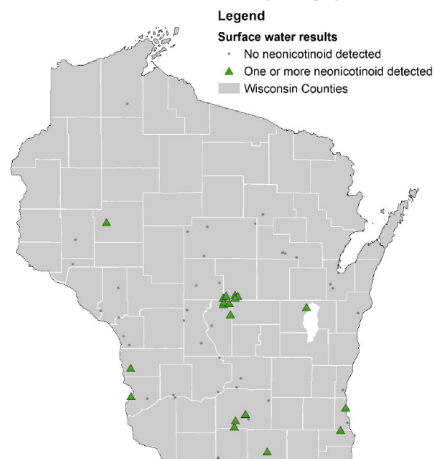
## Groundwater and Surface Water Sampling

- Determine which pesticides are found in the environment through multiple sampling programs
- Determine whether pesticide concentrations exceed groundwater/surface water benchmarks

### Neonic Groundwater Sampling (2011 – 2023):

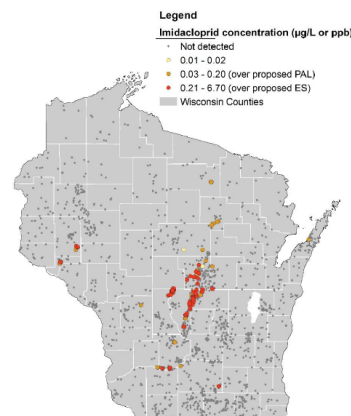


### Neonic Surface Water Sampling (2011 – 2023):



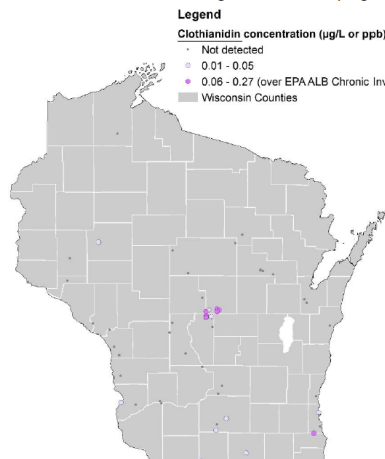
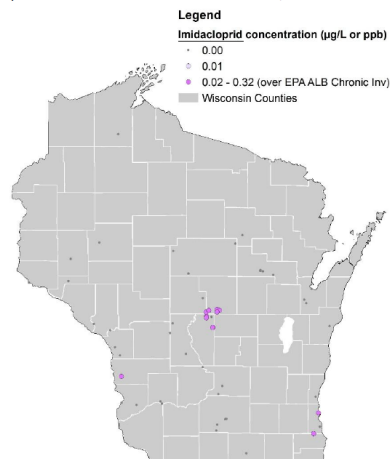
## Neonicotinoid Water Quality Benchmark Exceedances

GROUNDWATER	Compound	Proposed 2019 Wisconsin Preventive Action Limit		Proposed 2019 Enforcement Standard or Wisconsin Department of Health Services (DHS) Health Advisory Level	
		Benchmark concentration (µg/L or ppb)	Exceedance rate (2011 – 2023)	Benchmark concentration (µg/L or ppb)	Exceedance rate (2011 – 2023)
	Clothianidin	200	0%	1000	0%
	Imidacloprid	0.02	17%	0.2	9%
	Thiamethoxam	12	0%	120	0%



SURFACE WATER	Compound	U.S. Environmental Protection Agency (EPA) Aquatic Life Benchmarks (ALBs) For Freshwater Invertebrates*			
		Chronic		Acute	
		Benchmark concentration (µg/L or ppb)	Exceedance rate (2011 – 2023)	Benchmark concentration (µg/L or ppb)	Exceedance rate (2011 – 2023)
	Clothianidin	0.05	1%	11	0%
	Imidacloprid	0.01	8%	0.385	0%
	Thiamethoxam	0.74	0%	17.5	0%

\*EPA has published ALB's for freshwater vertebrates, but DATCP did not detect any exceedances of these benchmarks during 2011 – 2023 sampling



## Conclusions

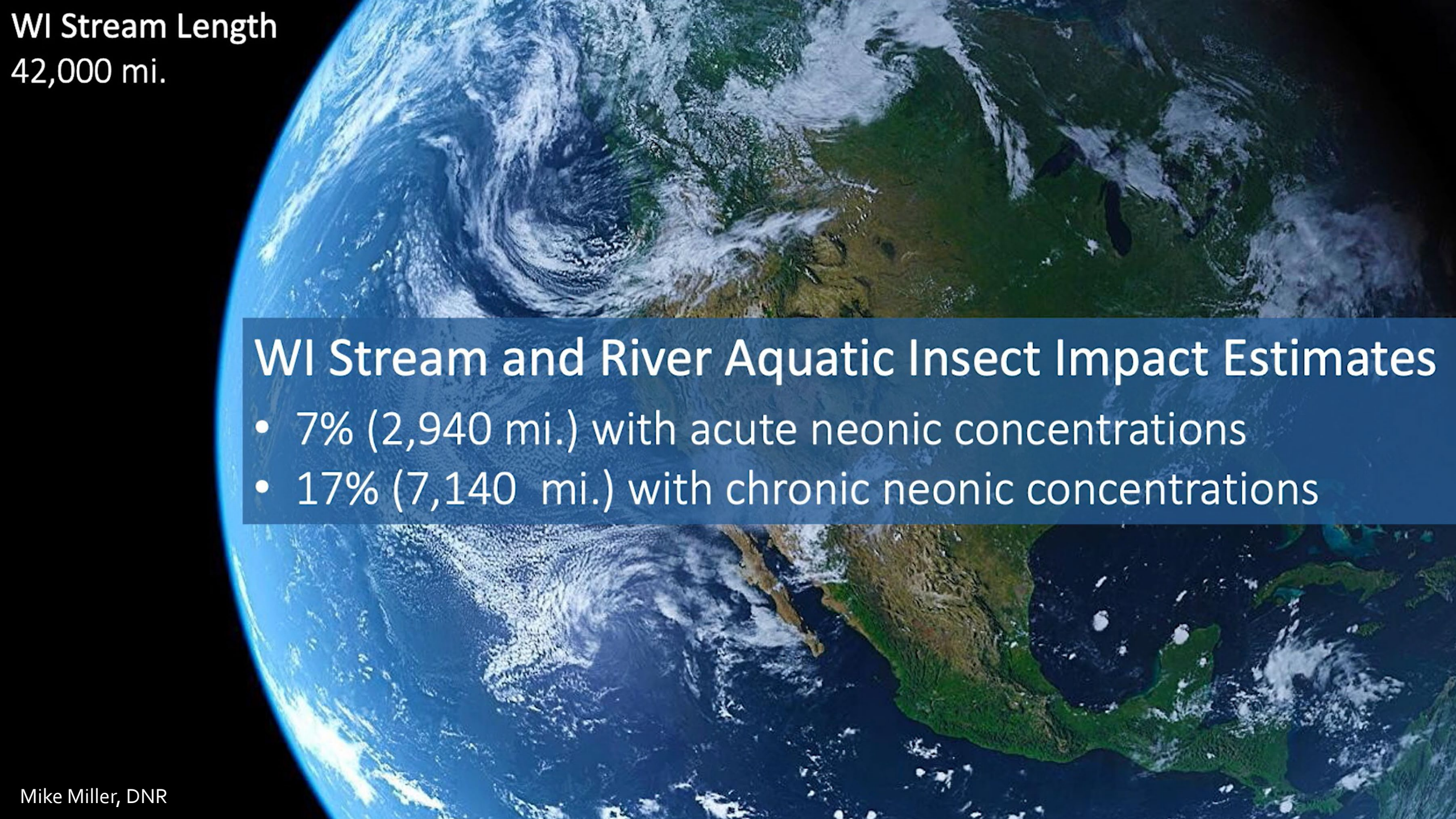
- Neonicotinoids have been detected in surface water and groundwater across Wisconsin.
- Clothianidin, imidacloprid, and thiamethoxam are the most frequently detected neonicotinoids, with a higher incidence in groundwater compared to surface water.
- Imidacloprid is the sole compound exceeding the Wisconsin Department of Health Services health advisory level in groundwater, with exceedances primarily in the Central Sands, Lower WI River Valley, and Western Wisconsin.
- Both clothianidin and imidacloprid exceed EPA's chronic aquatic life benchmarks for invertebrates in surface water, with exceedances found in Central Sands, Western, and Southeastern Wisconsin.



Check out our groundwater and surface water reports!

More questions? Reach out to the DATCP Environmental Quality Unit at: [datcp@wi.gov](mailto:datcp@wi.gov)



A satellite image of Earth showing the Western Hemisphere, including North America, South America, and the Pacific Ocean. The image is oriented vertically, with the top of the frame showing the Arctic region and the bottom showing the Antarctic region. The text is overlaid on the top left and a central blue box contains the main title and bullet points.

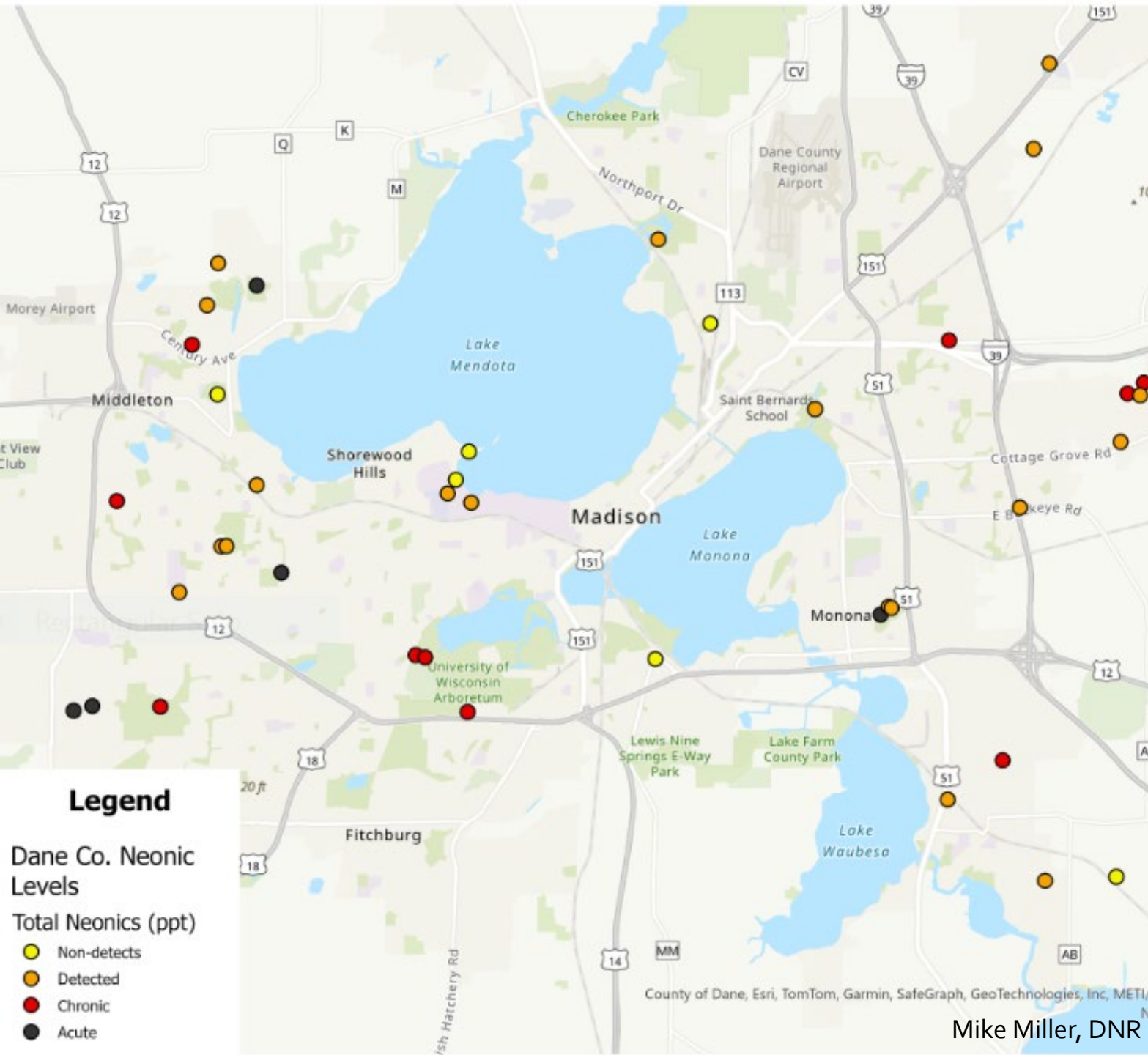
**WI Stream Length**  
42,000 mi.

## WI Stream and River Aquatic Insect Impact Estimates

- 7% (2,940 mi.) with acute neonic concentrations
- 17% (7,140 mi.) with chronic neonic concentrations

# Local Monitoring

- Ponds sampled in 2024
- Analyzed for imidacloprid, clothianidin
- 85% detected
- 25% chronic
- 12.5% acute



# Statewide Conservation Response

- Educate farmers & general public to grow awareness



## What's on your seed?

Seed treatments have been used for a number of years, mostly for protection against seedling diseases. However, there are a number of new seed treatments marketed for protection against a range of pests—including seedling diseases, insects and nematodes—and even improving plant health.

The purpose of this publication is to take some of the confusion of seed treatments away, giving you a better understanding of what is on your seed. The list covers seed treatments registered in the state of Wisconsin for use on corn and/or soybean seed. The seed treatments are grouped by the number of active ingredients (1-4), treatment type (fungicide, insecticide, nematicide or plant growth regulator) and then alphabetically by the product trade name. The list is not based on efficacy of the seed treatments and is not an endorsement or criticism of one product over another. You are responsible for using pesticides according to the manufacturer's current label directions.



Authors: Paul Esker, Assistant Professor of Plant Pathology & Richard Proost, Nutrient and Pest Management Program

Treatment Type **F** Fungicide **I** Insecticide **N** Nematicide **P** Plant Growth Regulator

Active Ingredient (s)	Product Trade Name	Crop
<b>F</b> azoxystrobin	<b>Dynasty®</b>	Corn, Soybean
	<b>Protégé™ FL</b>	Corn
<b>F</b> <i>Bacillus pumilus</i>	<b>Yield Shield®</b>	Corn, Soybean
<b>F</b> <i>Bacillus subtilis</i>	<b>HiStick® N/T</b>	Soybean
	<b>Vault® Hn</b>	Corn, Soybean



# Local Action

- Agricultural leases prohibit neonic coated seed on county owned lands

- C. LESSEE shall cease use of neonicotinoid treated seed or other neonicotinoid pesticides on the premises by 2026.

- a. Seed labels must be submitted to LWRD prior to planting each year.

- Further farmer education & assist with sourcing of neonic free seed

Neonicotinoid-free Corn and Soybean Seed Availability*								
Company	City	Contact	Phone	Web	Corn		Soybeans	
					Typically available	Best to order by	Typically available	Best to order by
Abbe Hills Farm	Mt. Vernon, Iowa	Laura Krouse	319-895-6924	<a href="http://www.abbehills.com">www.abbehills.com</a>	Feb-May	May	-	-
Albert Lea Seed	Albert Lea, MN	Mac Ehrhardt	800-352-5247	<a href="http://www.alseed.com">www.alseed.com</a>	Sep-Nov	Nov	Sep-Jul	May
Blue River Hybrids	Kelley, Iowa	Maury Johnson	800-370-7979	<a href="http://www.blueriverorgseed.com">www.blueriverorgseed.com</a>	Sep-May	Dec	Sep-Jun	Jun
Brownseed Genetics	Bay City, WI	Charlie Brown	888-712-7696	<a href="http://www.brownseedgenetics.com">www.brownseedgenetics.com</a>	Sept-Dec	Dec	-	-
eMerge Genetics	West Des Moines, Iowa	Wayne Hoener	866-769-7200	<a href="http://www.emergegenetics.com">www.emergegenetics.com</a>	Sep-Nov	Nov	Jan-Dec	Apr
Epley Brothers Hybrids, Inc.	Shell Rock, Iowa	Billy Boyer	319-885-6293		Jan-Dec	Mar	Jan-Dec	Apr