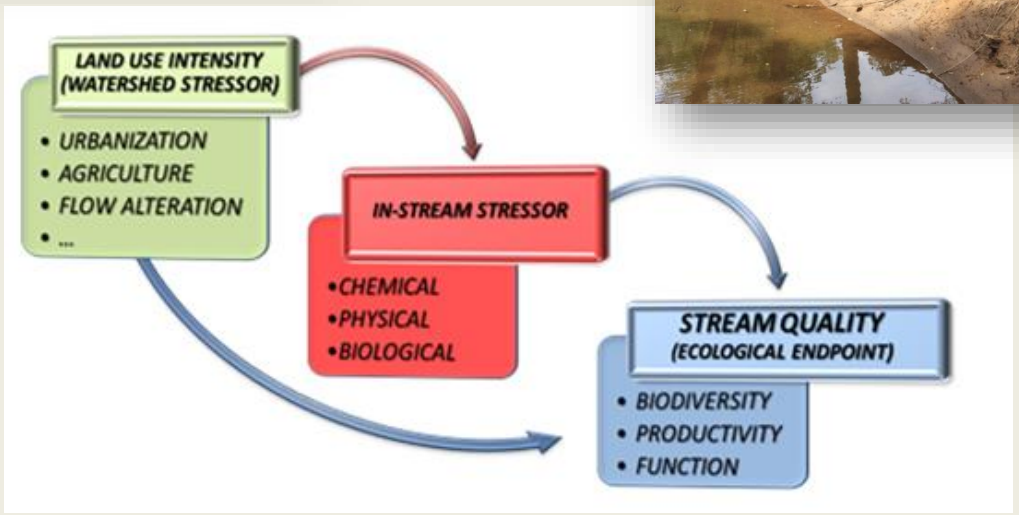
NAWQA Regional Stream Quality Assessments

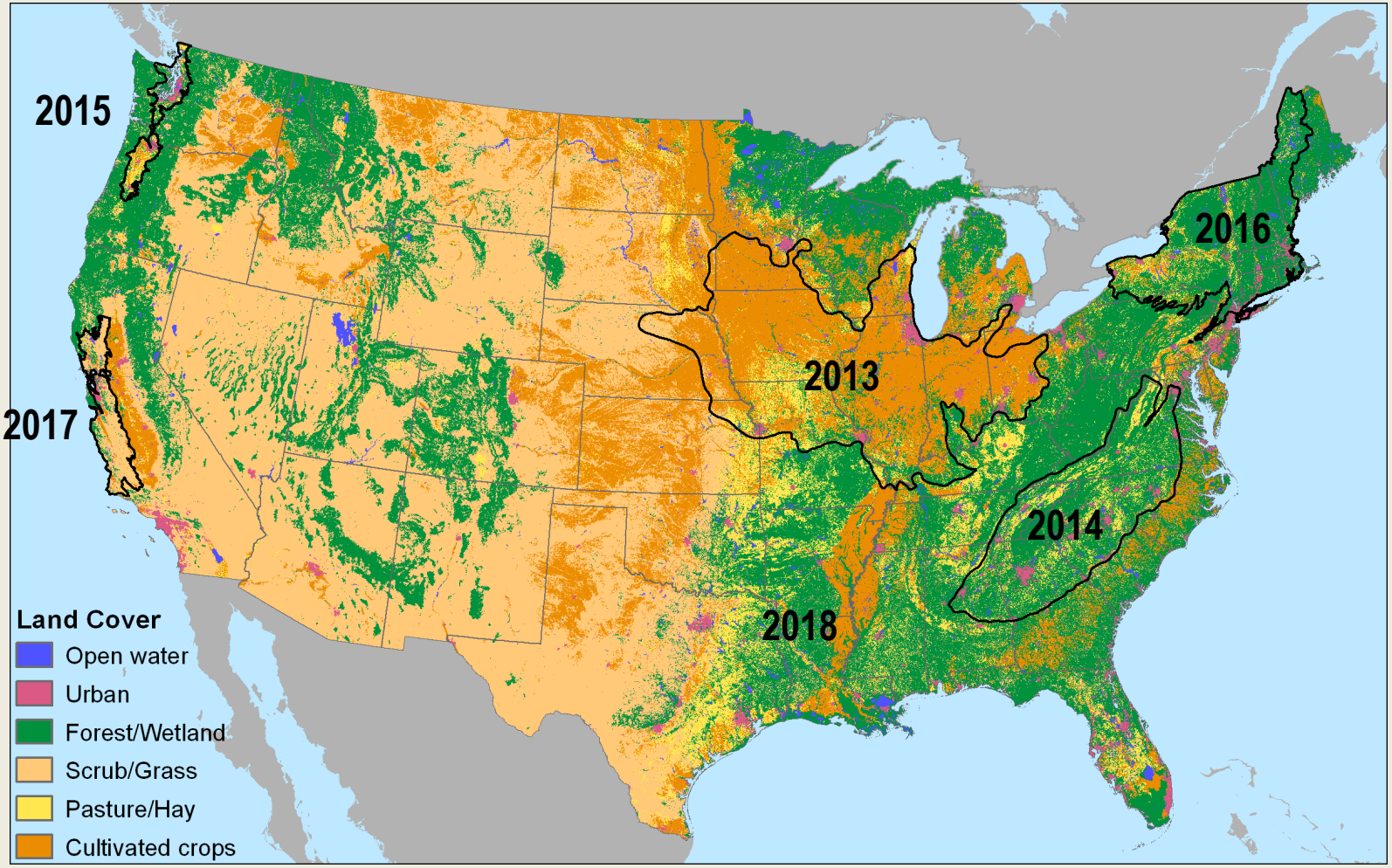
Peter Van Metre,
U.S. Geological Survey

USGS

Linking Landscape, Stressors, and Ecology



RSQA


2015
2016
2013
2017
2014
2018
Land Cover
Open water
Urban
Forest/Wetland
Scrub/Grass
Pasture/Hay
Cultivated crops

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Midwest Stream Quality Assessment NAWQA/NRSA collaboration

Effects of multiple stressors on biological communities in Midwest Corn Belt streams

- National Rivers and Streams Assessment (NRSA):
  - Many sites
  - Probabilistic site selection
  - Limited stressor data

- National Water Quality Assessment (NAWQA):
  - Fewer sites
  - Targeted site selection
  - Intensive stressor characterization

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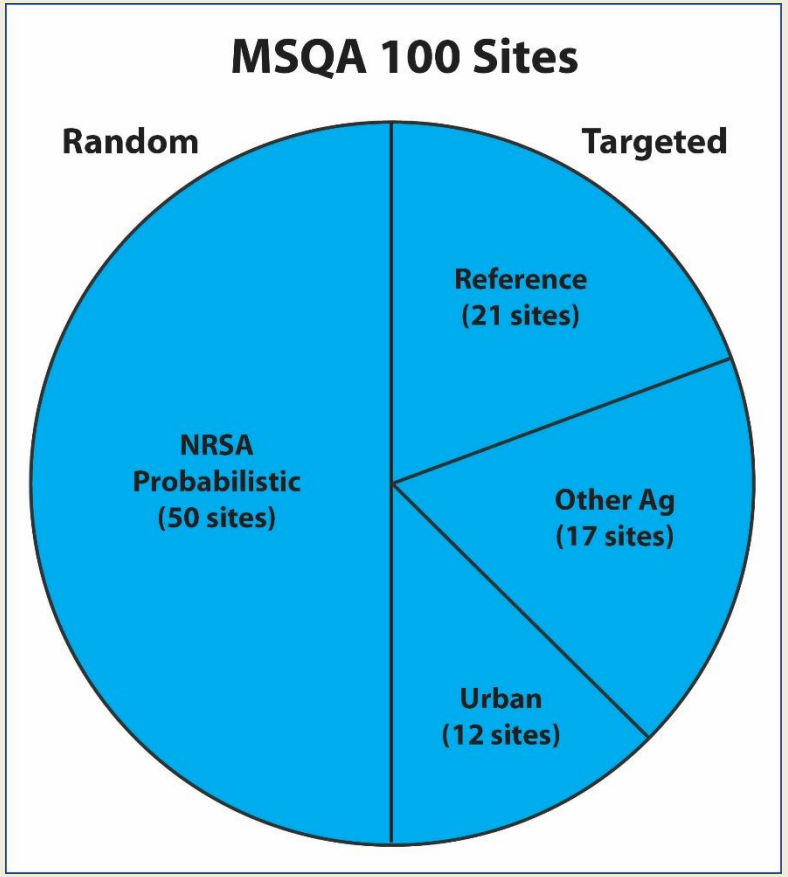
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

100 Sites

- Matched our sampling to NRSA's first 50 random sites
- Add the following site types:
  - Reference – 21 sites
  - Urban – 12 sites
  - Trend – 17 sites



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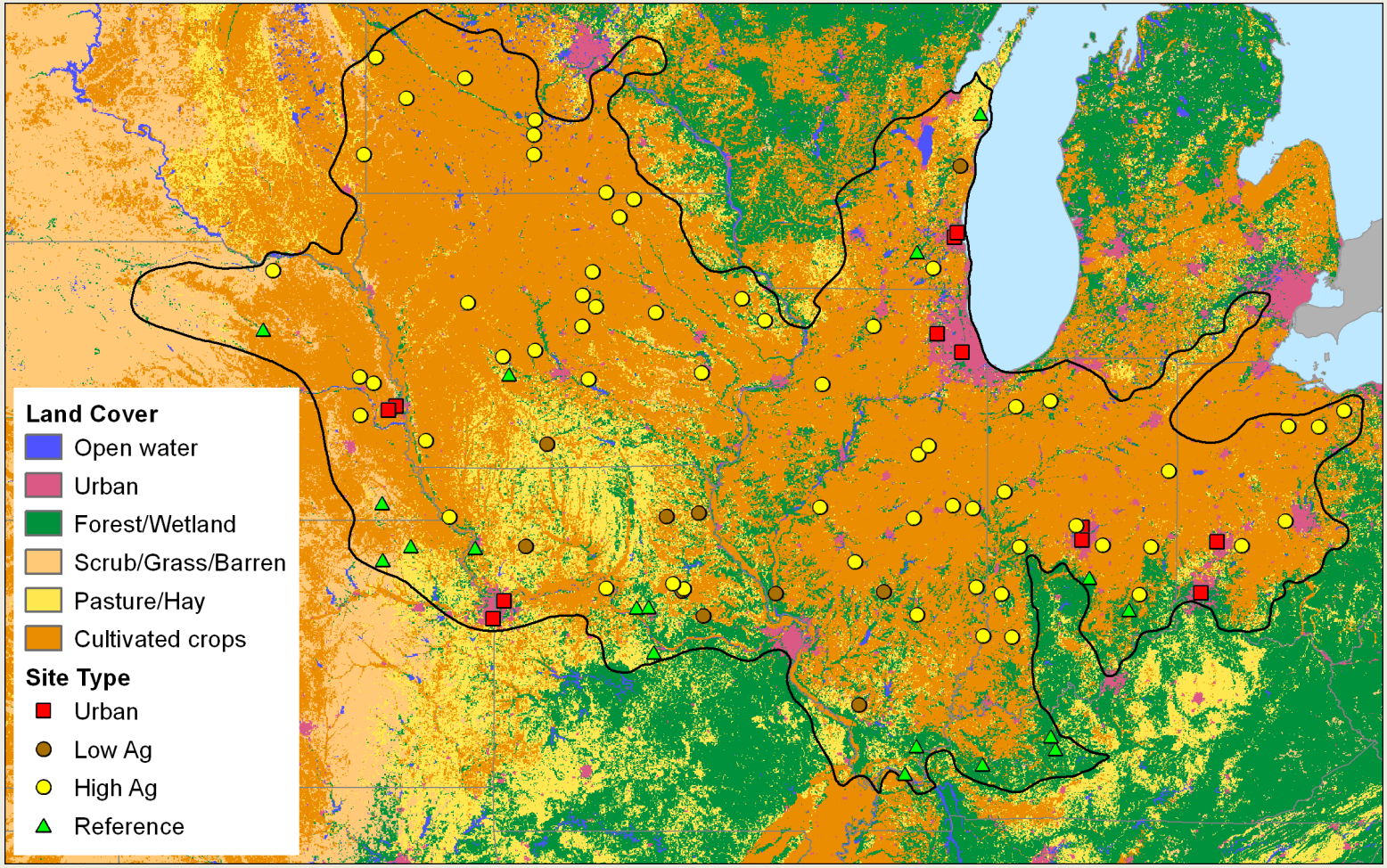
MSQA Sites



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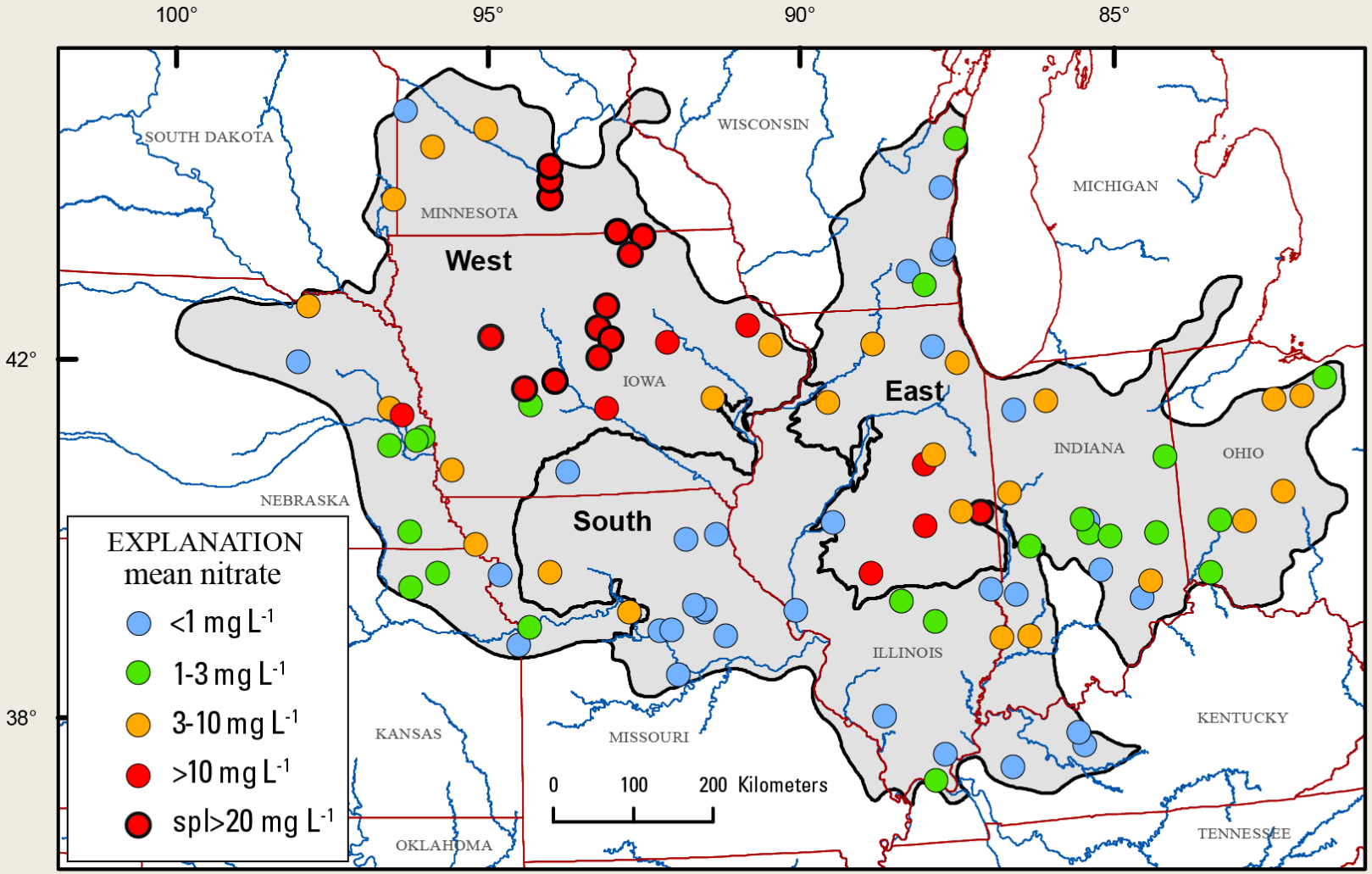
Sampling

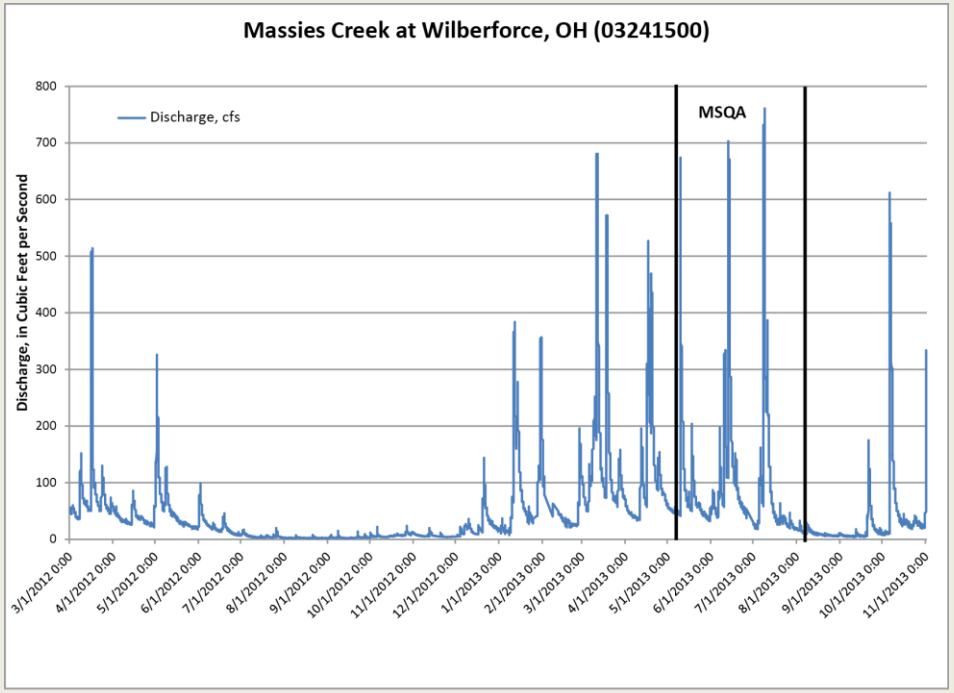
- **Water**
  - **Weekly samples at all sites:** pesticides, glyphosate, nutrients, major ions, sediment, and organic carbon
  - **Selected weeks:** mercury and N and O isotopes {waste indicator compound, pharmaceuticals, and hormones}
  - **POCIS:** pesticides {waste indicator compound, pharmaceuticals, and estrogen assay test}
- **Sediment**
  - **Chemistry:** metals, PAHs, organohalogens, hormones {waste indicator compounds}
  - **Toxicity:** Hyalella, chironomus, mussel
- **Ecology** inverts, algae, fish, habitat, plus continuous temp and stage

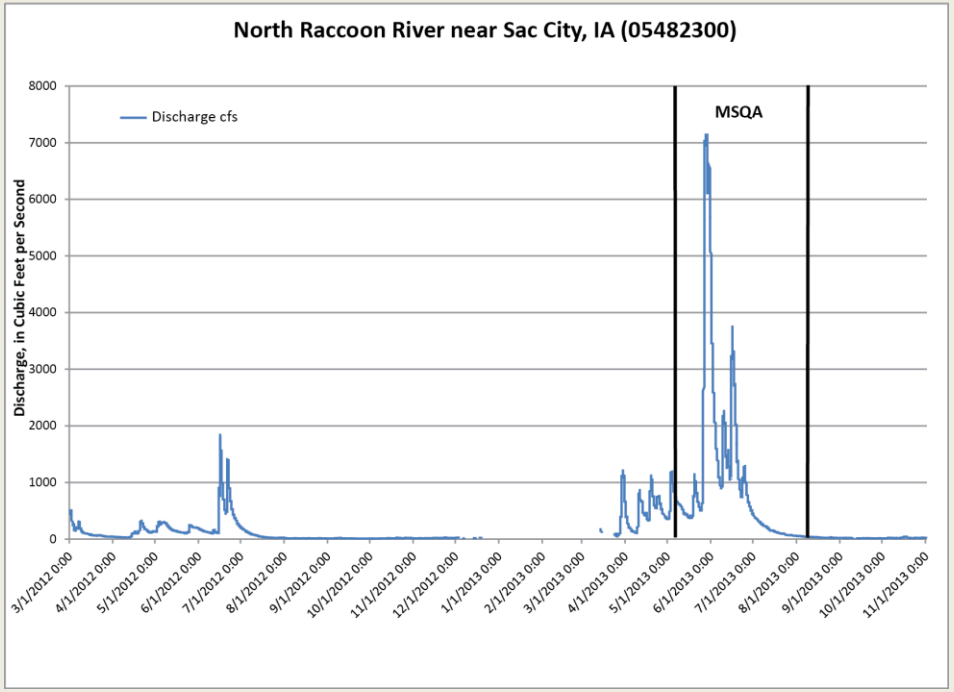
Very high nitrate in IA and MN in 2013



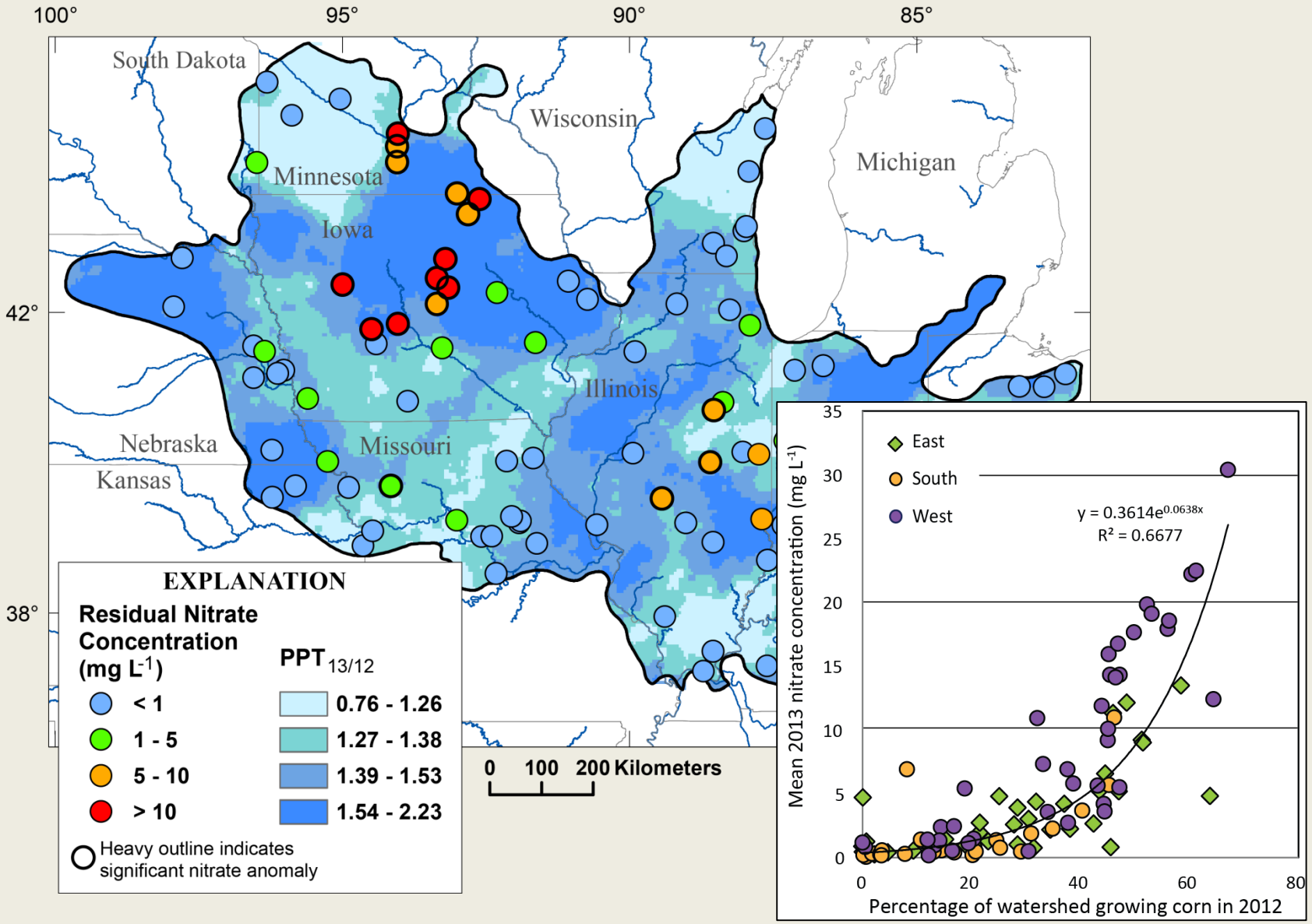
Van Metre et al., 2016, *Journal of Env. Qual.*

2012 drought effect stronger in the west



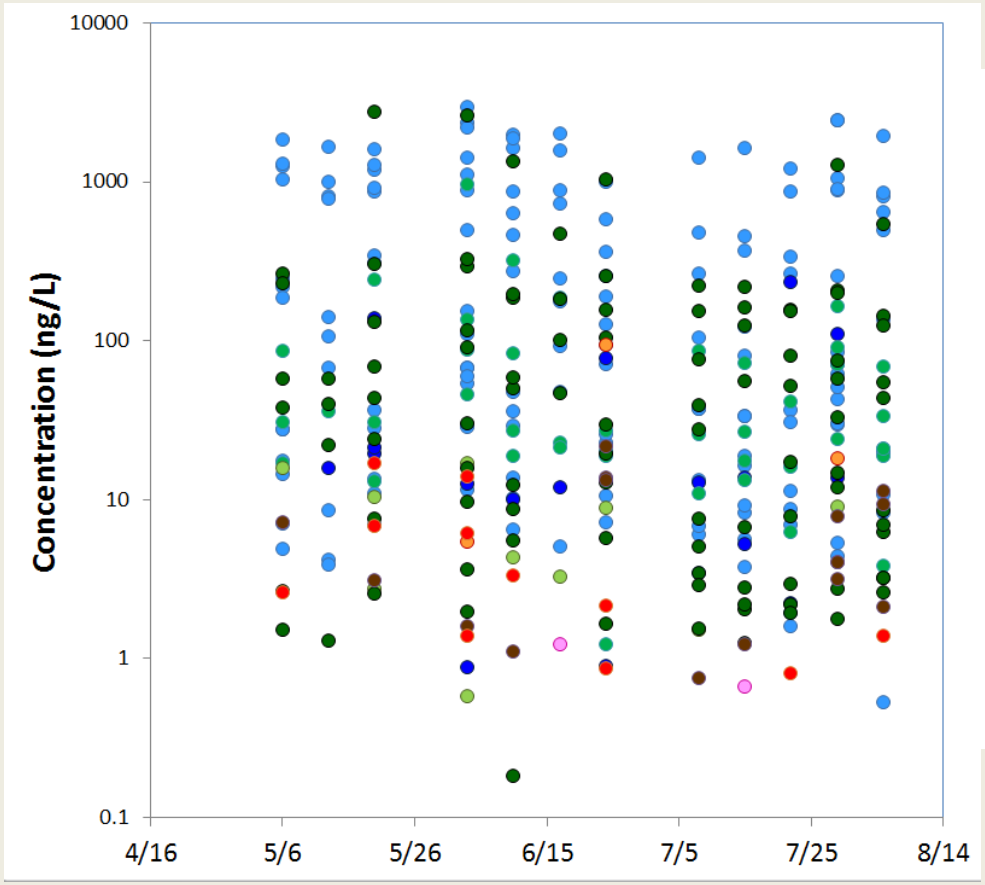


Rainfall anomaly leads to nitrate anomaly



Dissolved pesticides in water

227 pesticides analyzed by DAI LC-MS/MS

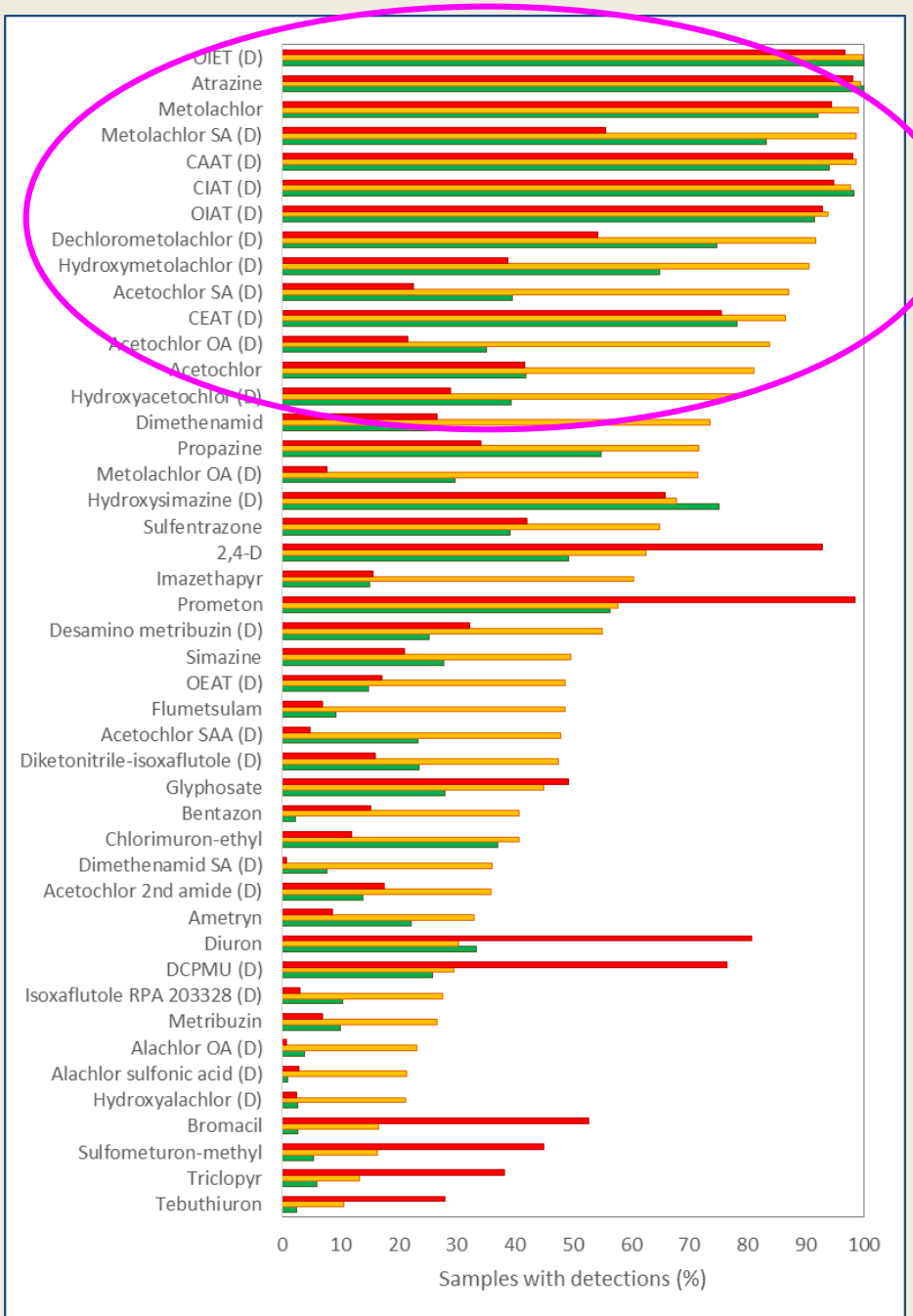


- acetanilide & amide-H
- acid-H
- miscellaneous-H
- sulfonylurea & urea-H
- triazine-H
- fungicide
- miscellaneous-I
- organophosphate-I
- pyrethroid & phenylpyrazine-I

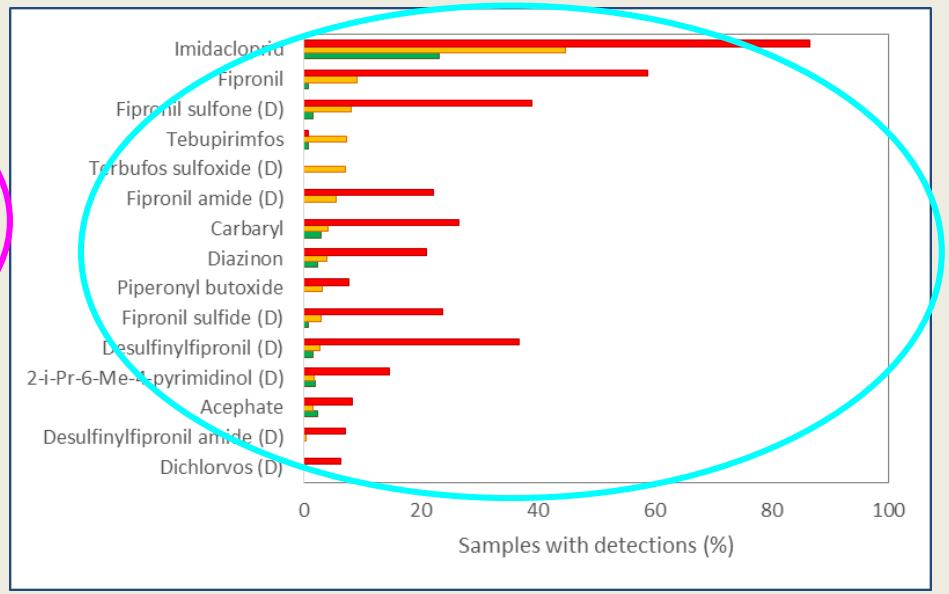
Lisa Nowell

- **South Fork Iowa River near Providence, IA, 2013:**
- **16-38 compounds per sample (MEDIAN=25)**

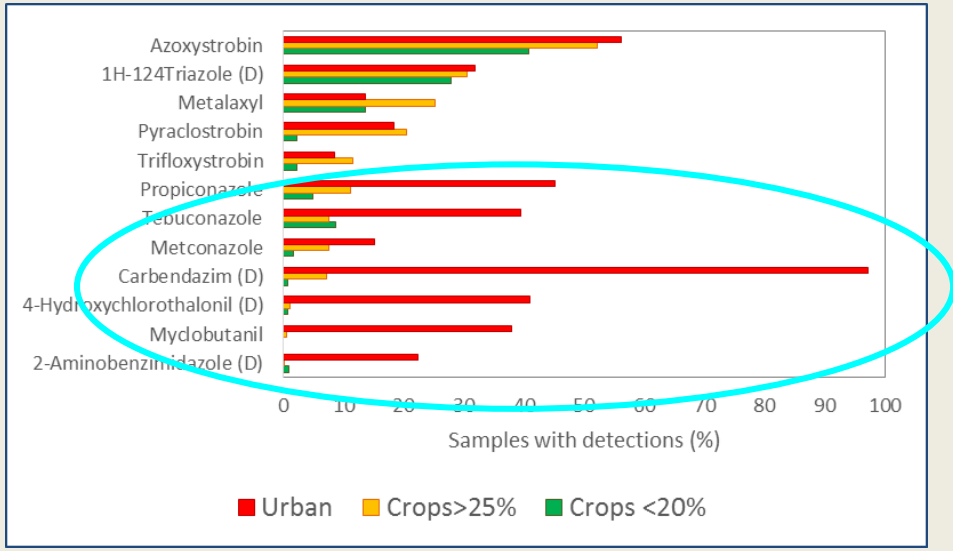
Herbicides



Insecticides

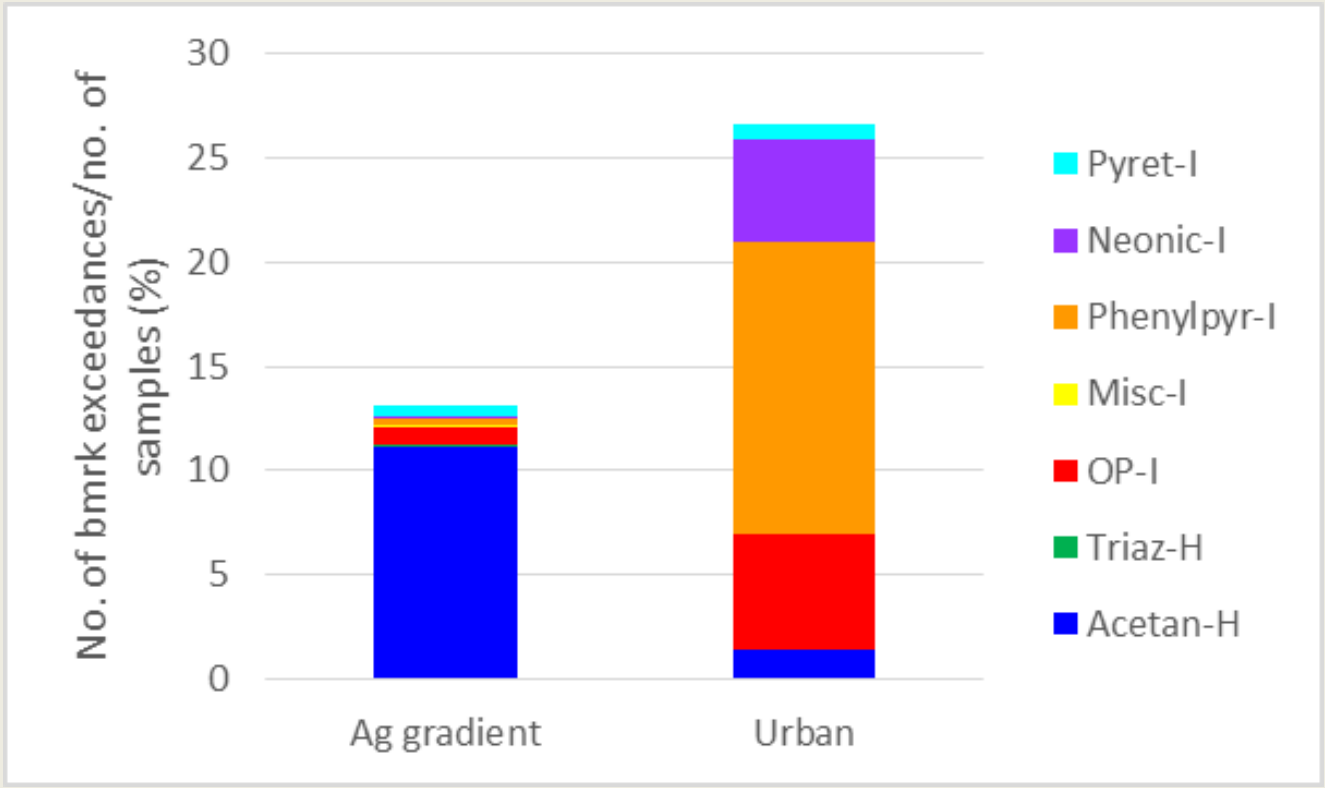


Fungicides



Benchmark exceedances help to identify important components of a mixture

Chronic Invertebrate benchmarks



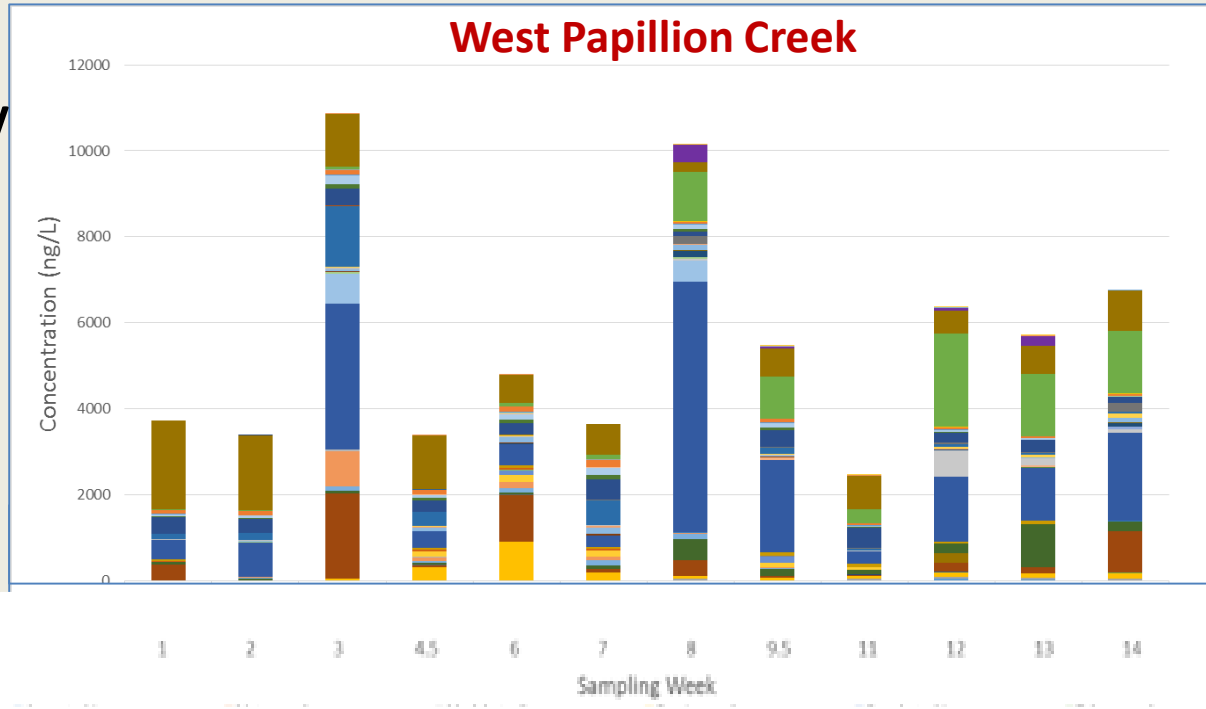
- **Fipronil, imidacloprid, OP insecticides, bifenthrin (at Urban sites)**
- **Metolachlor (at Ag gradient sites)**

Pesticide Toxicity Index: can be used to assess potential toxicity of mixtures

$$PTI_t = \sum_{i=1}^{n} \left(\frac{E_i}{TC_{i,t}}\right)$$

- Weights the concentration of each compound by its relative acute toxicity to standard test taxa
- Assumes additivity
- Screening-level tool
- 3 Taxonomic groups: fish, cladocerans, benthic invertebrates

Munn & Gilliom, 2001
Nowell et al. 2014



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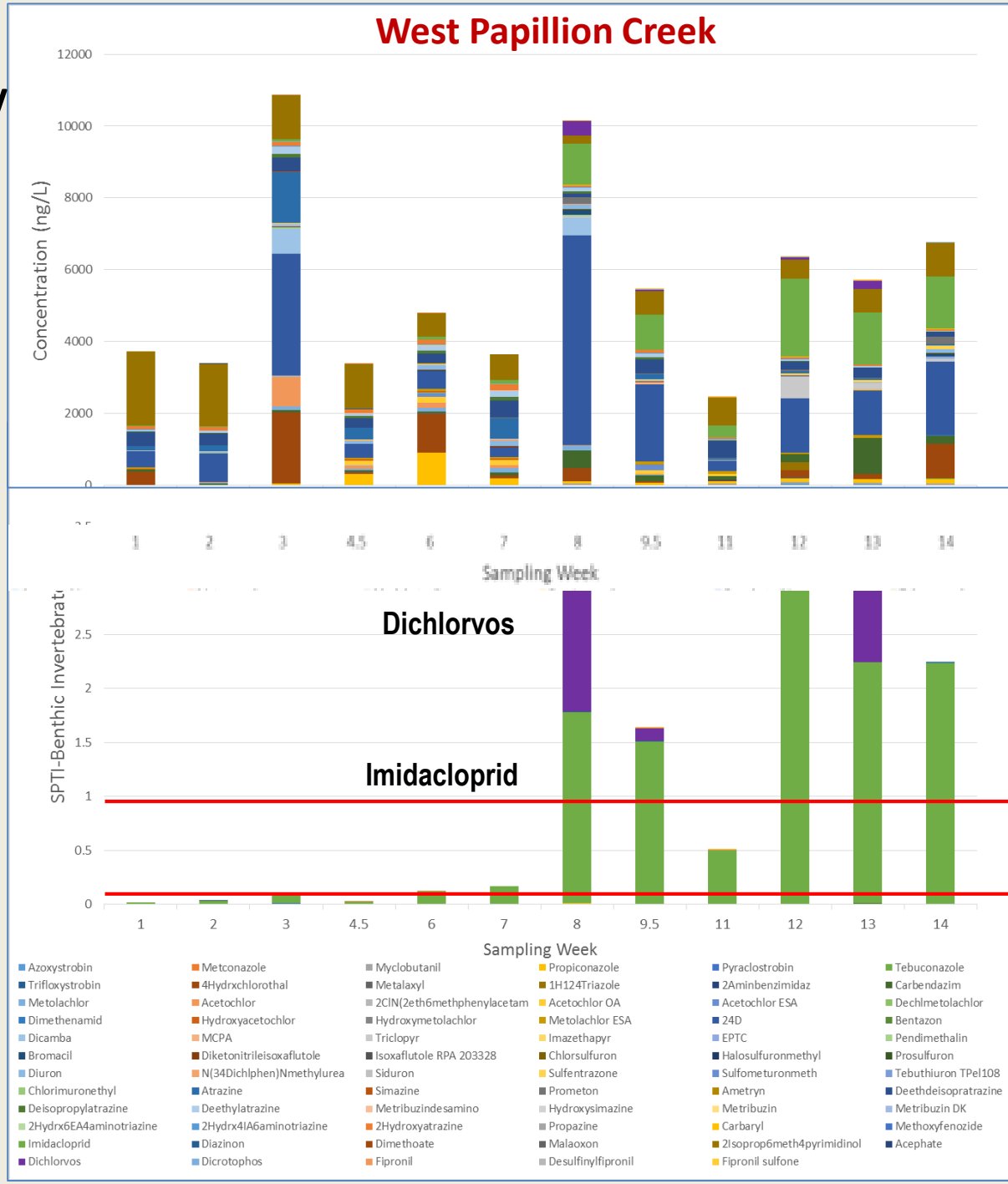


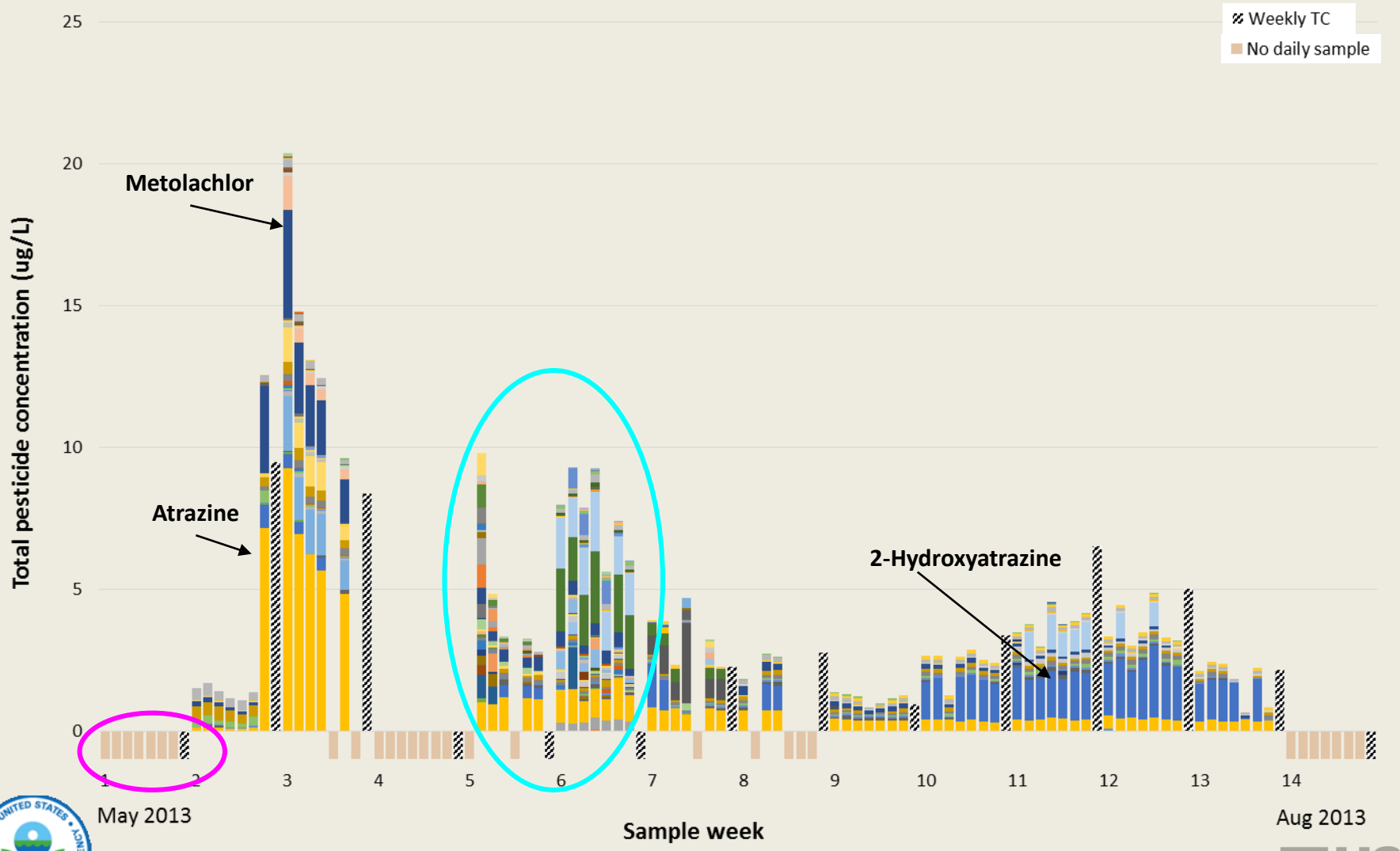
USGS
science for a changing world

Pesticides in daily autosamplers

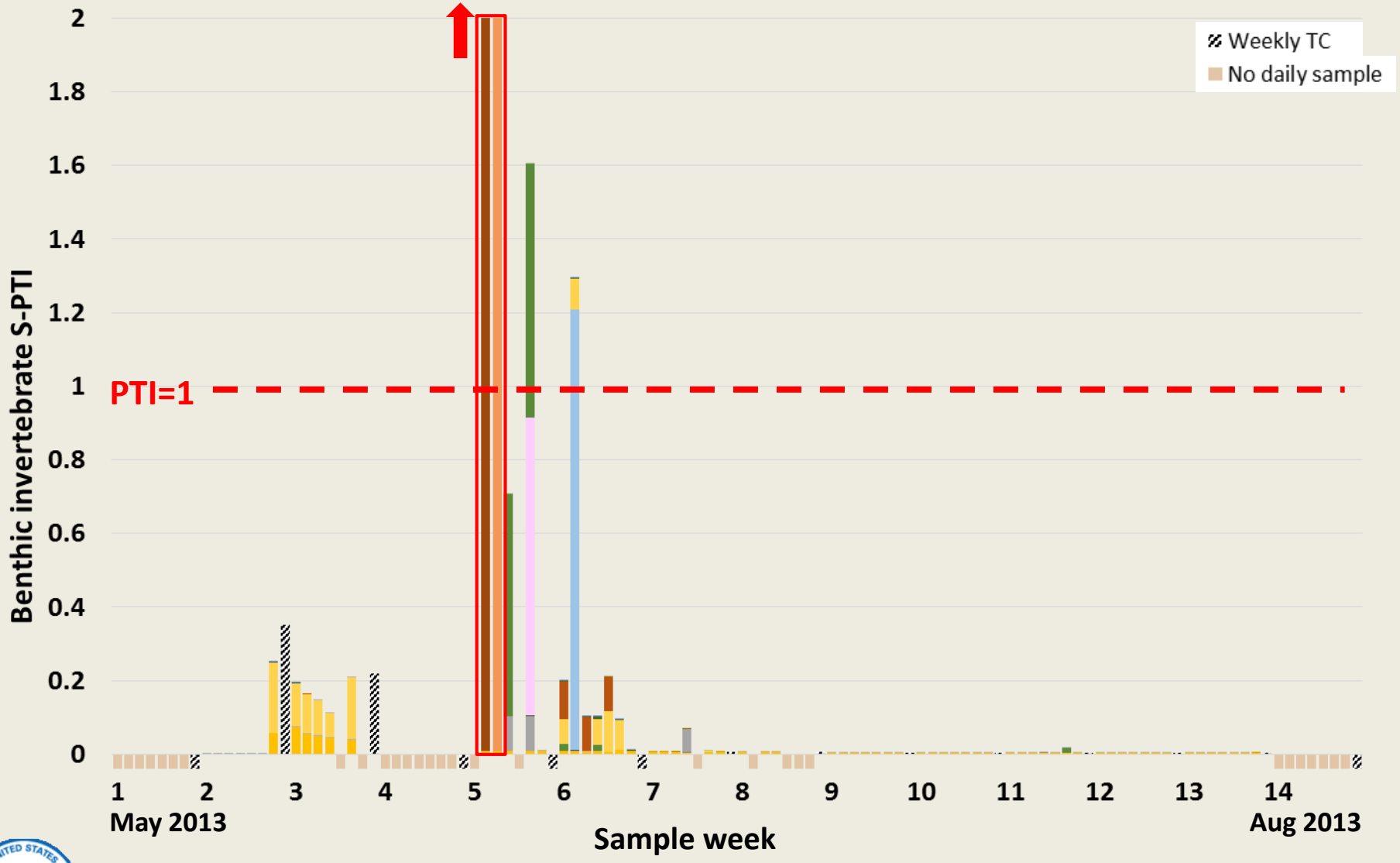
Julia Norman

USGS

High short-term variability in pesticides at Goodwater Creek, MO



Insecticides caused large spikes in benthic invertebrate PTI, Goodwater Ck



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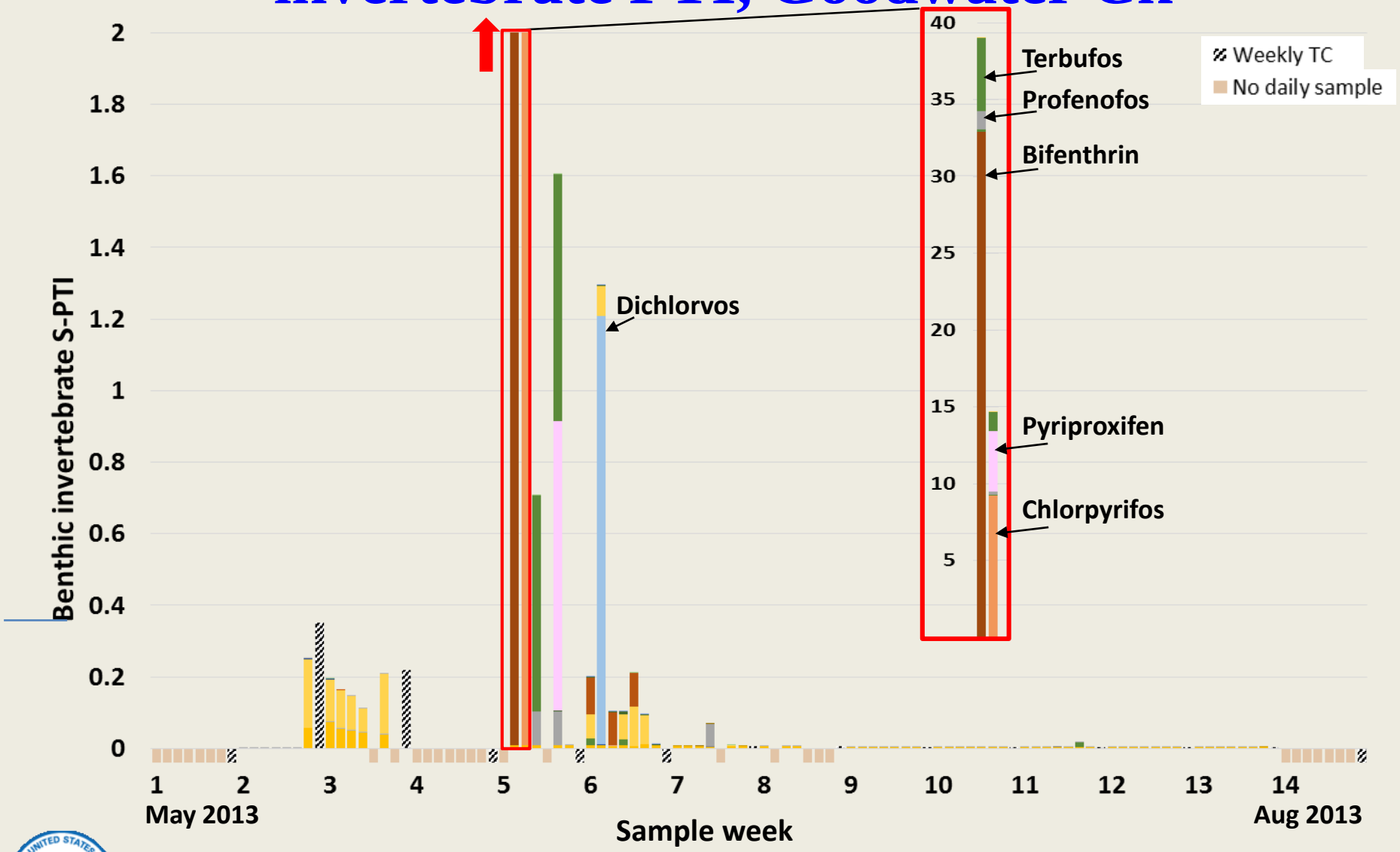
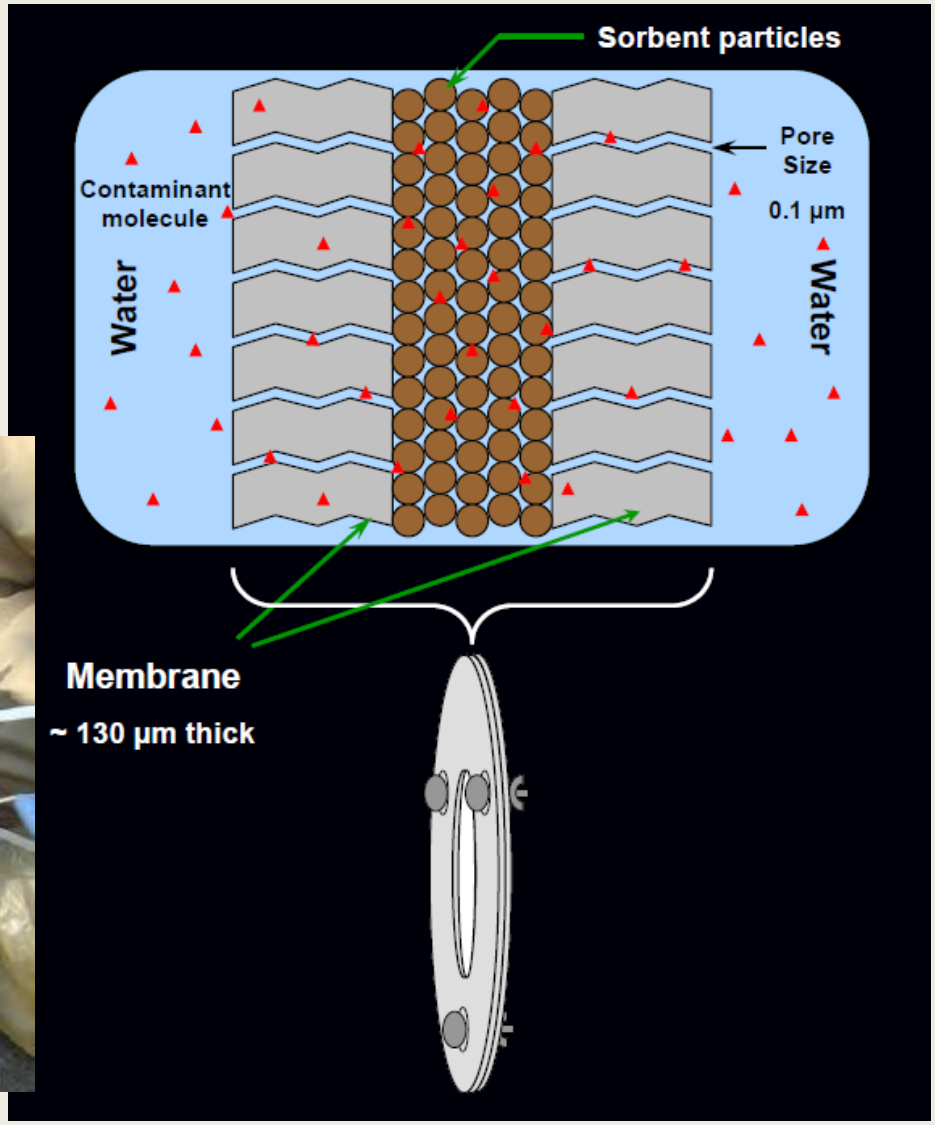
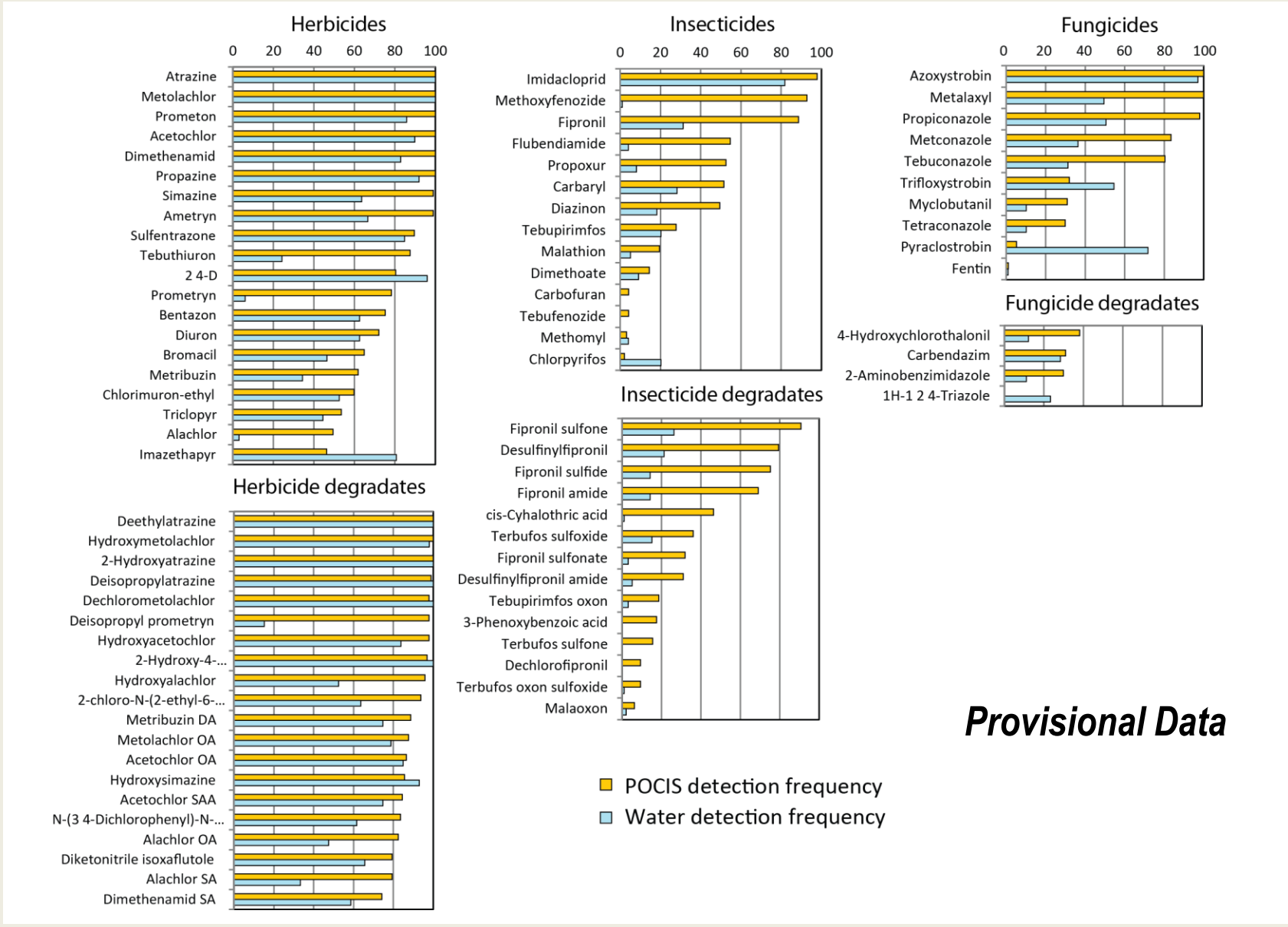


Polar Organic Chemical Integrative Sampler – POCIS



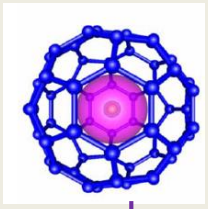
Van Metre et al., submitted, *Environmental Pollution*

Median of 62 pesticides detected by POCIS



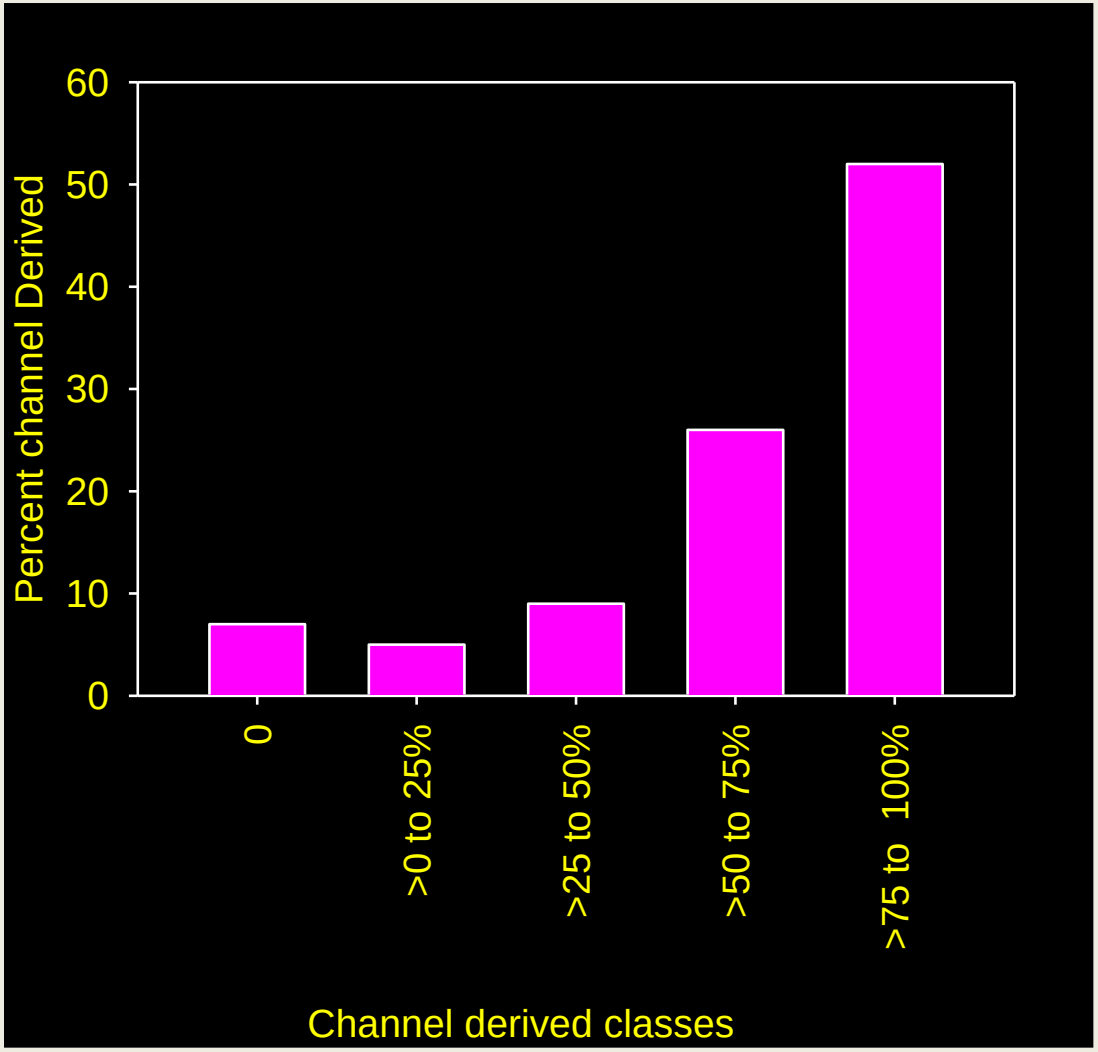
Accessing sediment sources using fallout radionuclides

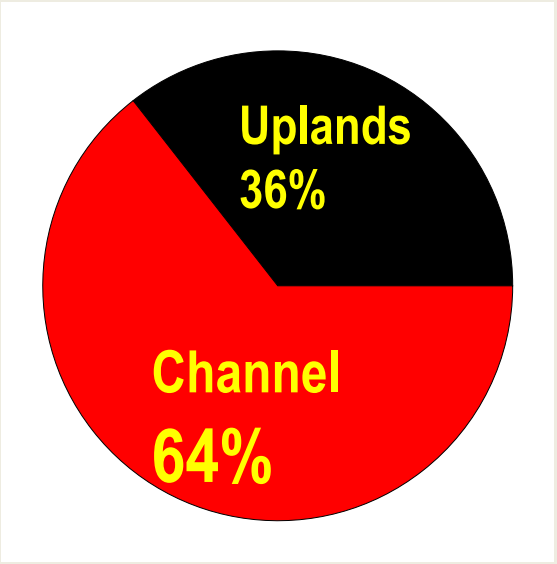
$^{210}Pb_{ex}$
$t_{1/2}$ 22 y



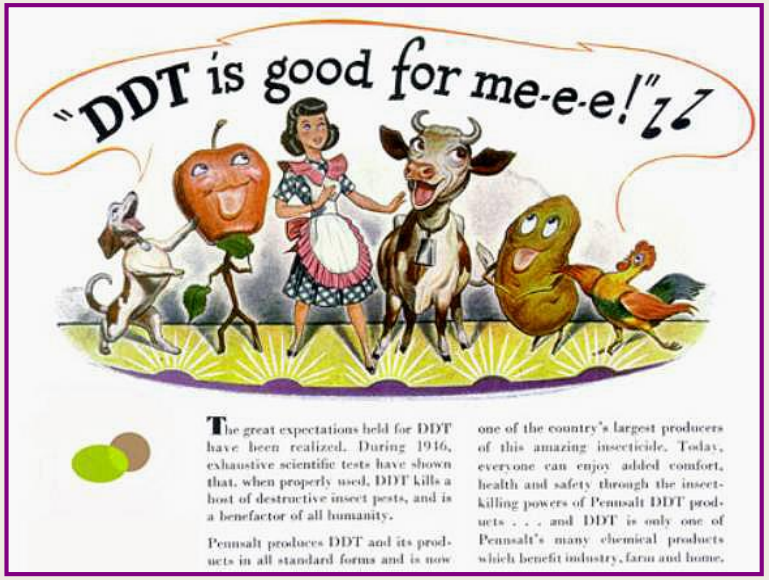
^{7}Be
$t_{1/2}$ 53 d

Bank and channel sources dominate

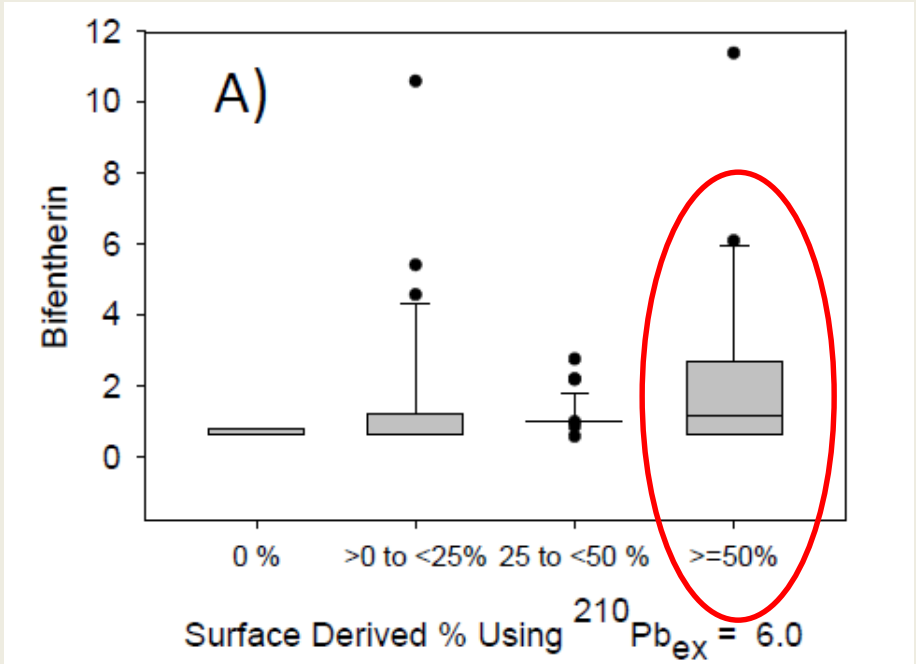


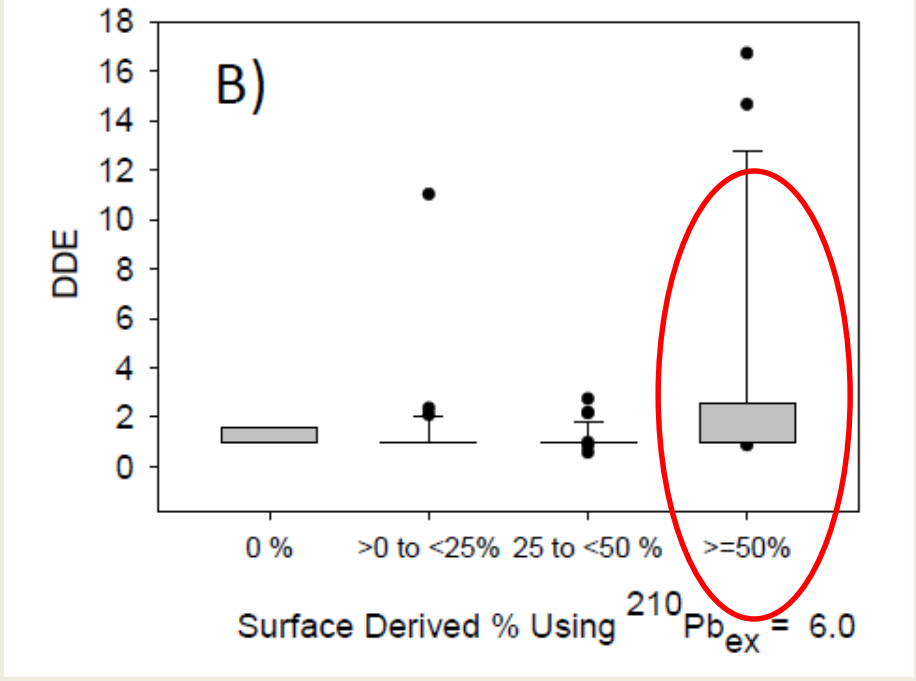


DDE and bifenthrin concentrations correlate to surface sediment sources

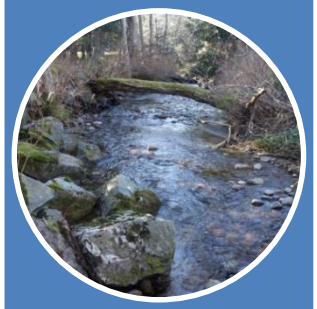


1950s Magazine Ad





Multiple stressors and ecology



Habitat:

Streamflow

Channel width

Reach char.

Contaminants:

HQs (sediment)

Chronic HQs (pestic./water)

Sediment:

Suspended sediment loads

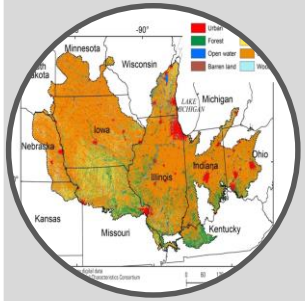
Sediment grain-size

Nutrients:

Max NH3

Total P

Ortho P



GIS:

Canopy cover

Sand content

N, P loadings

USGS

Boosted Regression Tree Models:
GIS + Env.All R^2 (3 – 7 variables)

Unpublished; subject to revision	Model Statistic	GIS n = 46	Habitat n = 52	Nutrients n= 44	Contam. n = 73	Env. All n = 51	GIS + Env n = 67
EPTR	R^2	0.72	0.61	0.62	0.63	0.73	0.74
		(5)	(6)	(5)	(4)	(6)	(6)
Ave Tolerance of all Taxa: RichTOL	R^2	0.77	0.86	0.57	0.36	0.73	0.85
		(6)	(6)	(5)	(4)	(6)	(6)
Richness of Intolerant Taxa: INTOL_RICH	R^2	0.79	0.81	0.62	0.74	0.66	0.83
		(6)	(6)	(5)	(3)	(6)	(4)
MMI	R^2	0.86	0.74	0.53	0.79	0.87	0.95
		(5)	(5)	(5)	(4)	(7)	(6)

Provisional Data

Waite et al., submitted, *Freshwater Science*

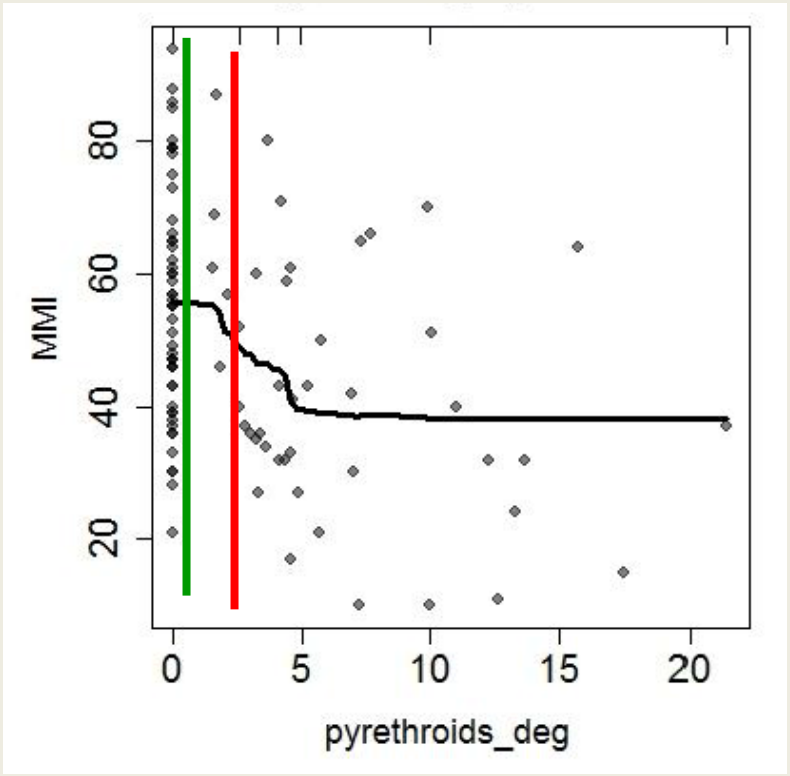
Most important *MMI* model variables:

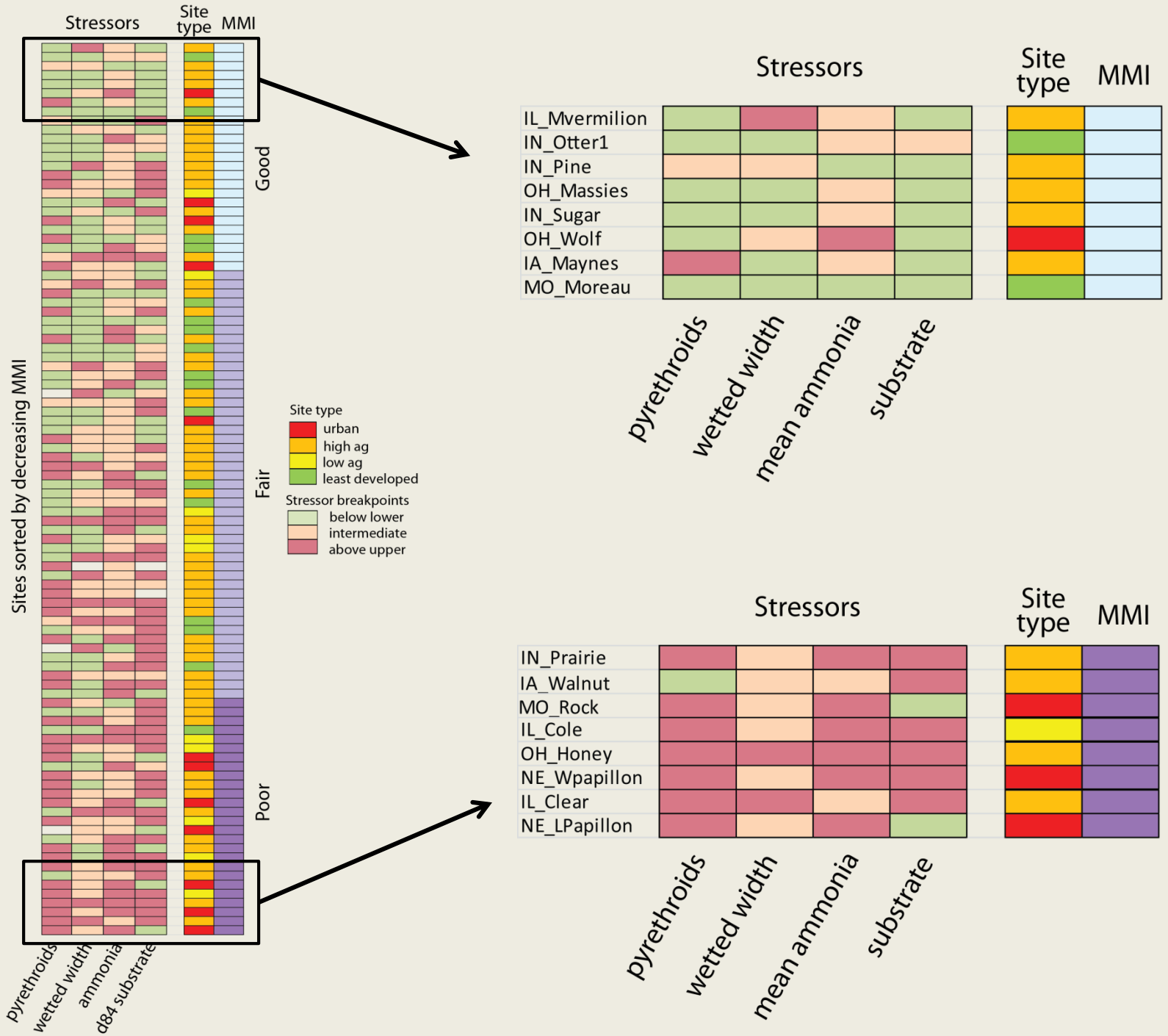
- Pyrethroid degradates (contam.)
- Channel geometry (habitat)
- Ammonia (nutrient)
- Substrate (habitat)

Stressees

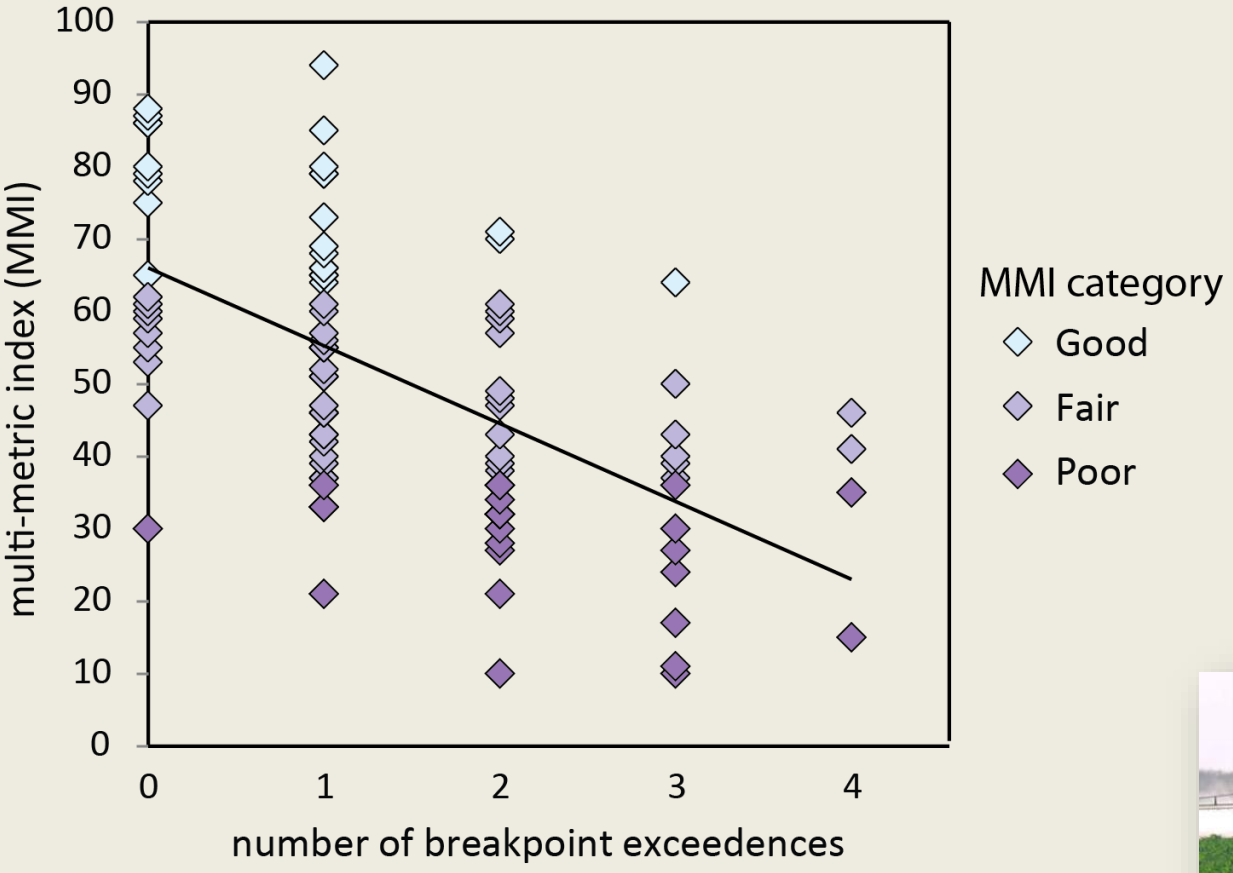
Stressors

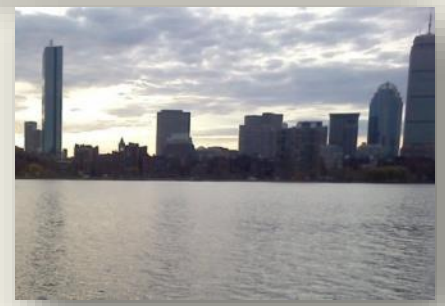
Pyrethroid degradates




Stressors
Site type
MMI
Sites sorted by decreasing MMI
Good
Fair
Poor
Site type
urban
high ag
low ag
least developed
Stressor breakpoints
below lower
intermediate
above upper
pyrethroids
wetted width
ammonia
d84 substrate
Stressors
Site type
MMI
IL_Mvermilion
IN_Otter1
IN_Pine
OH_Massies
IN_Sugar
OH_Wolf
IA_Maynes
MO_Moreau
pyrethroids
wetted width
mean ammonia
substrate
Stressors
Site type
MMI
IN_Prairie
IA_Walnut
MO_Rock
IL_Cole
OH_Honey
NE_Wpapillon
IL_Clear
NE_LPapillon
pyrethroids
wetted width
mean ammonia
substrate

Is it which stressor, or how many?





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