Meta-**A**nalysis of **G**lobal **I**mpacts of **C**hemicals (MAGIC)

Meta-analysis of Insecticide Risks and their Drivers for Surface Waters in the United States

Jakob Wolfram
Sebastian Stehle
Lara Petschick
Sascha Bub
Ralf Schulz

University of Koblenz-Landau
iES – Institute for Environmental Sciences
magic.eco

Introduction

- Insecticides
  - (Aquatic) Ecological Risk Assessment (U.S. EPA)
  - No unacceptable effects in valued ecosystems
  - Identification of most sensitive endpoint
  - Derivation of regulatory threshold levels (**RTL**[1])
  - RTLs vs. measured insecticide concentrations (**MIC**)

MIC > RTL = Risk

1 Stehle and Schulz, **PNAS,** 2015.

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Introduction

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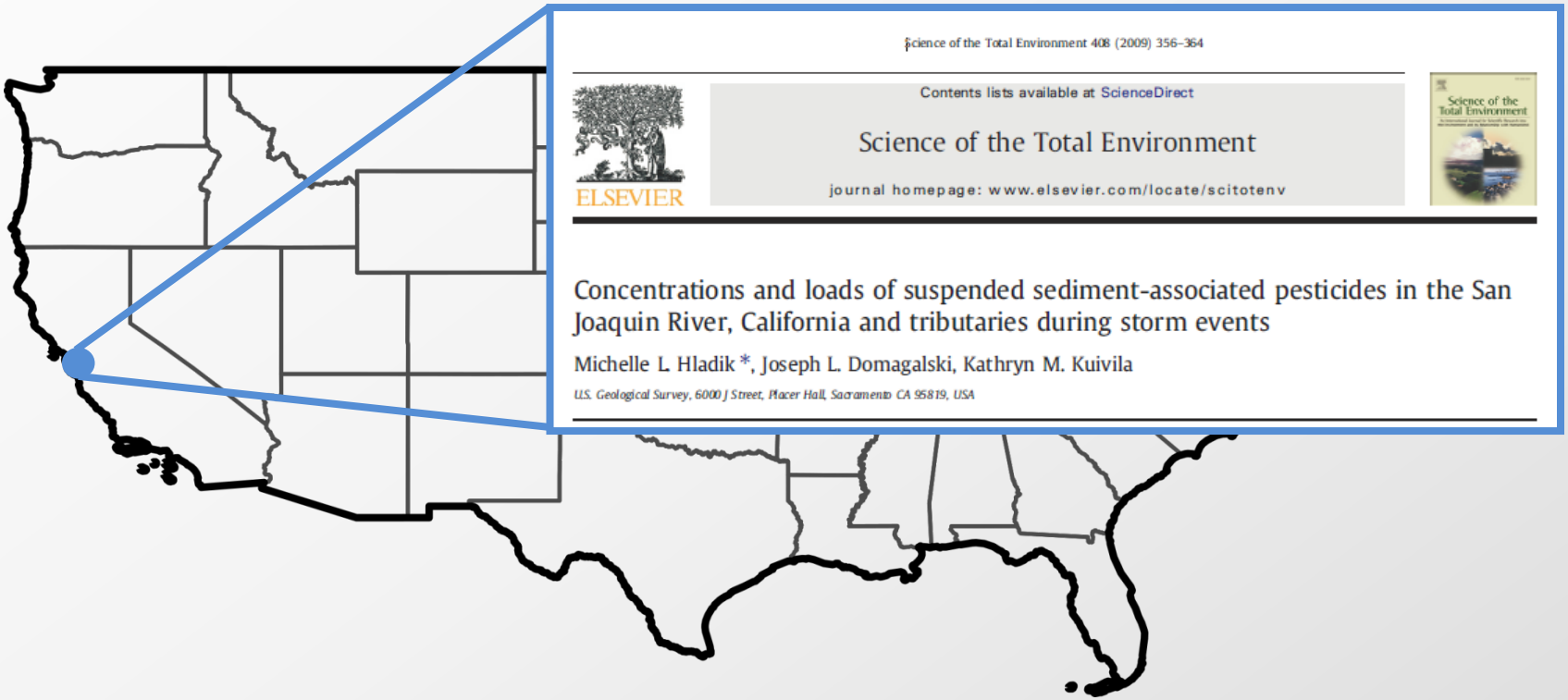
Introduction

- Abundance of scientific studies



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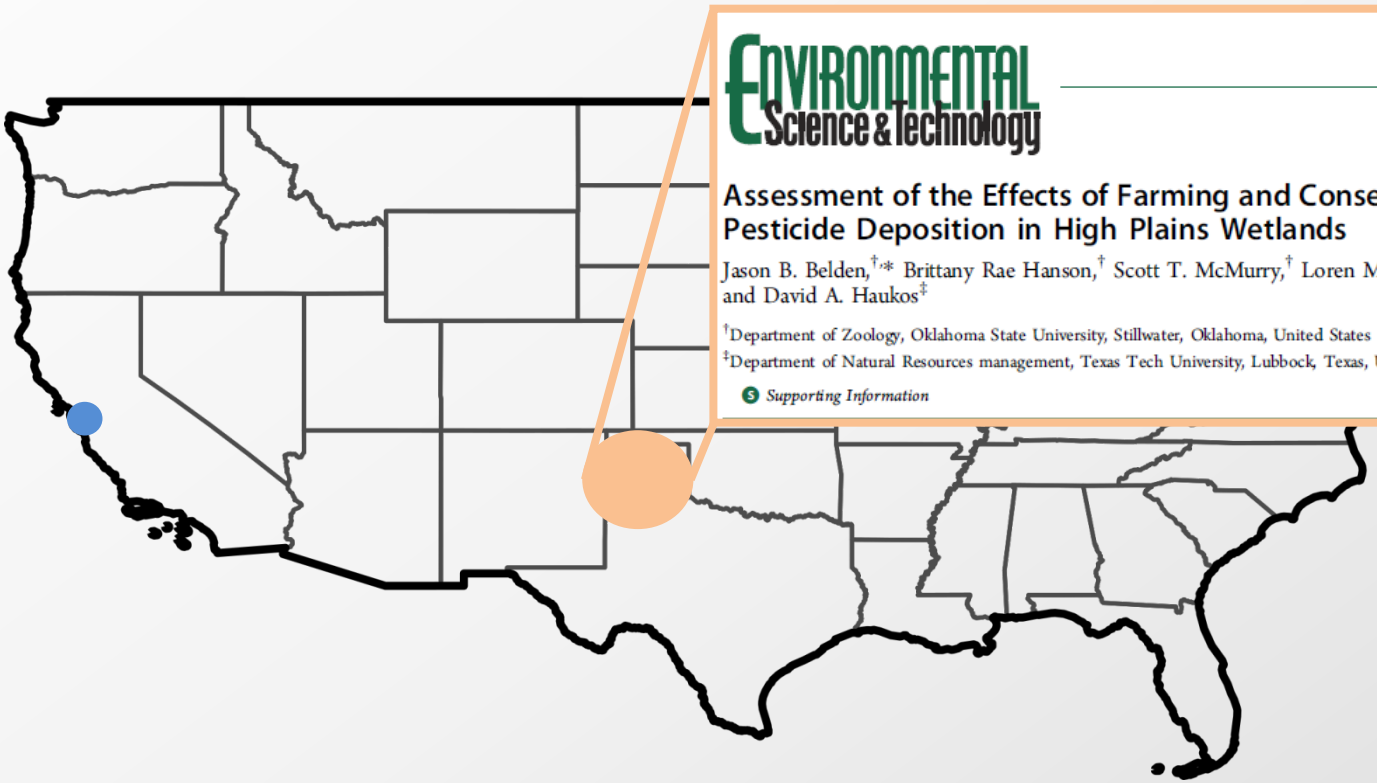

Environmental Science & Technology

Article

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Assessment of the Effects of Farming and Conservation Programs on Pesticide Deposition in High Plains Wetlands

Jason B. Belden,[†,*] Brittany Rae Hanson,[†] Scott T. McMurry,[†] Loren M. Smith,[†] and David A. Haukos[‡]

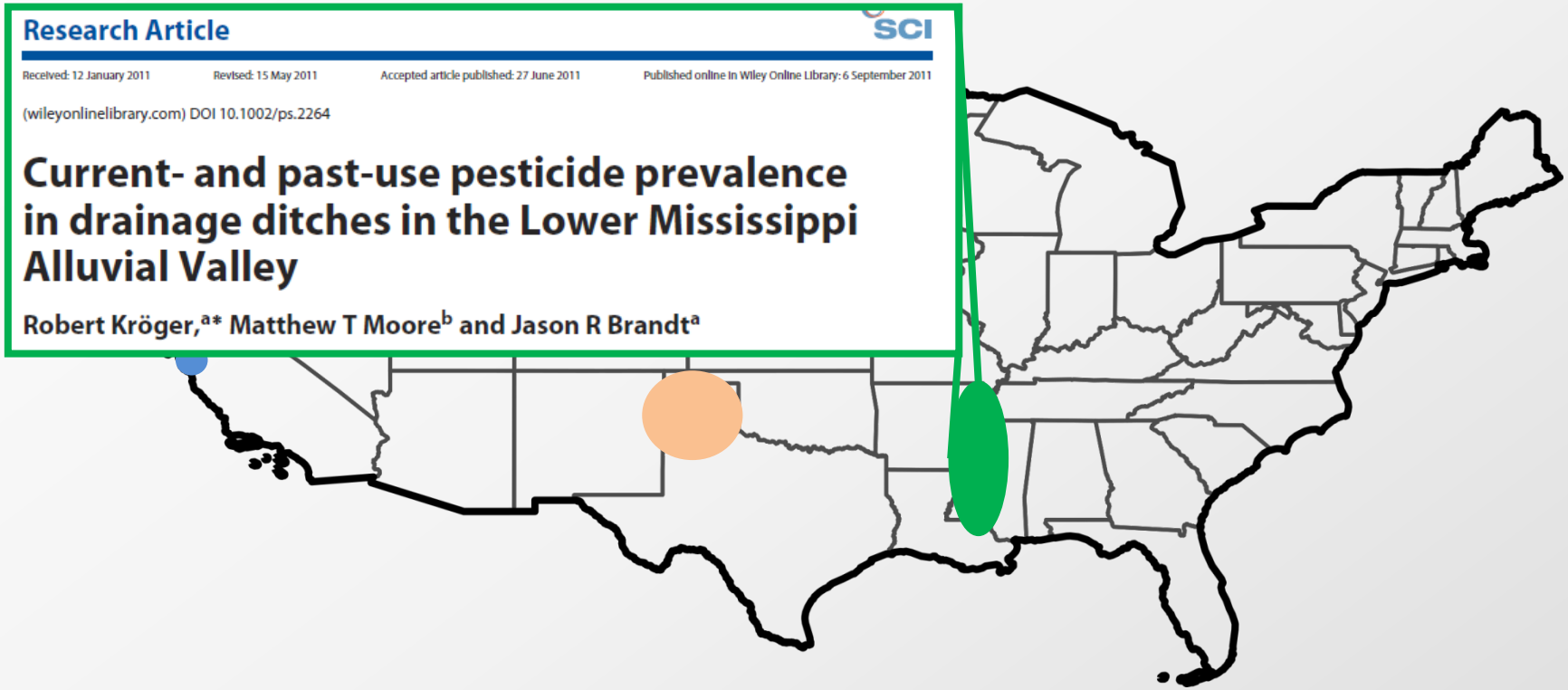
[†]Department of Zoology, Oklahoma State University, Stillwater, Oklahoma, United States

[‡]Department of Natural Resources management, Texas Tech University, Lubbock, Texas, United States

Supporting Information

Introduction

- Abundance of scientific studies



Research Article

SCI

Received: 12 January 2011 Revised: 15 May 2011 Accepted article published: 27 June 2011 Published online in Wiley Online Library: 6 September 2011

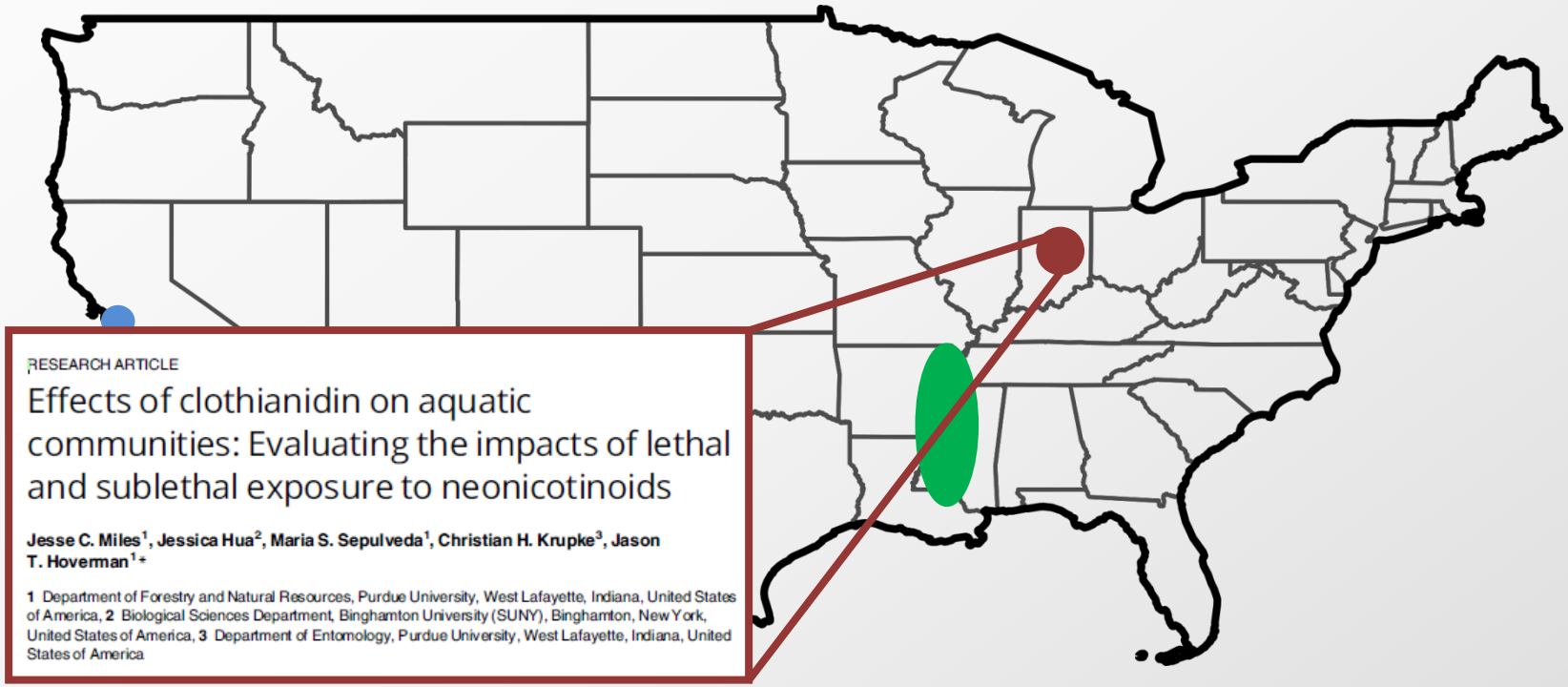
(wileyonlinelibrary.com) DOI 10.1002/ps.2264

Current- and past-use pesticide prevalence in drainage ditches in the Lower Mississippi Alluvial Valley

Robert Kröger,[a]* Matthew T Moore[b] and Jason R Brandt[a]

Introduction

- Abundance of scientific studies



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Introduction

- Abundance of scientific studies

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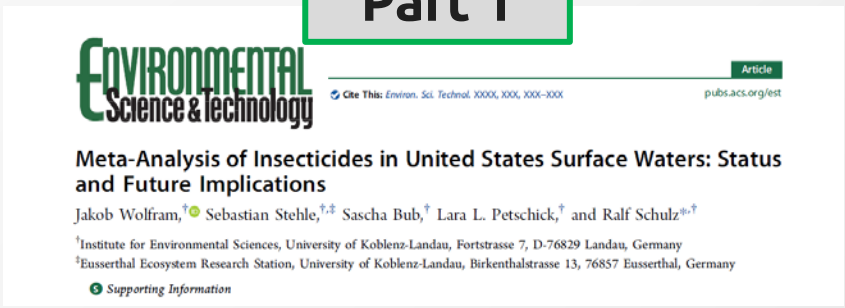
Methods

- Literature synthesis
  - >100 search queries
  - >50,000 screened articles

259 peer-reviewed studies

n = 5830 MIC 1962 – 2015 ~644 water bodies

Part 1


Environmental Science & Technology

Article

Cite This: Environ. Sci. Technol. XXXX, XXX, XXX−XXX

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Meta-Analysis of Insecticides in United States Surface Waters: Status and Future Implications

Jakob Wolfram,[†] Sebastian Stehle,[†,‡] Sascha Bub,[†] Lara L. Petschick,[†] and Ralf Schulz*[,†]

[†]Institute for Environmental Sciences, University of Koblenz-Landau, Fortstrasse 7, D-76829 Landau, Germany

[‡]Eusserthal Ecosystem Research Station, University of Koblenz-Landau, Birkenthalstrasse 13, 76857 Eusserthal, Germany

Supporting Information

Part 2


Environmental Science & Technology

Article

Cite This: Environ. Sci. Technol. XXXX, XXX, XXX−XXX

pubs.acs.org/est

Insecticide Risk in US Surface Waters: Drivers and Spatiotemporal Modeling

Jakob Wolfram,[†] Sebastian Stehle,[†,‡] Sascha Bub,[†] Lara L. Petschick,[†] and Ralf Schulz*[,†]

[†]iES Landau, Institute for Environmental Sciences, University of Koblenz-Landau, Fortstrasse 7, D-76829 Landau, Germany

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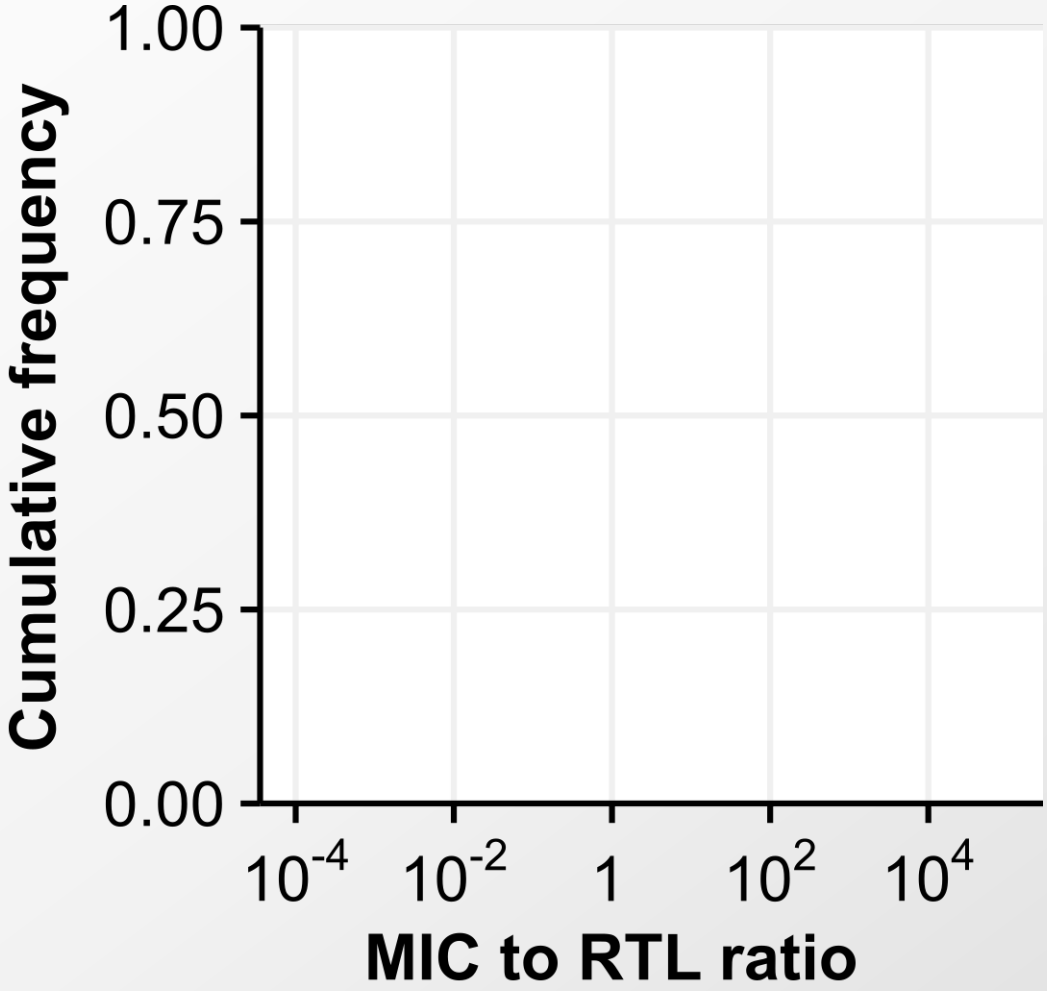
Supporting Information

Risk in U.S. surface waters



Water phase
n = 4051

Wolfram et al., **ES&T,** 2018

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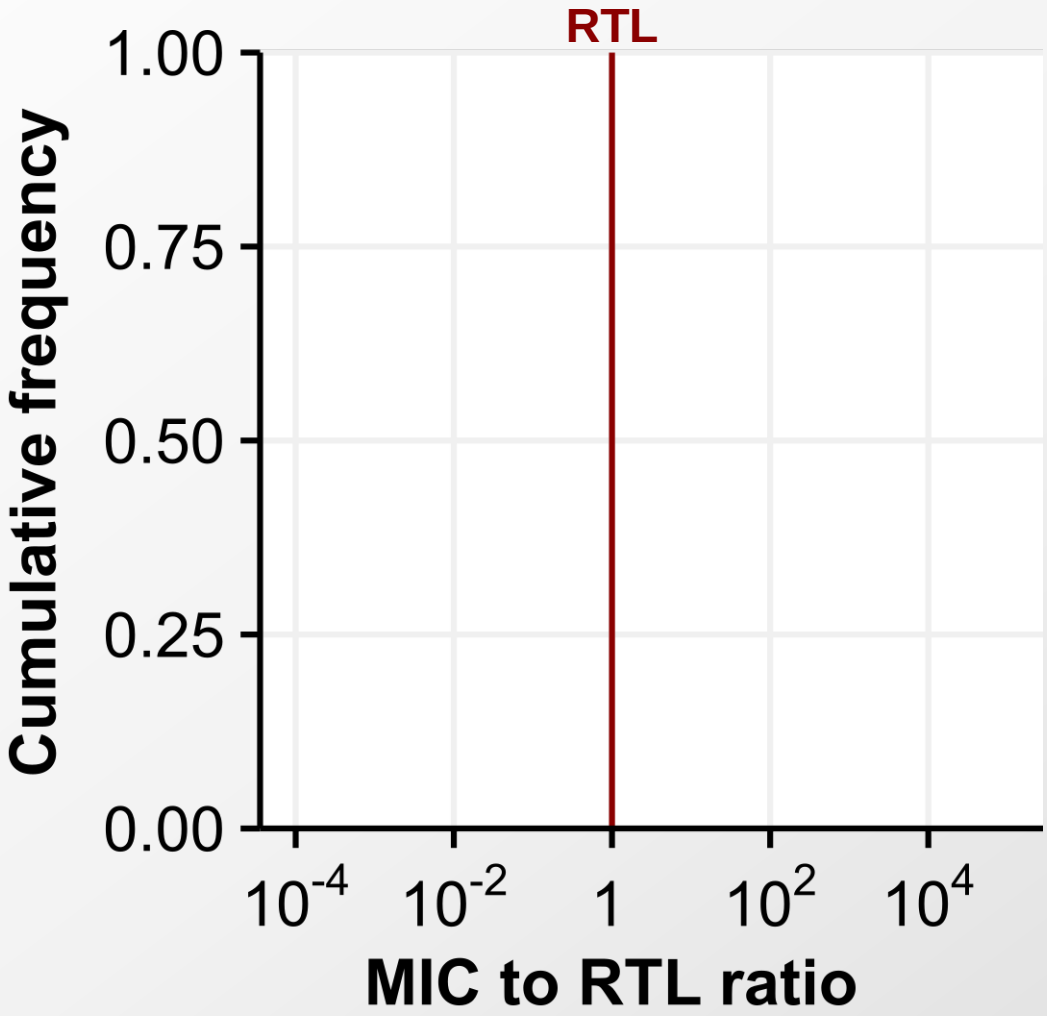
Risk in U.S. surface waters



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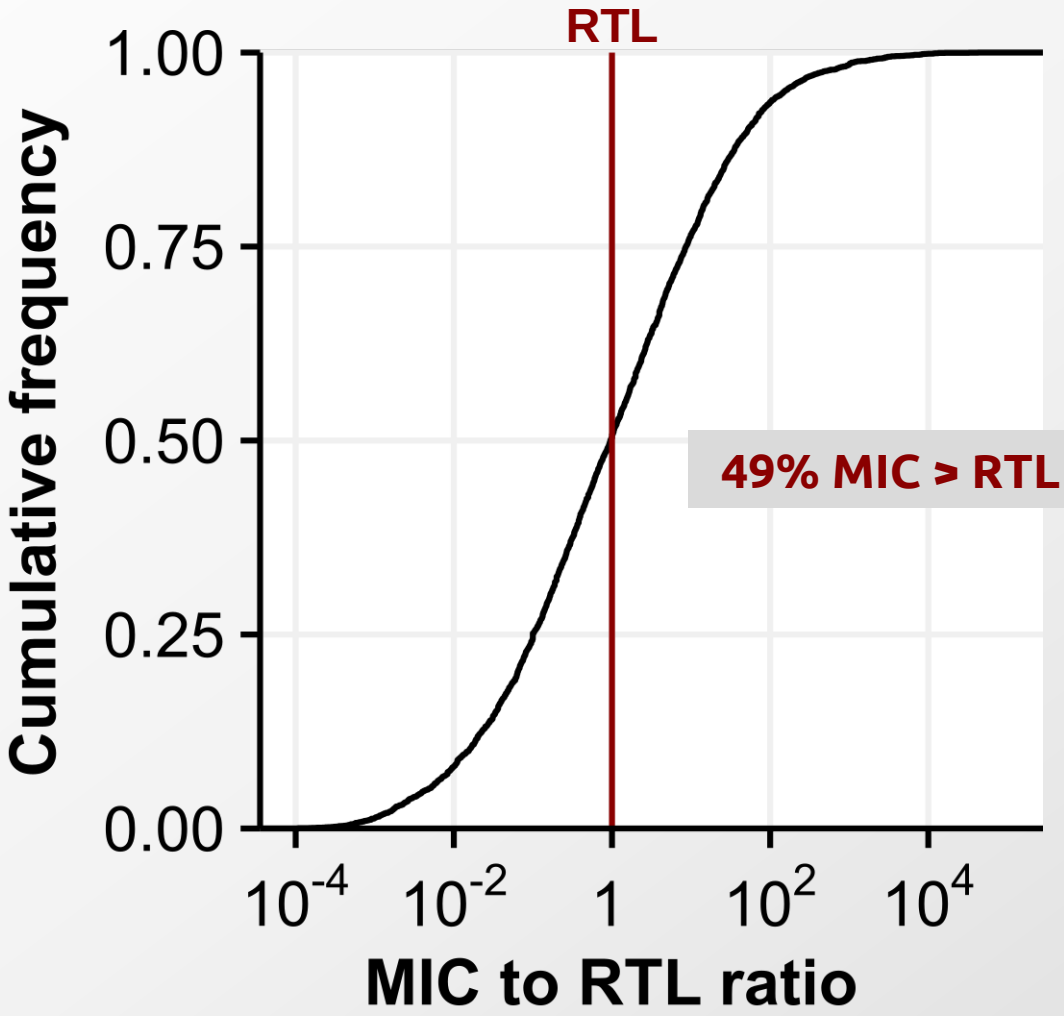

Water phase
n = 4051

49% MIC > RTL

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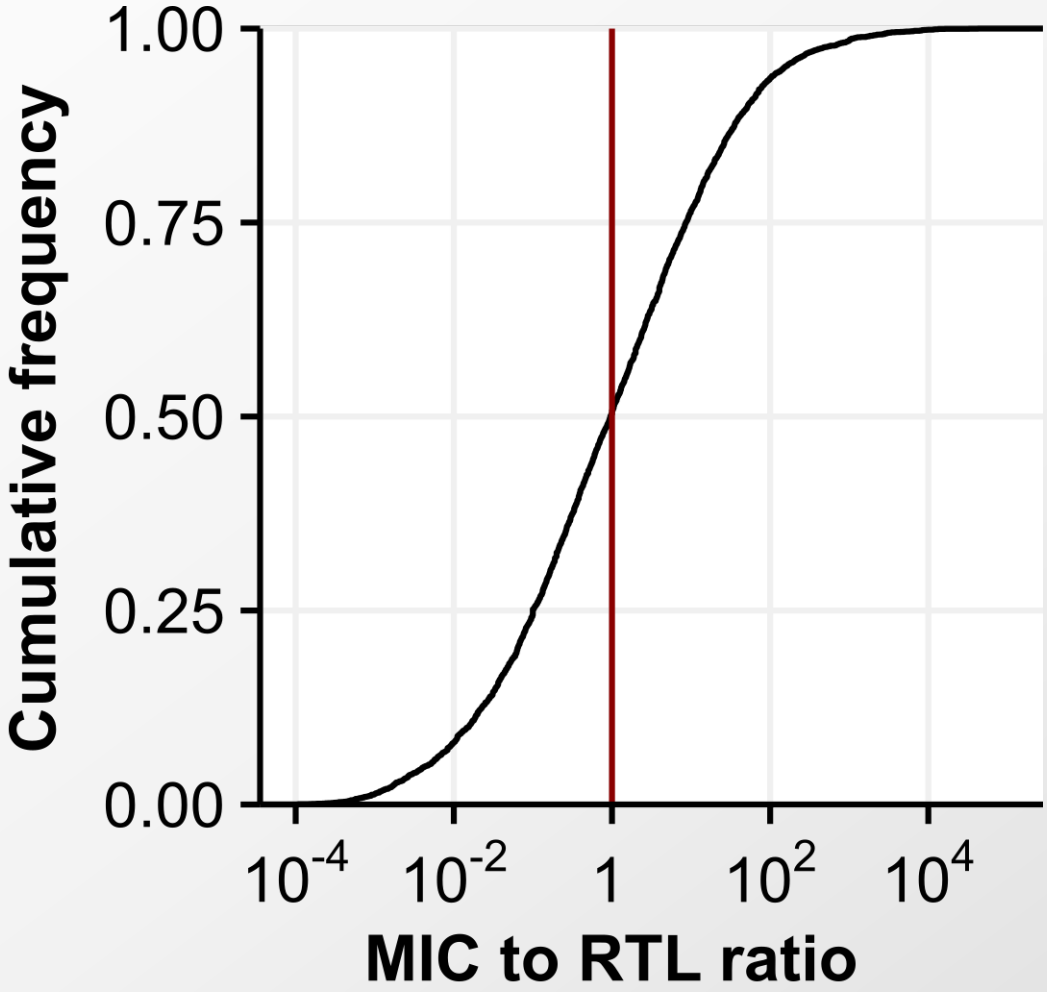
Risk in U.S. surface waters



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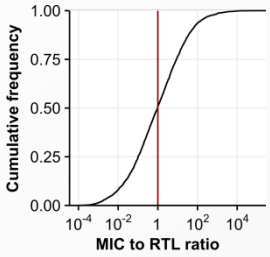

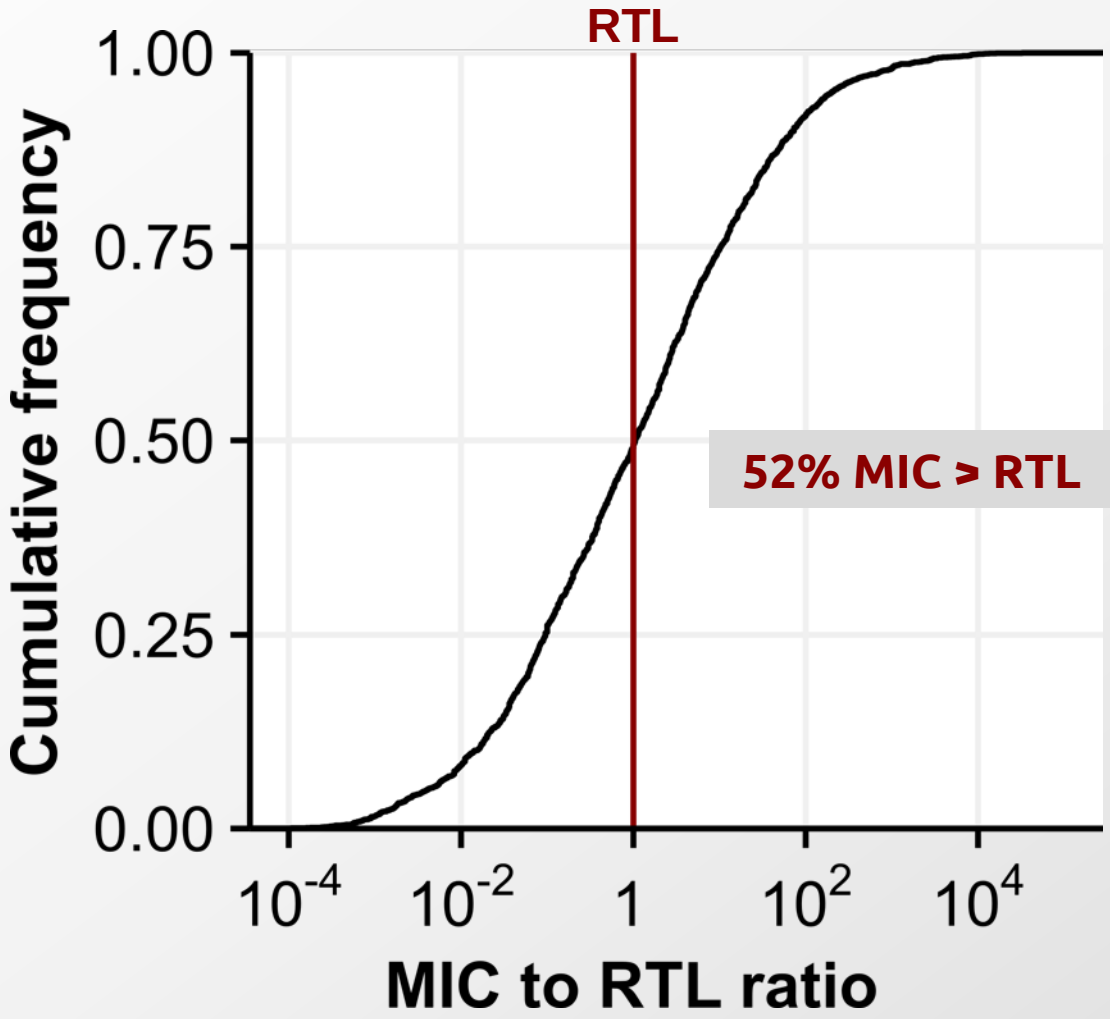

Sediment
n = 1779

Wolfram et al., **ES&T,** 2018

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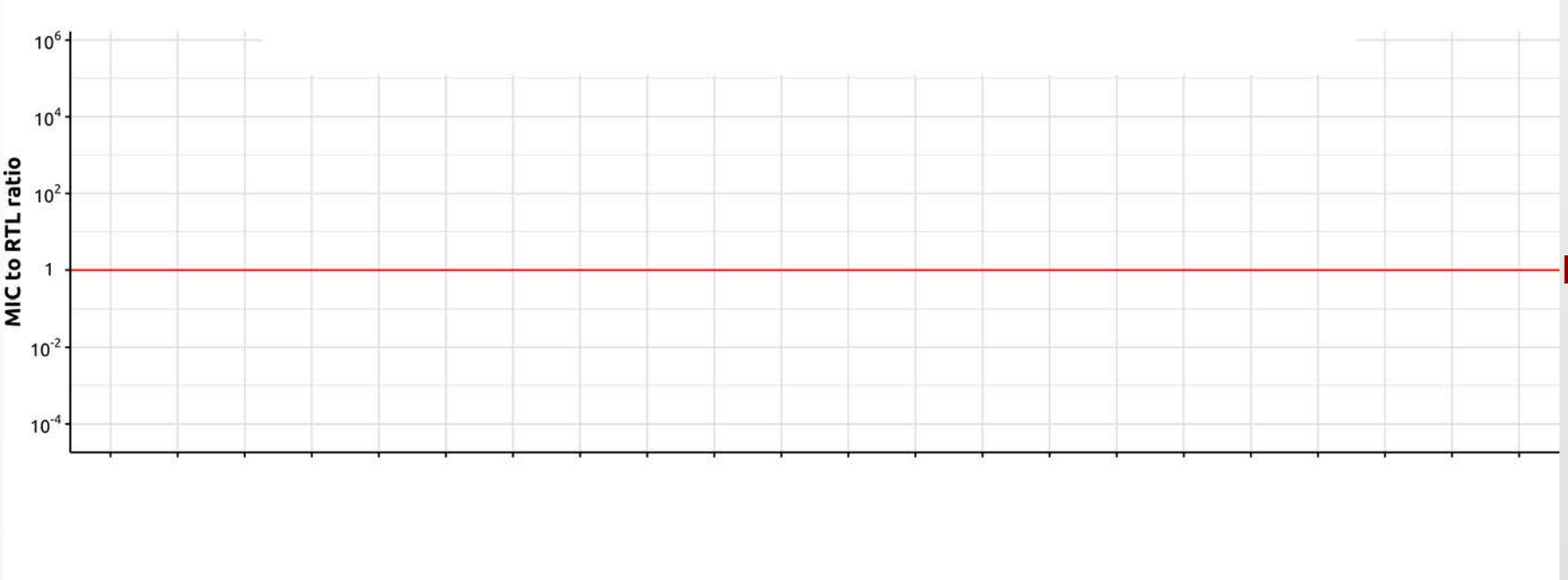
Risk per compound

Water phase



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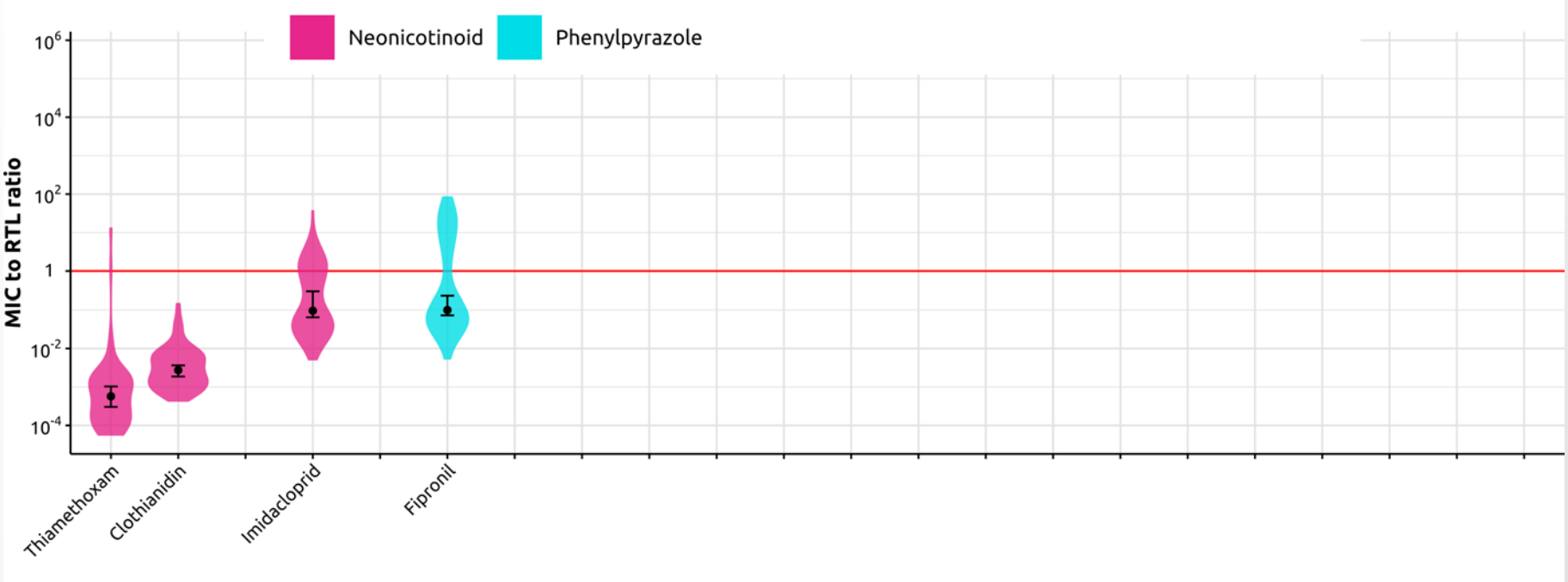
Risk per compound

Water phase



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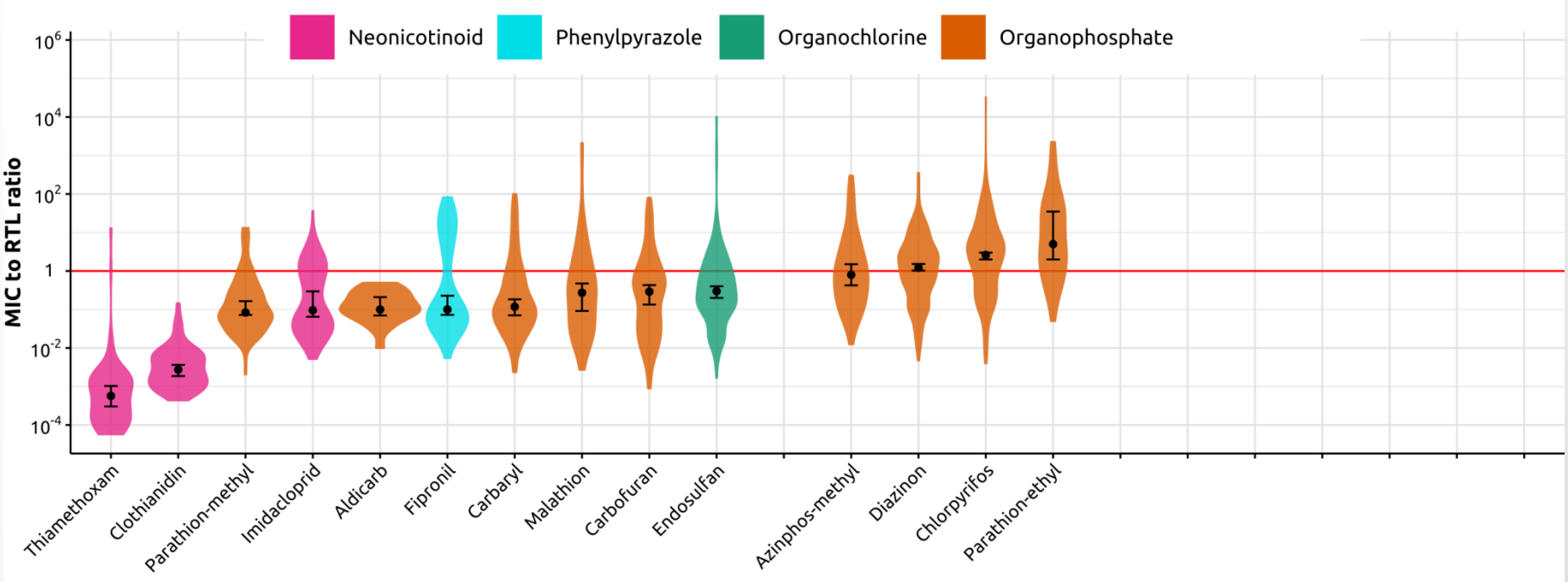
Risk per compound

Water phase



Wolfram et al., **ES&T,** 2018

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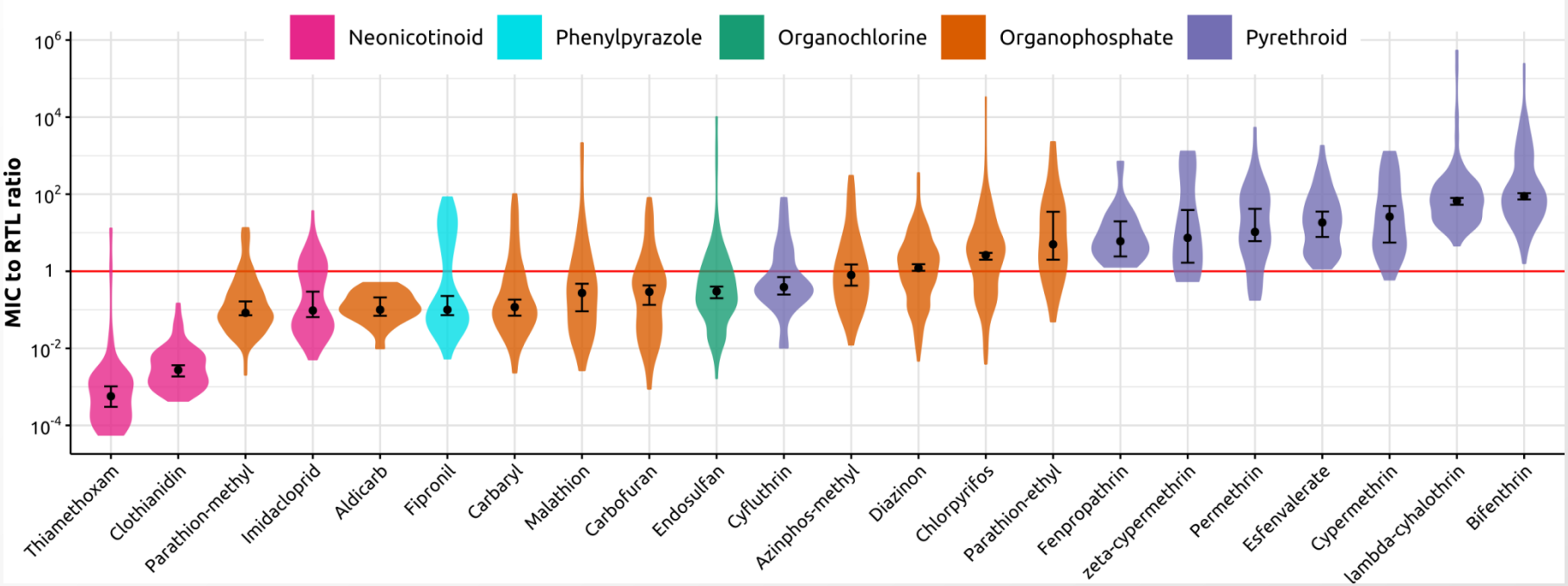
Risk per compound

Water phase



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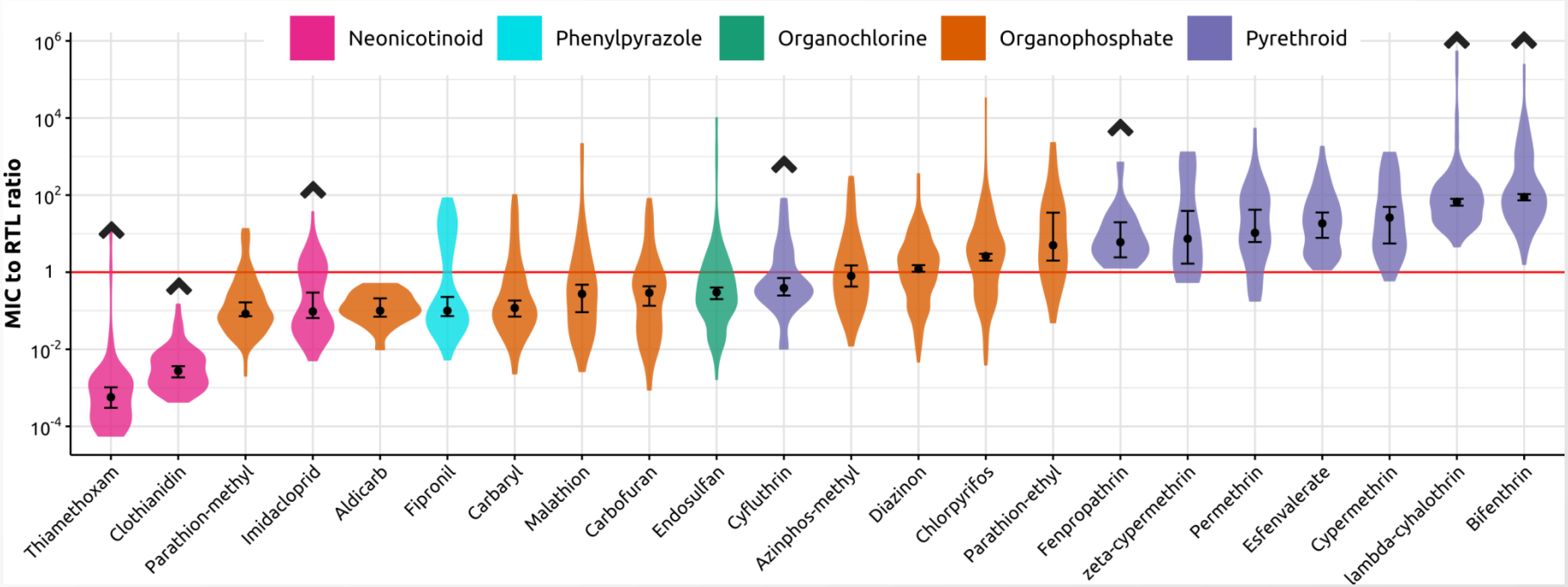
Risk per compound

Water phase



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Risk per compound

Wolfram et al., **ES&T,** 2018

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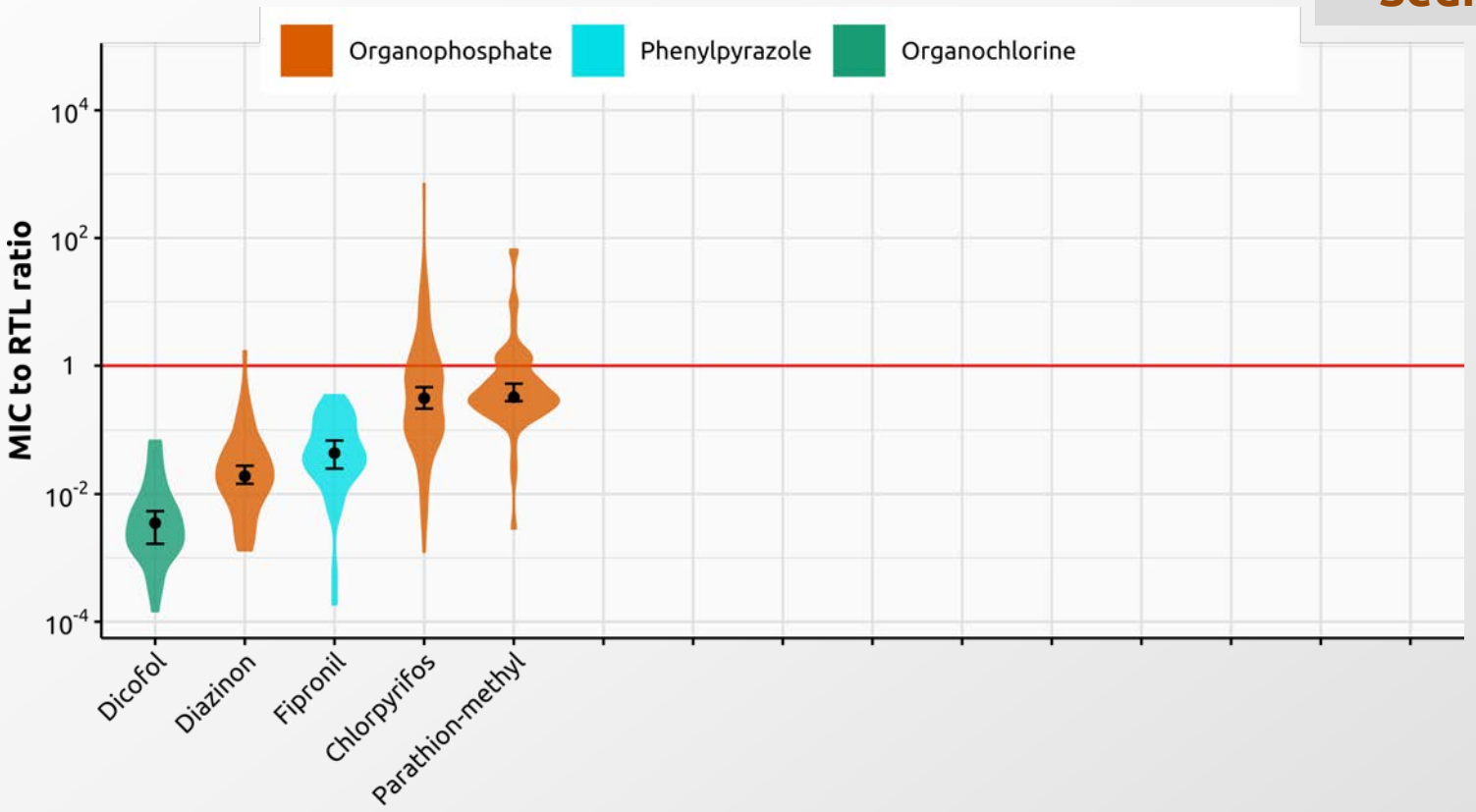
Risk per compound

Sediment



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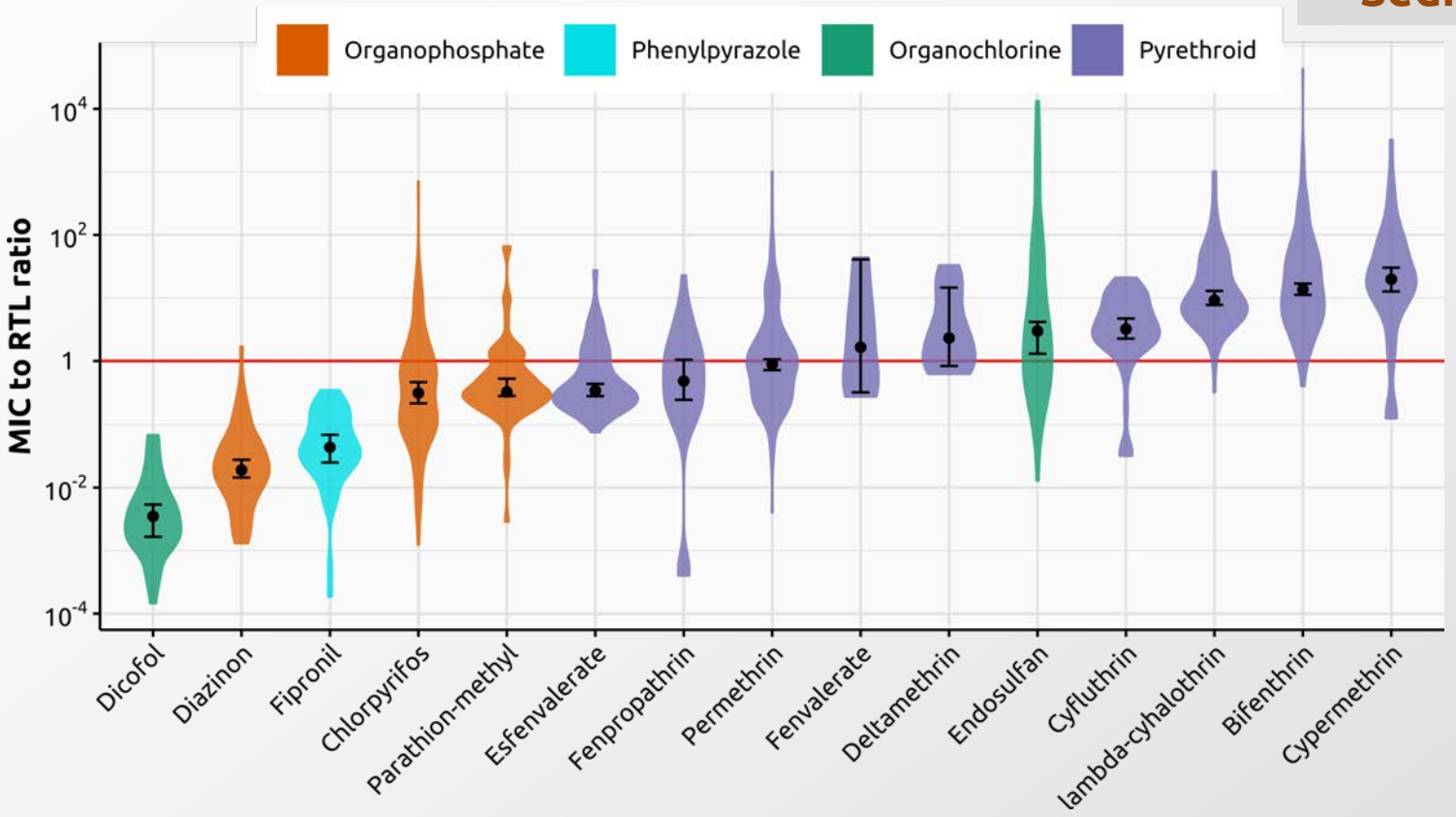
Risk per compound

Sediment



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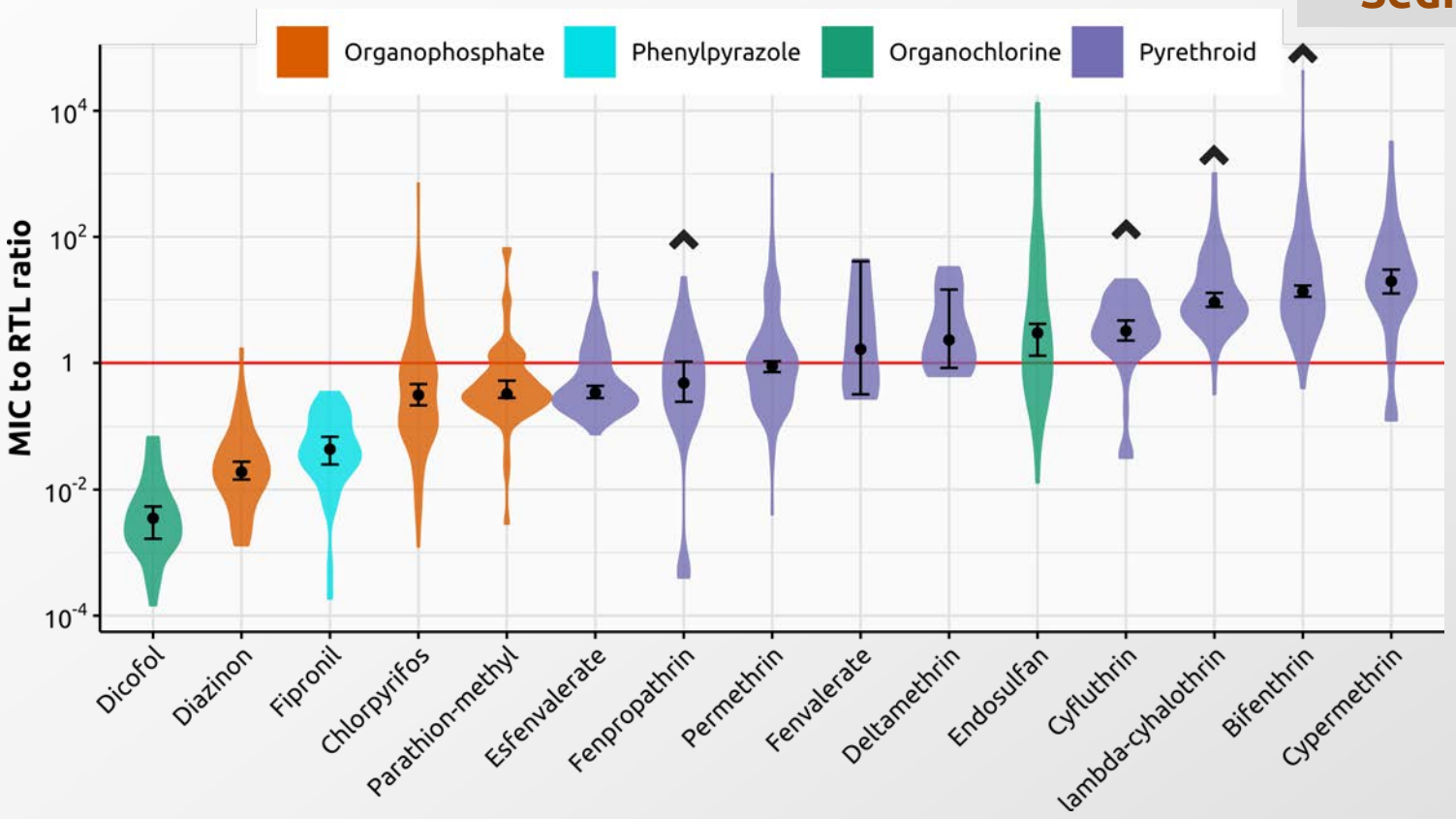
Risk per compound

Sediment



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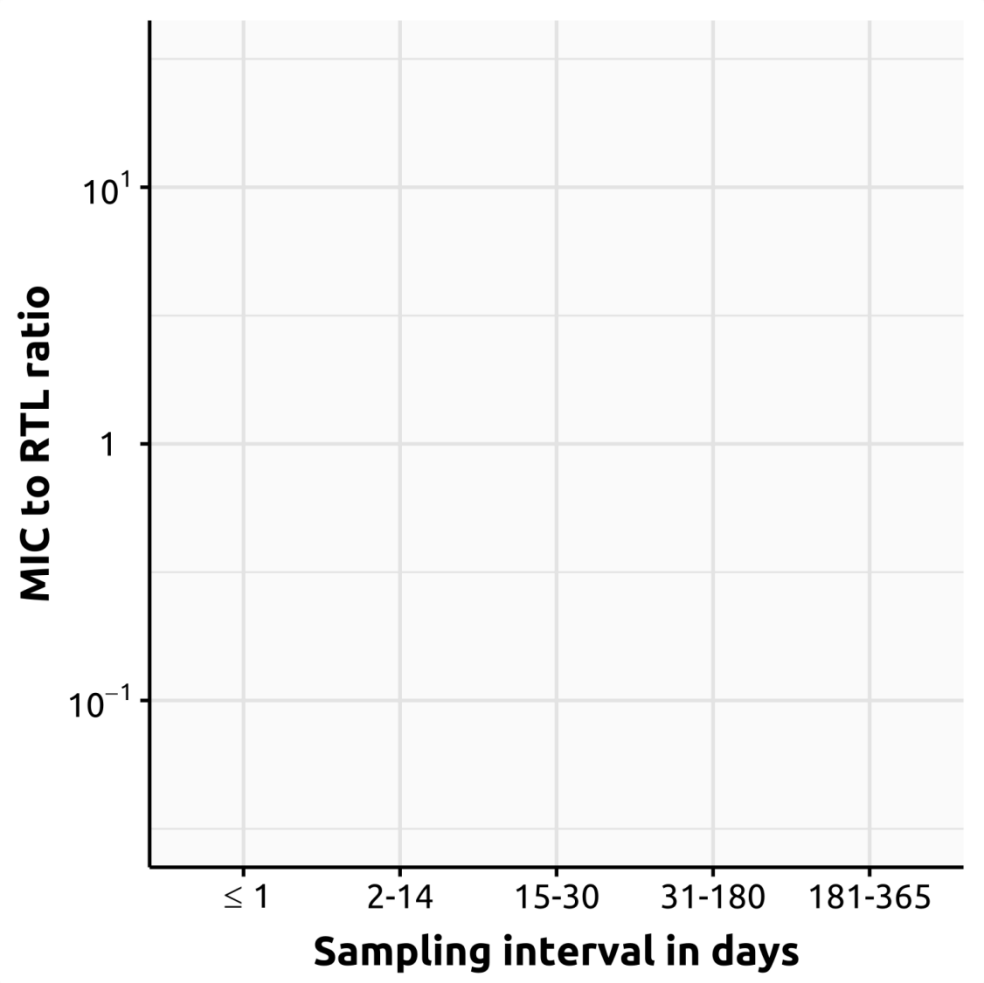
Risk Drivers

Predictor variable	Estimate	Std. error	*t*-value	*p*-value	Std. beta	SBR	VIF
Intercept	-1.927	0.275	-6.996	<0.001			
Catchment size [km²]	-0.150	0.020	-7.387	<0.001	-0.146	4	1.897
Sampling interval [d]	-0.198	0.017	-11.496	<0.001	-0.189	3	1.311
Time [y]	-0.057	0.004	-13.200	<0.001	-0.287	2	2.283
Toxicity-normalized use [kg × RTL^{-1}]	0.386	0.020	18.815	<0.001	0.381	1	1.987
Burst factor	0.015	0.002	5.990	<0.001	0.131	5	2.310
Irrigated agricultural land-use [%]	0.426	0.073	5.832	<0.001	0.101	6	1.448
Organophosphates [factor]	0.240	0.227	1.055	0.292			1.653
Pyrethroids [factor]	1.228	0.231	5.315	<0.001			1.653
Neonicotinoids [factor]	0.431	0.237	1.818	0.069			1.653
Phenylpyrazole [factor]	1.234	0.254	4.855	<0.001			1.653

Wolfram et al., **ES&T,** 2019

Risk Drivers: sampling



Water phase

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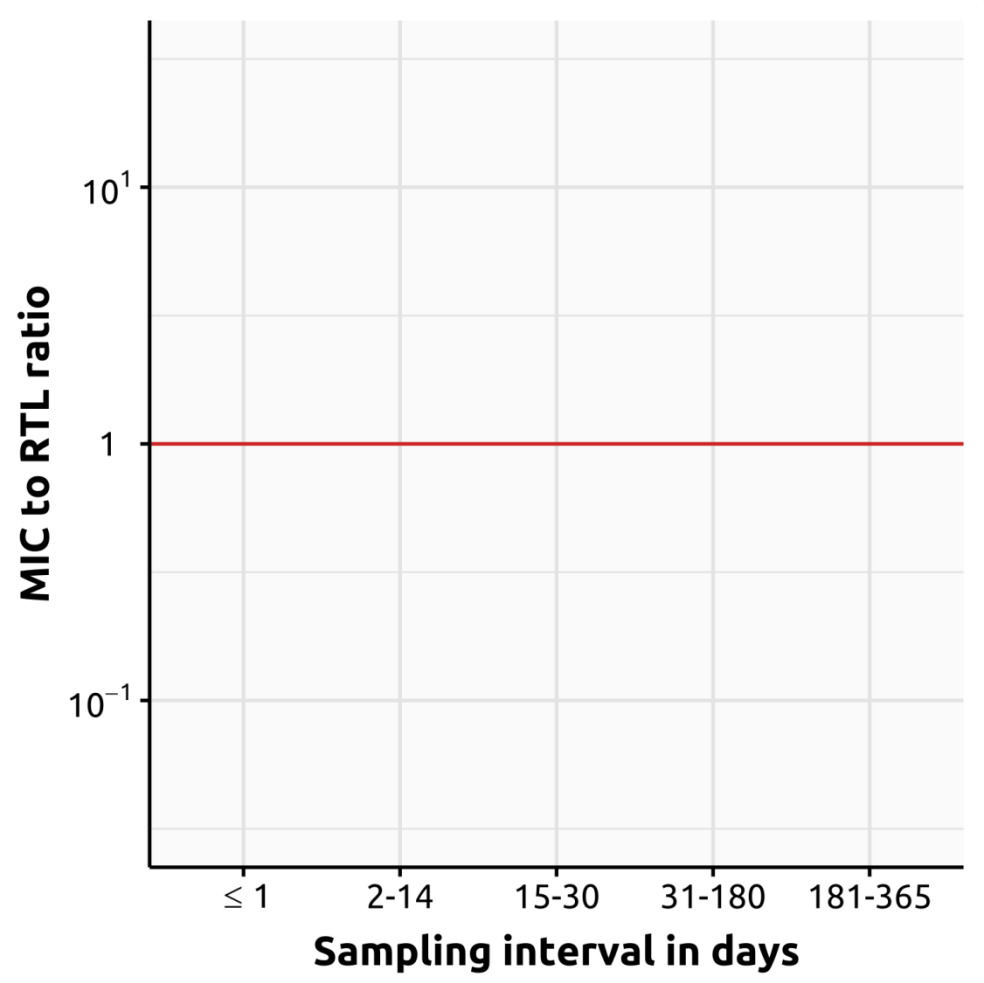
Risk Drivers: sampling



Water phase

RTL

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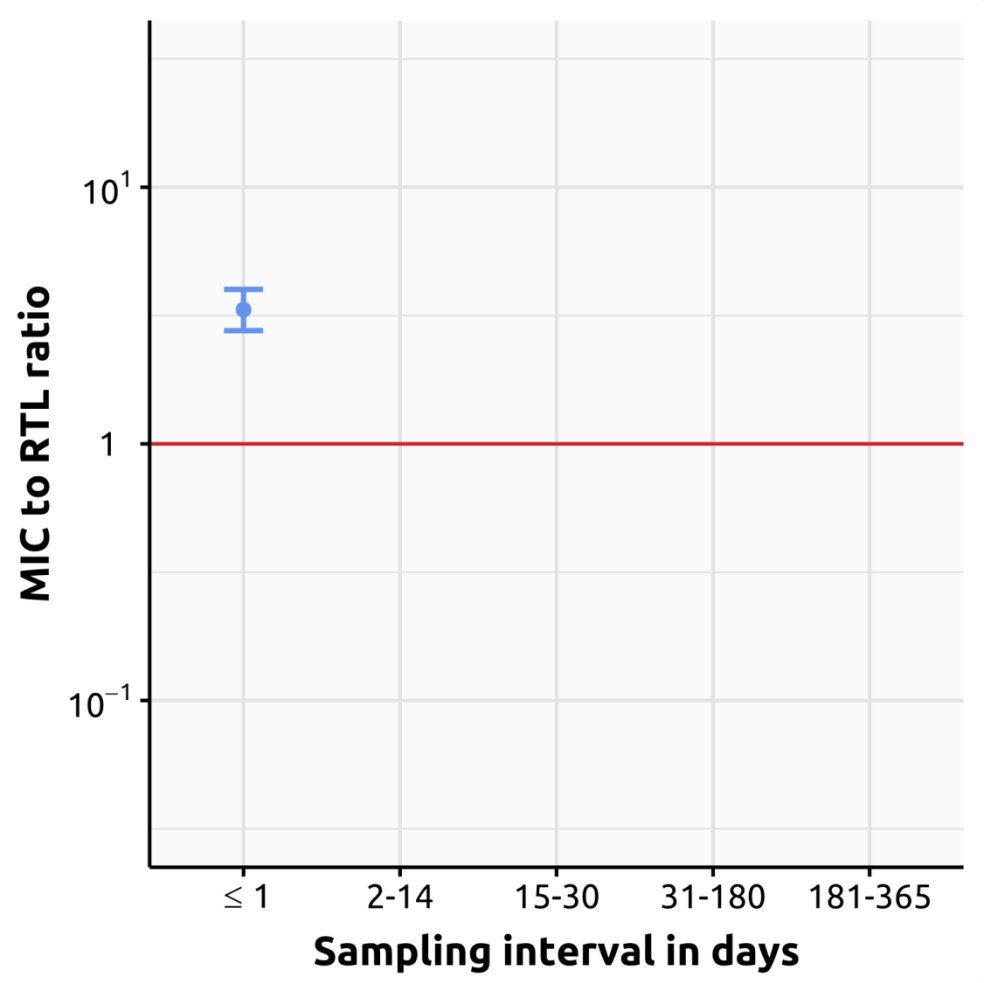
Risk Drivers: sampling



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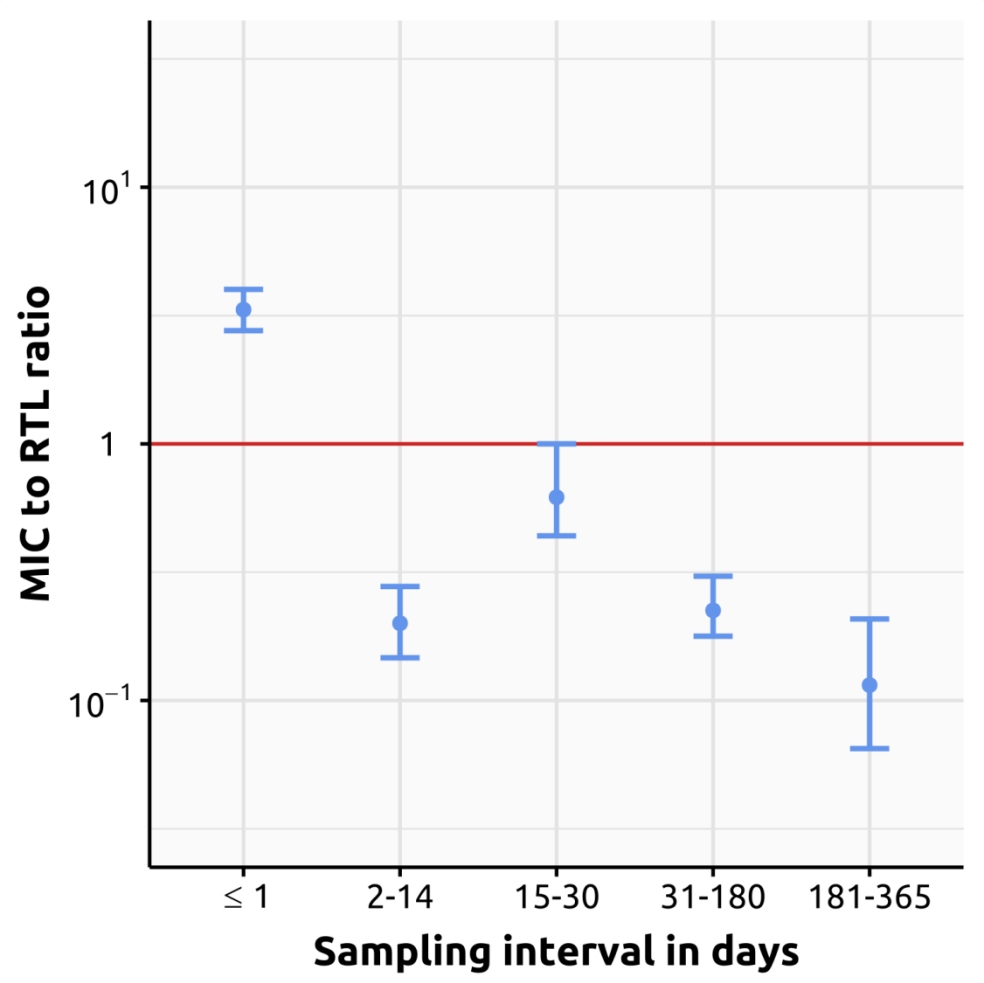

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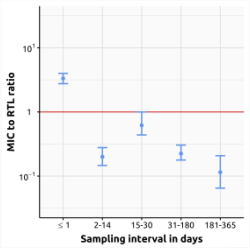

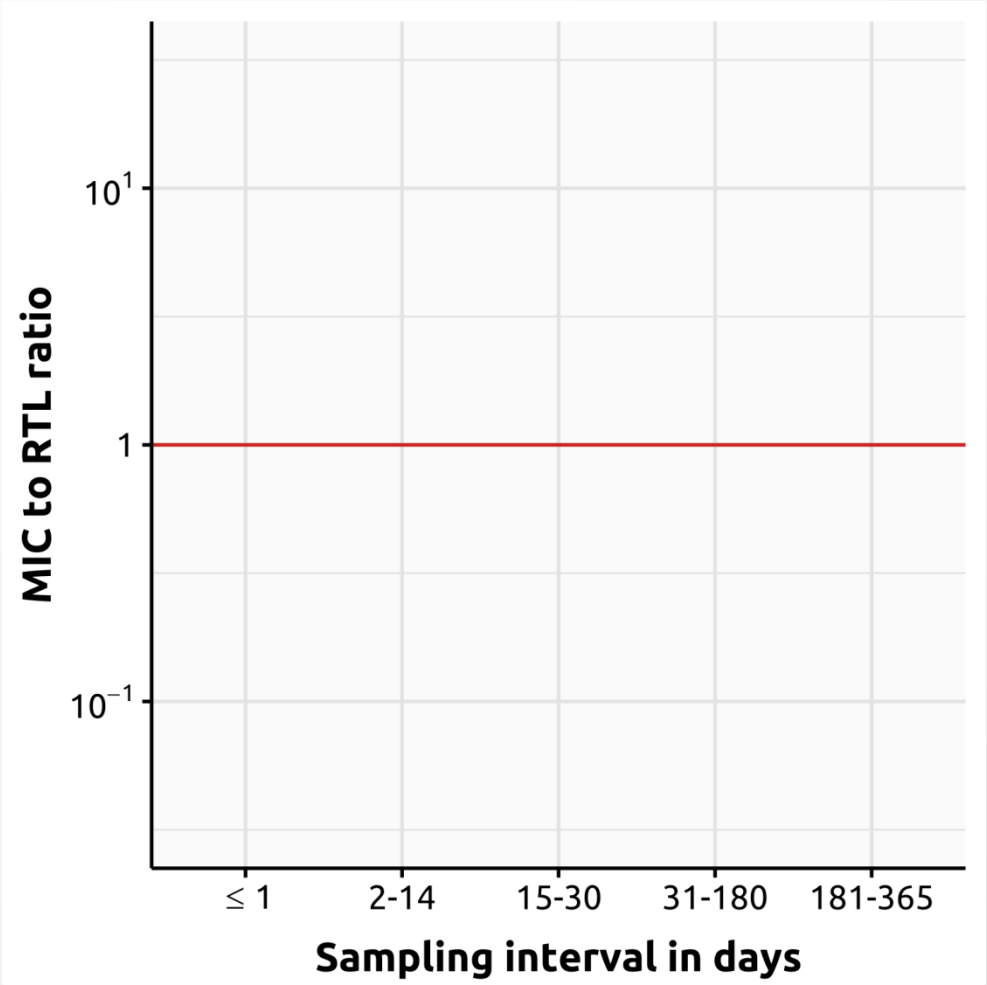

Sediment

RTL

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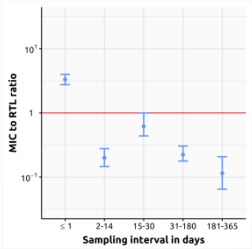
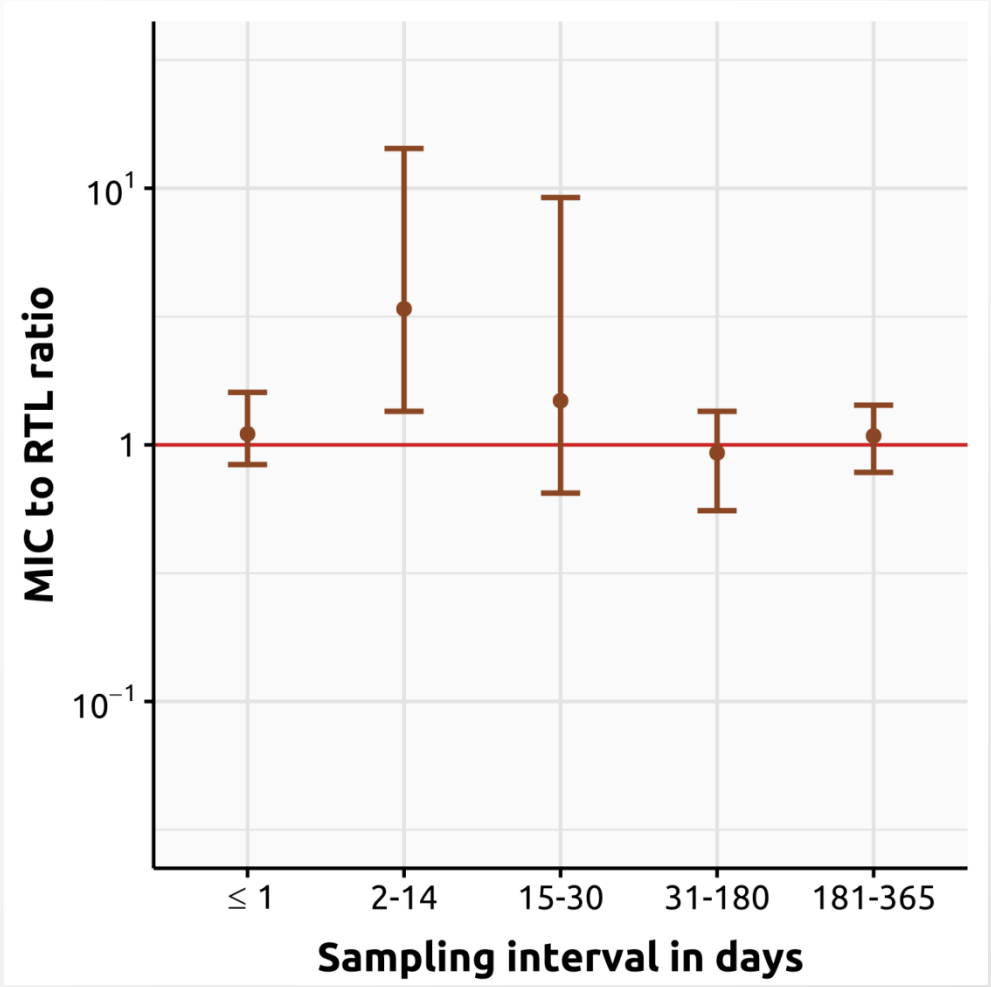
Risk Drivers: sampling





Sediment

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RTL

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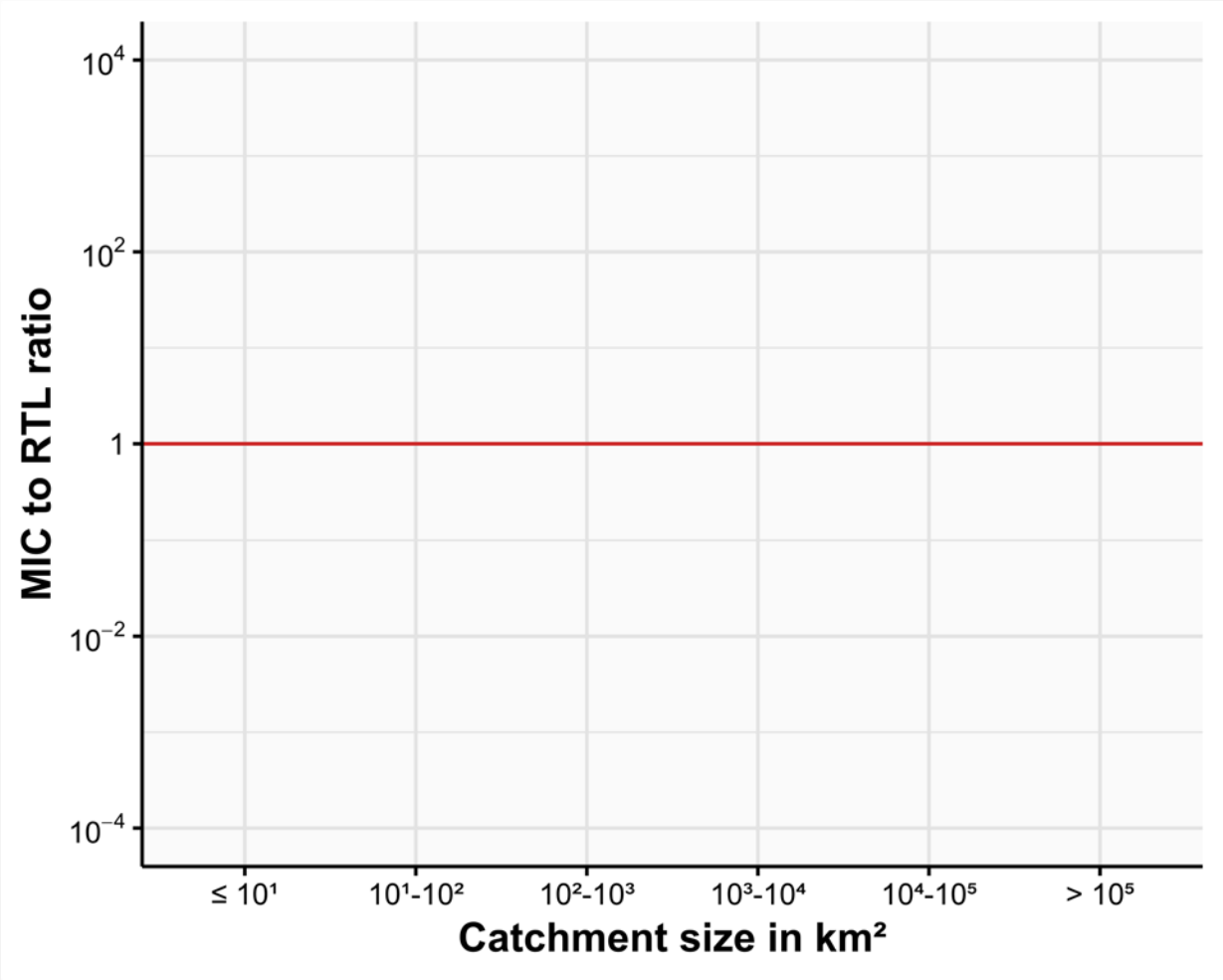
Risk Drivers: catchments



Water phase

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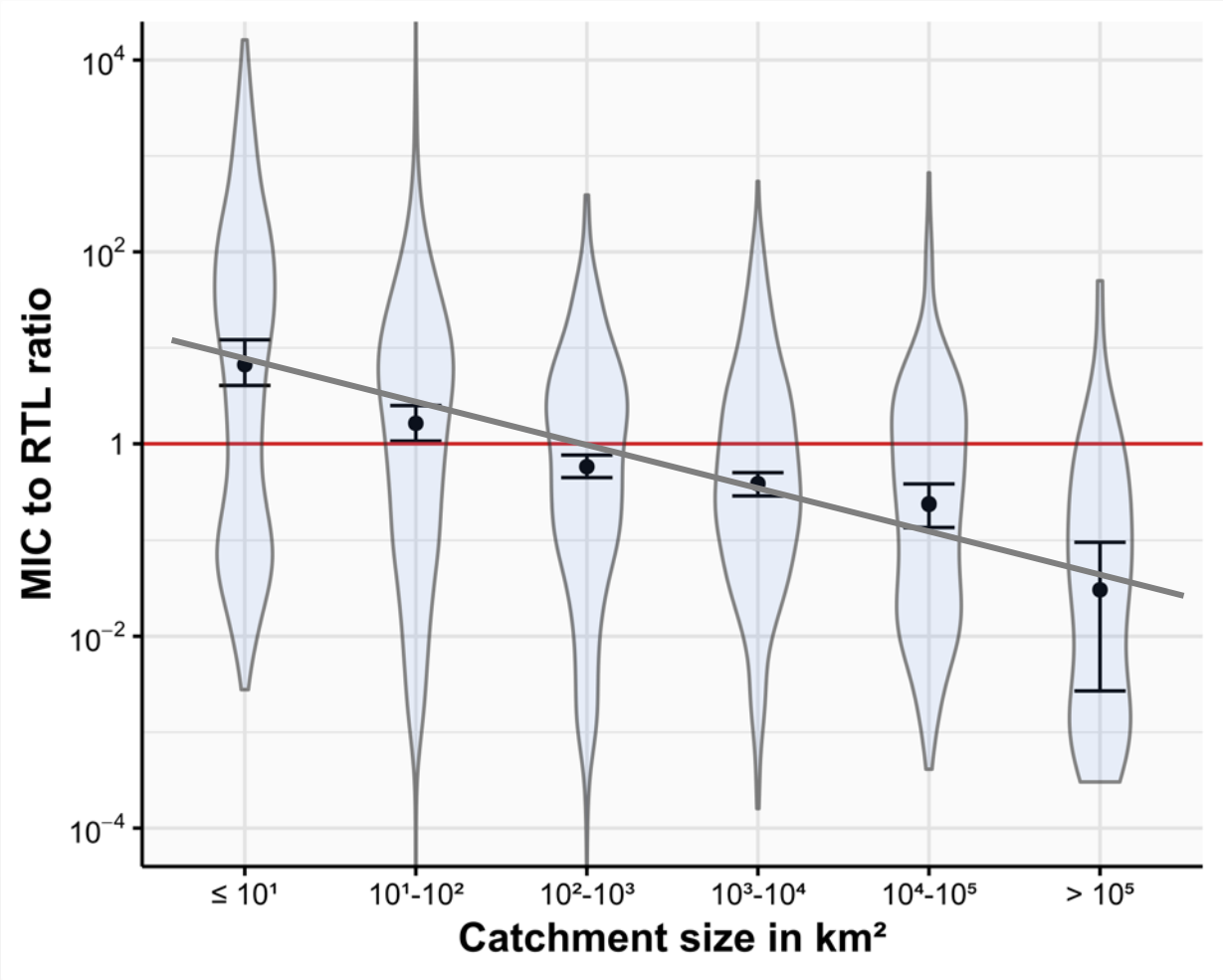

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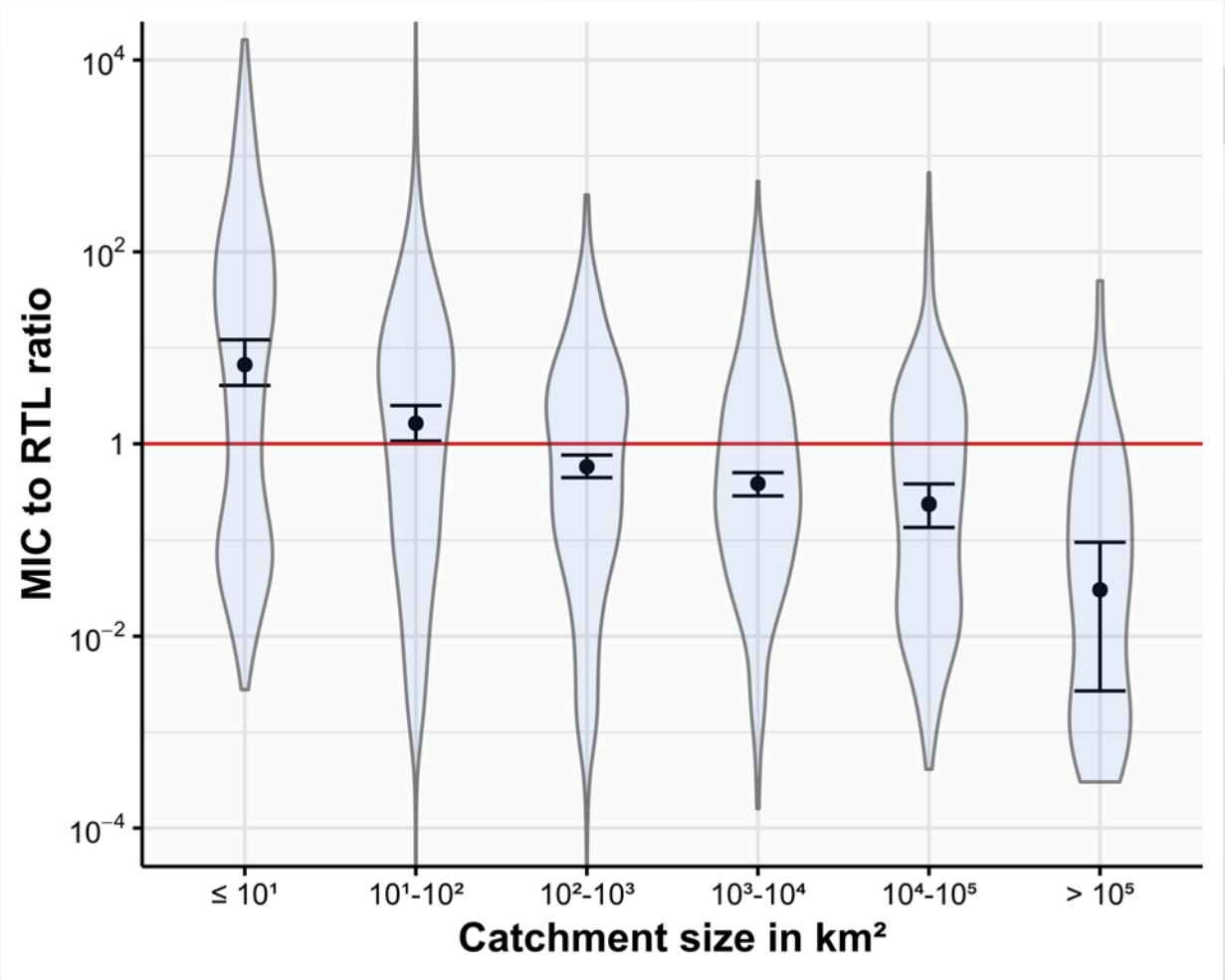

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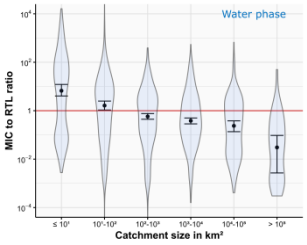

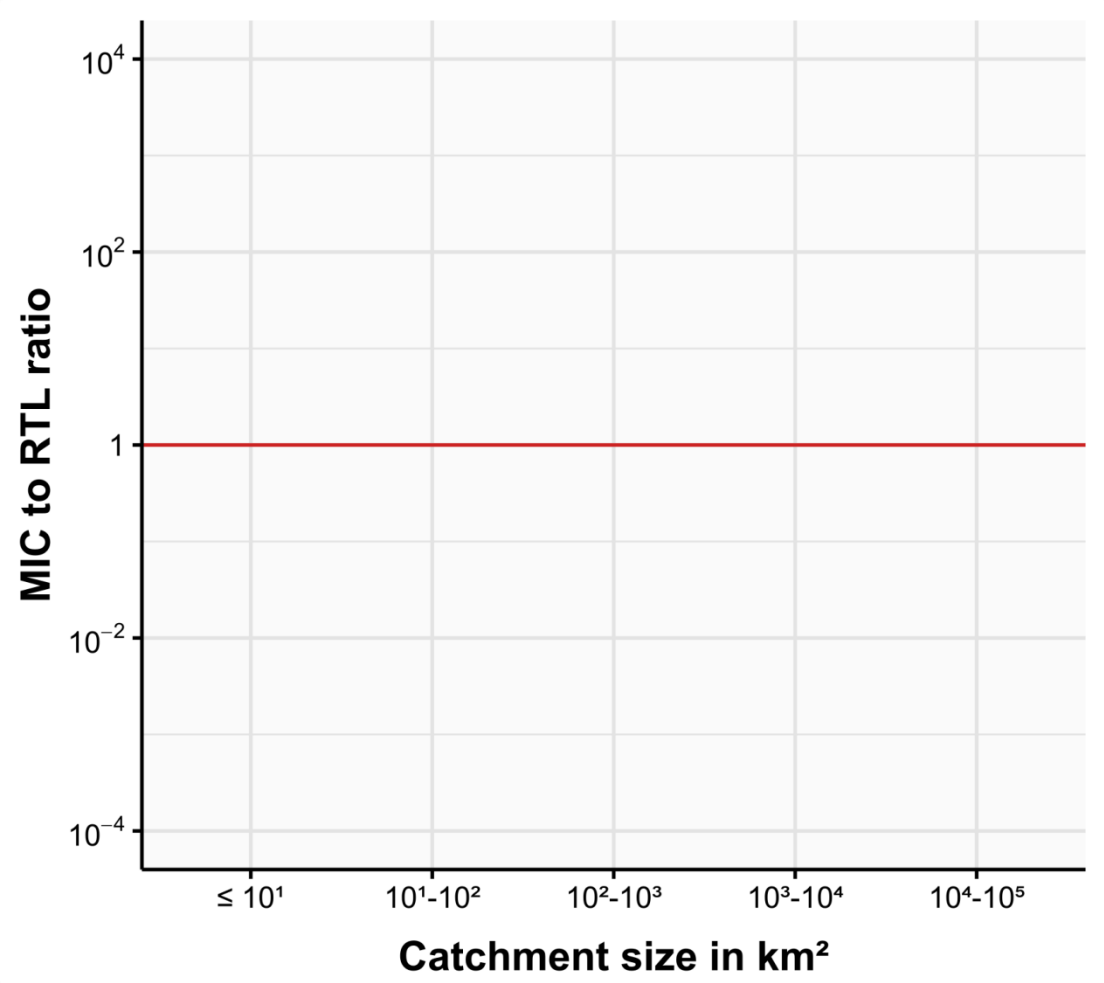

Sediment

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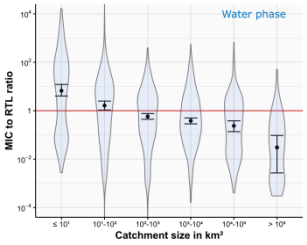

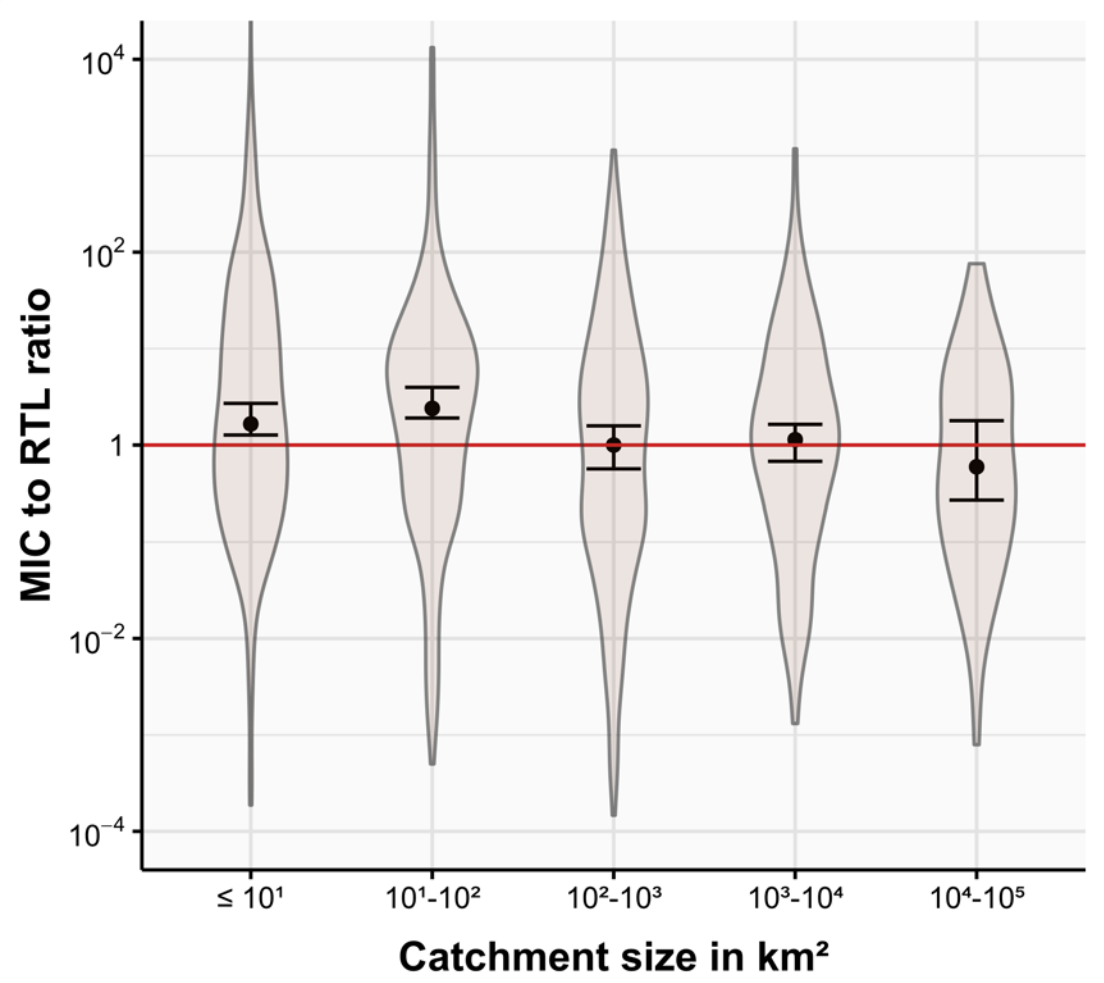

Sediment

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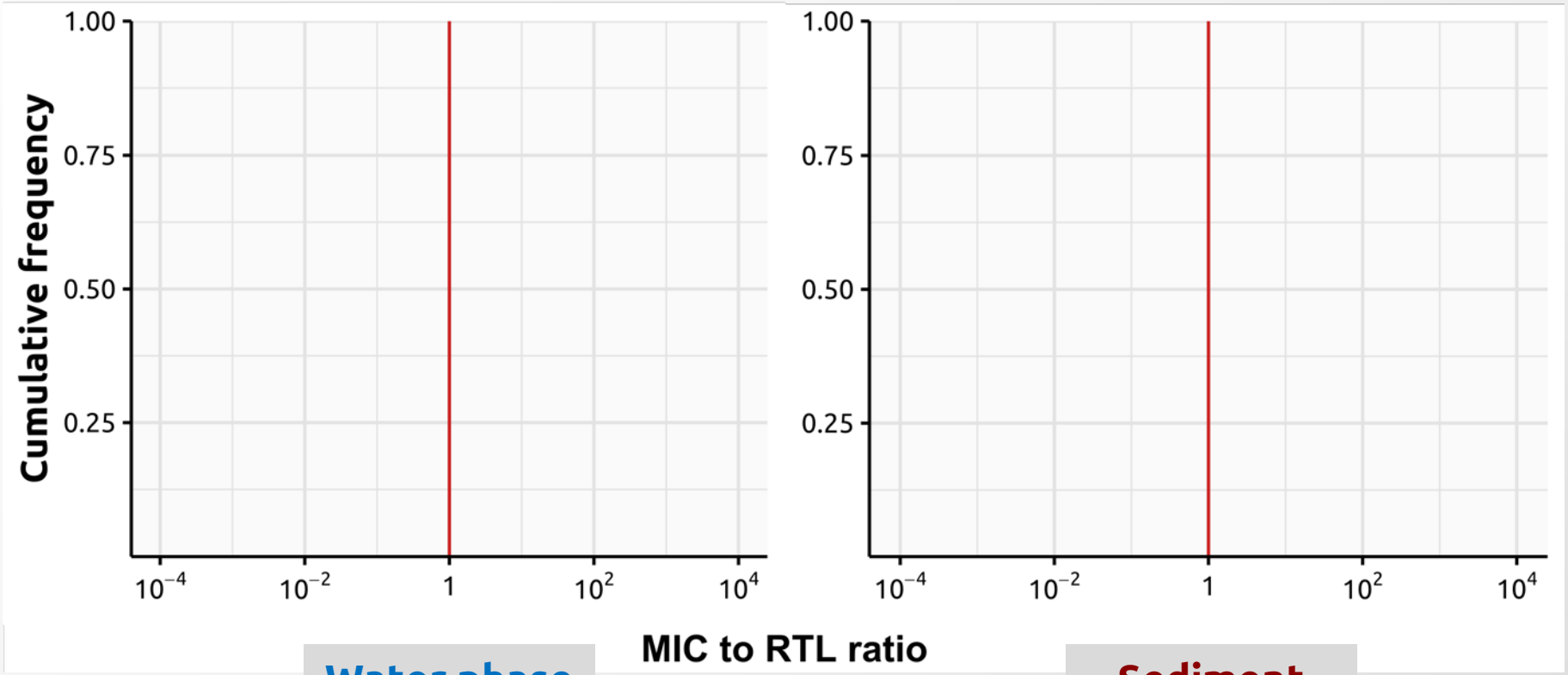
Single substances vs. mixtures



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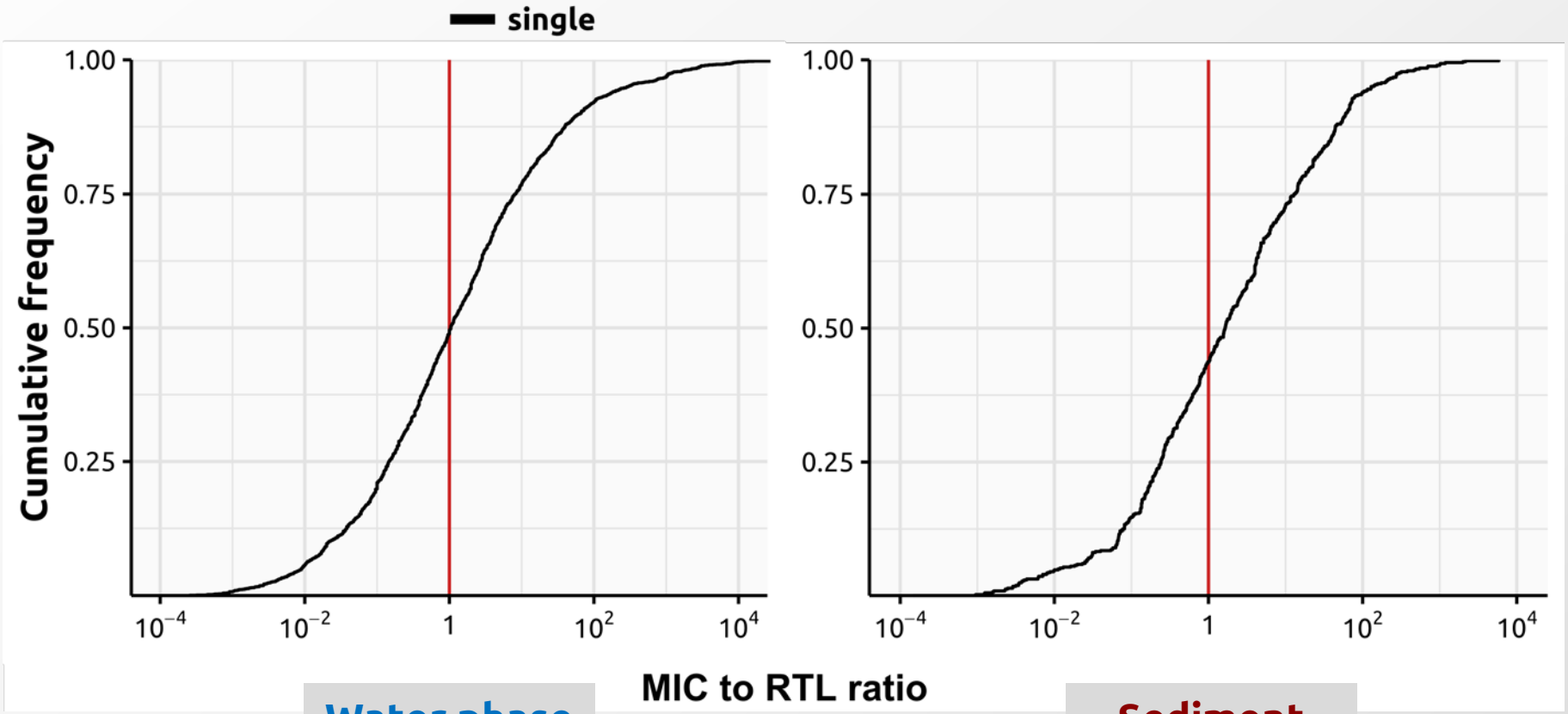

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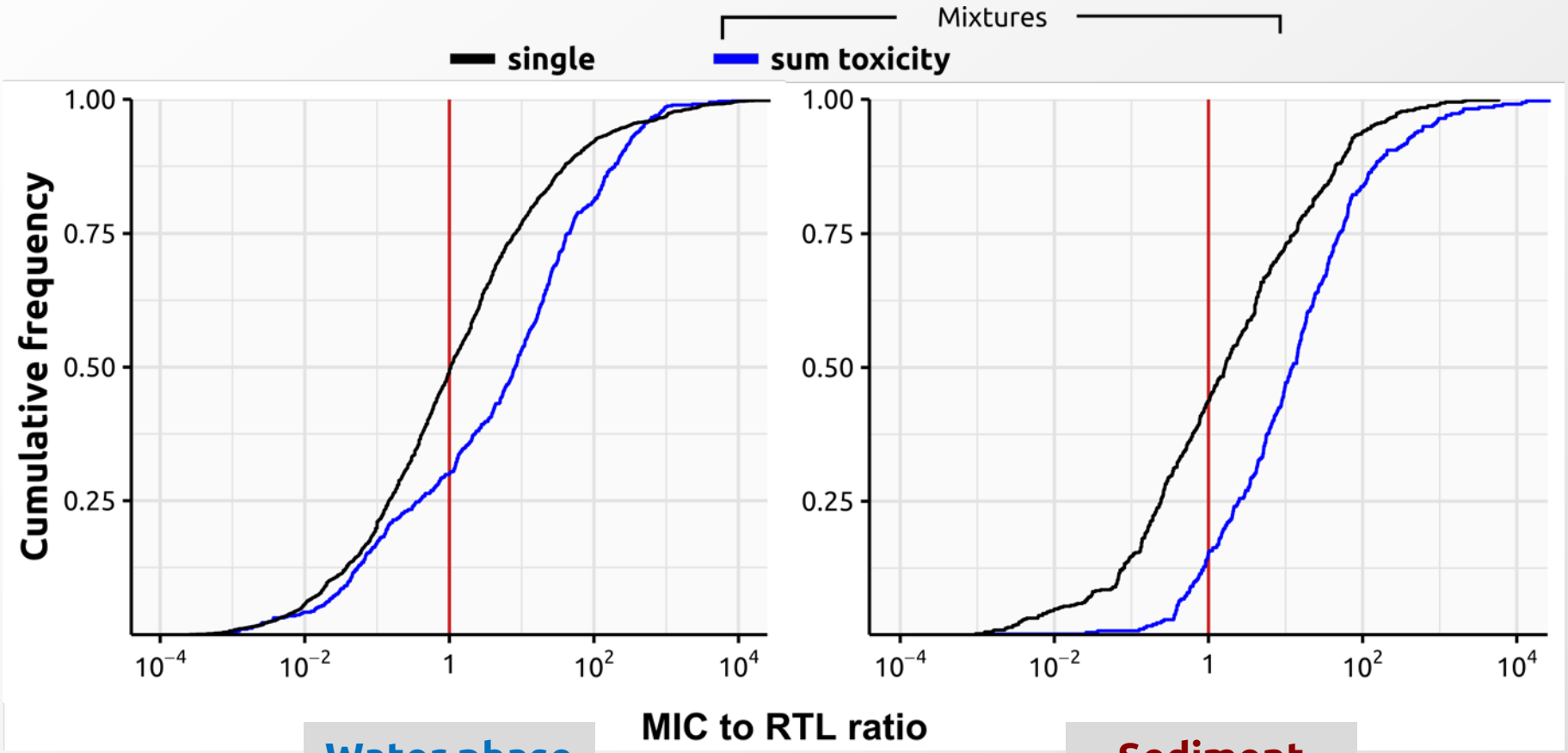

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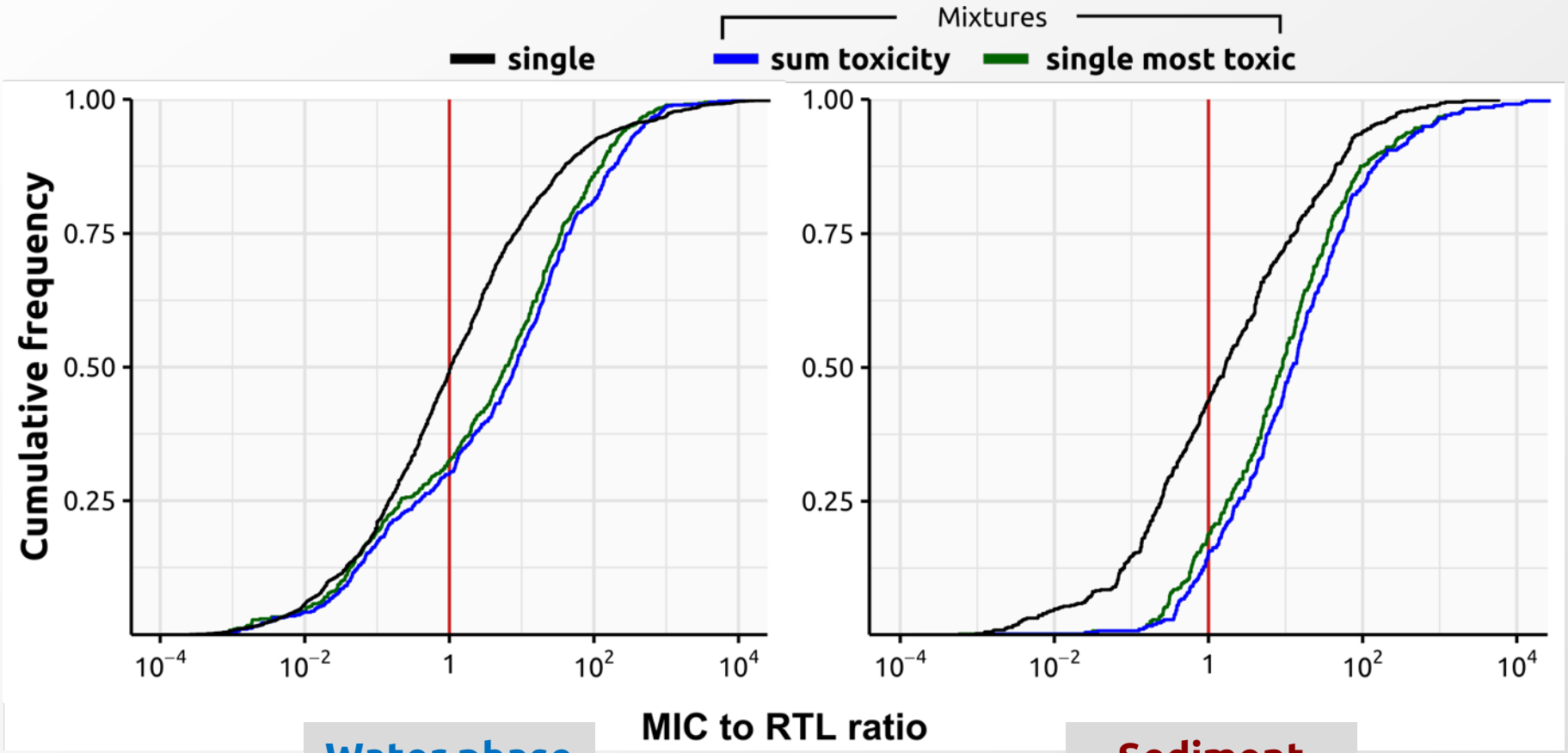

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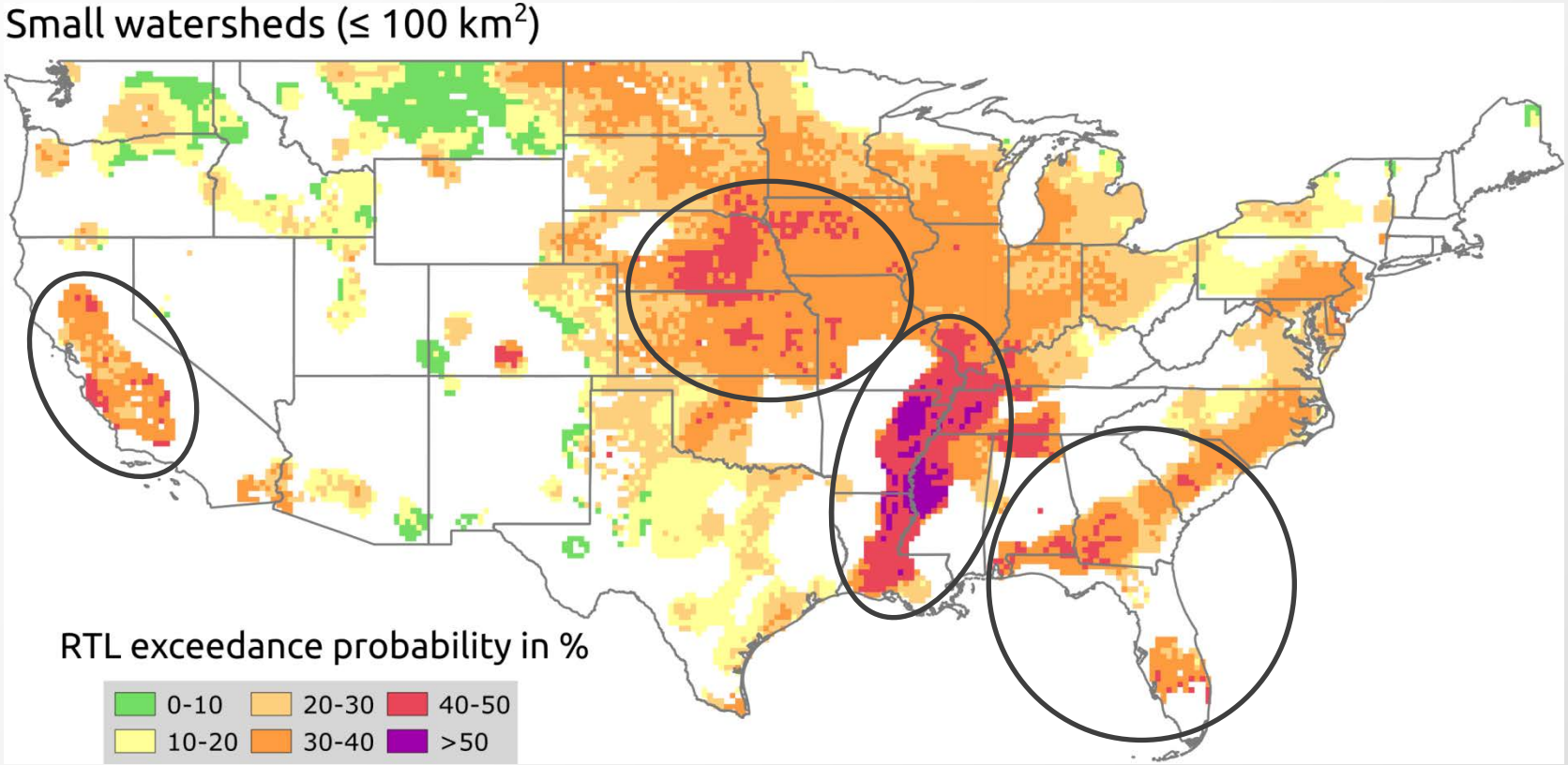
Risk Mapping

National insecticide risk model for 2017



Wolfram et al., **ES&T,** 2019

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Conclusion

- Substantial insecticide risks in the U.S.
- Water phase: highest risks in small catchments
- More uniform contamination in sediments
- Mapping insecticide risk across the U.S.

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Thank you for your time

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