

Neonicotinoid Pollution: Harms to Biodiversity and Threats to Human Health

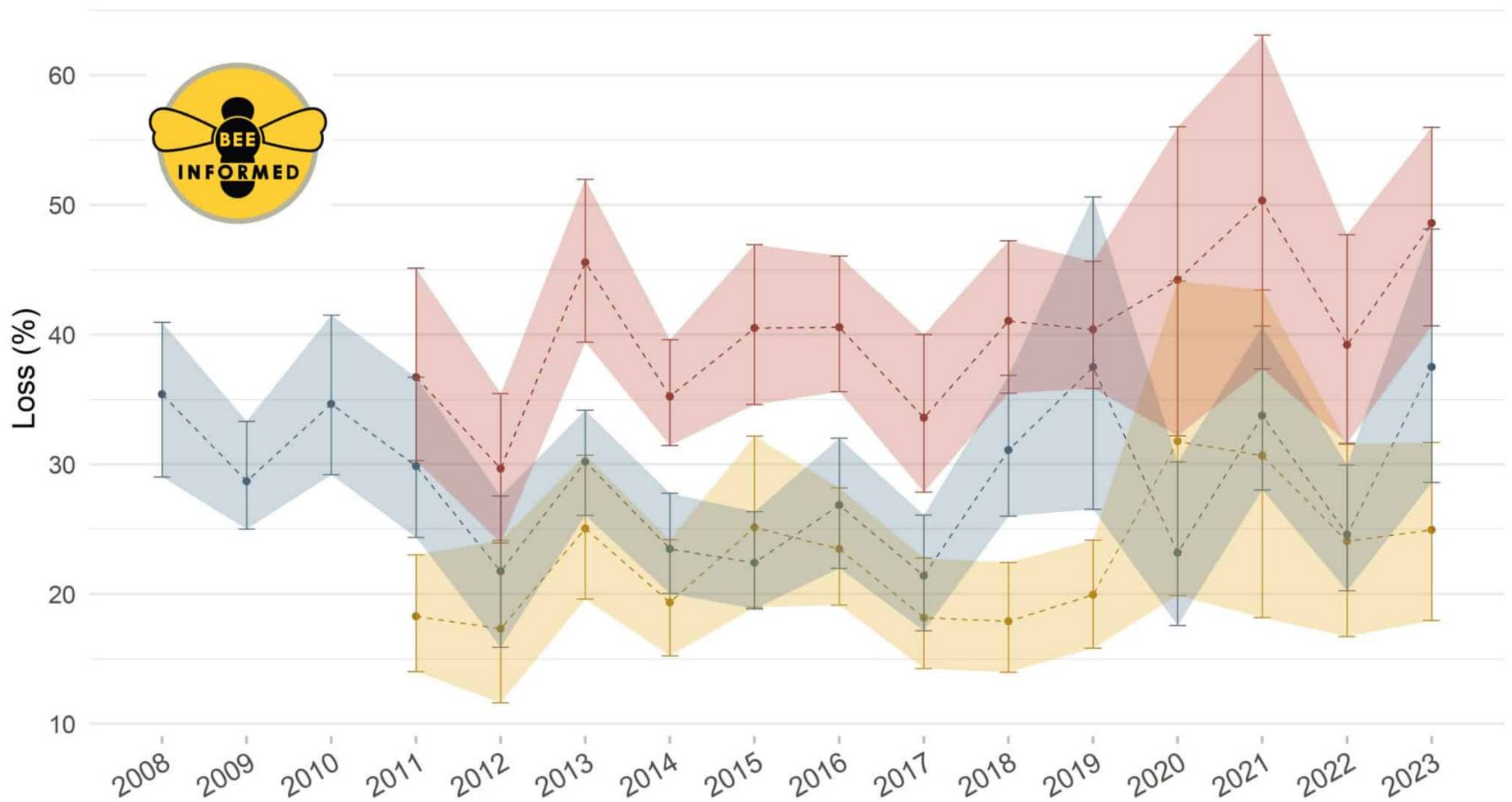


Dan Raichel, Director, Pollinators & Pesticides
Natural Resources Defense Council (NRDC)



U.S. managed honey bee colonies loss rates

A) All beekeepers



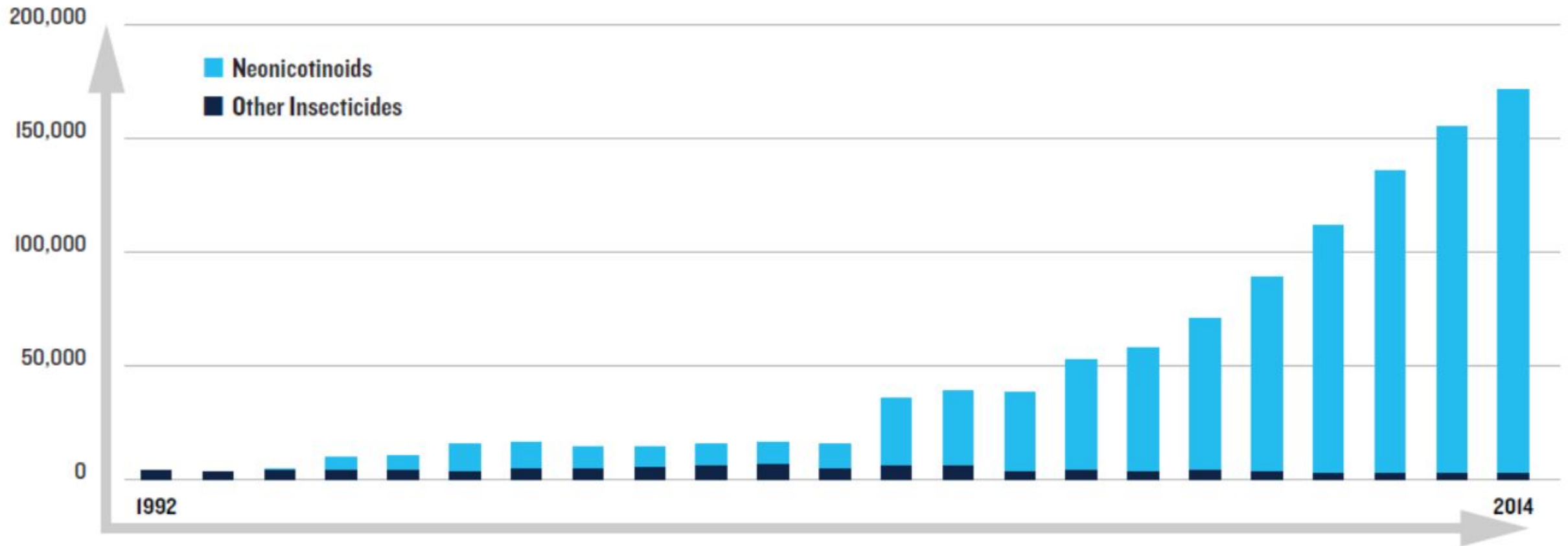
Three Main Concerns with Neonics

1. Highly toxic to insects.

- Just one neonic-treated corn seed can have enough active ingredient to kill 250,000 bees or more.

TOTAL ACUTE ORAL INSECT-TOXICITY LOAD OF INSECTICIDES IN U.S. AGRICULTURE BY YEAR (IN LD₅₀-DAYS)

U.S. AGRICULTURE IS **48 TIMES MORE HARMFUL** TO INSECT LIFE NOW THAN 25 YEARS AGO—
WHEN USING NEONIC PESTICIDES USE BEGAN



Data from Michael DiBartolomeis et al., "An Assessment of Acute Insecticide Toxicity Loading (AITL) of Chemical Pesticides Used on Agricultural Land in the United States," *PLoS One* (August 6, 2019).

Three Main Concerns with Neonics

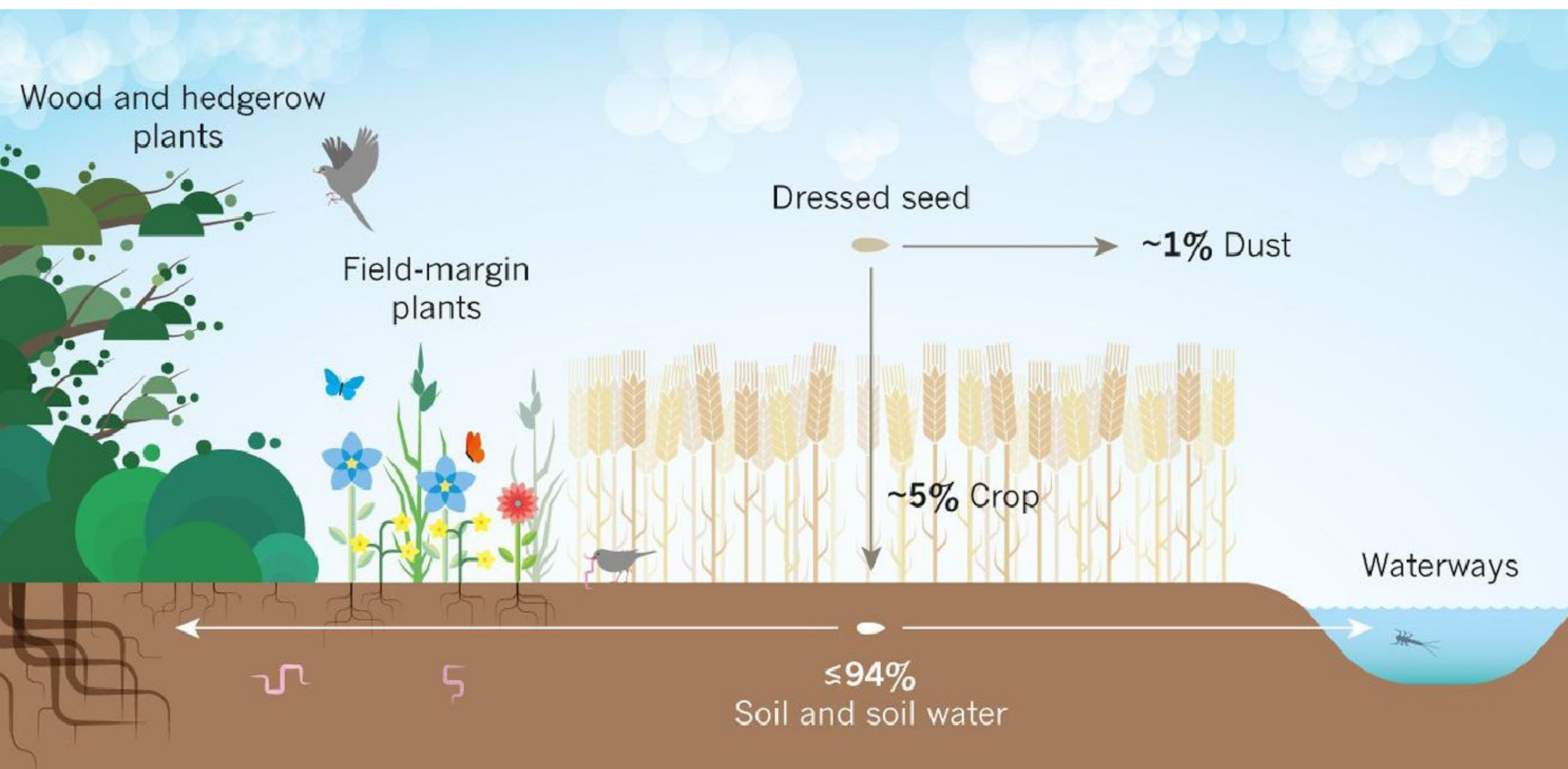
1. Highly toxic to insects.

- Just one neonic-treated corn seed can have enough active ingredient to kill 250,000 bees or more.

2. They easily make their way through the environment.

- “Systemic,” meaning they permeate the plant – leaves, roots, fruit, pollen, nectar, etc.
- Persist up to several years in soil.
- Move easily in water (e.g., rain or lawn watering) into surface water supplies.





Three Main Concerns with Neonics

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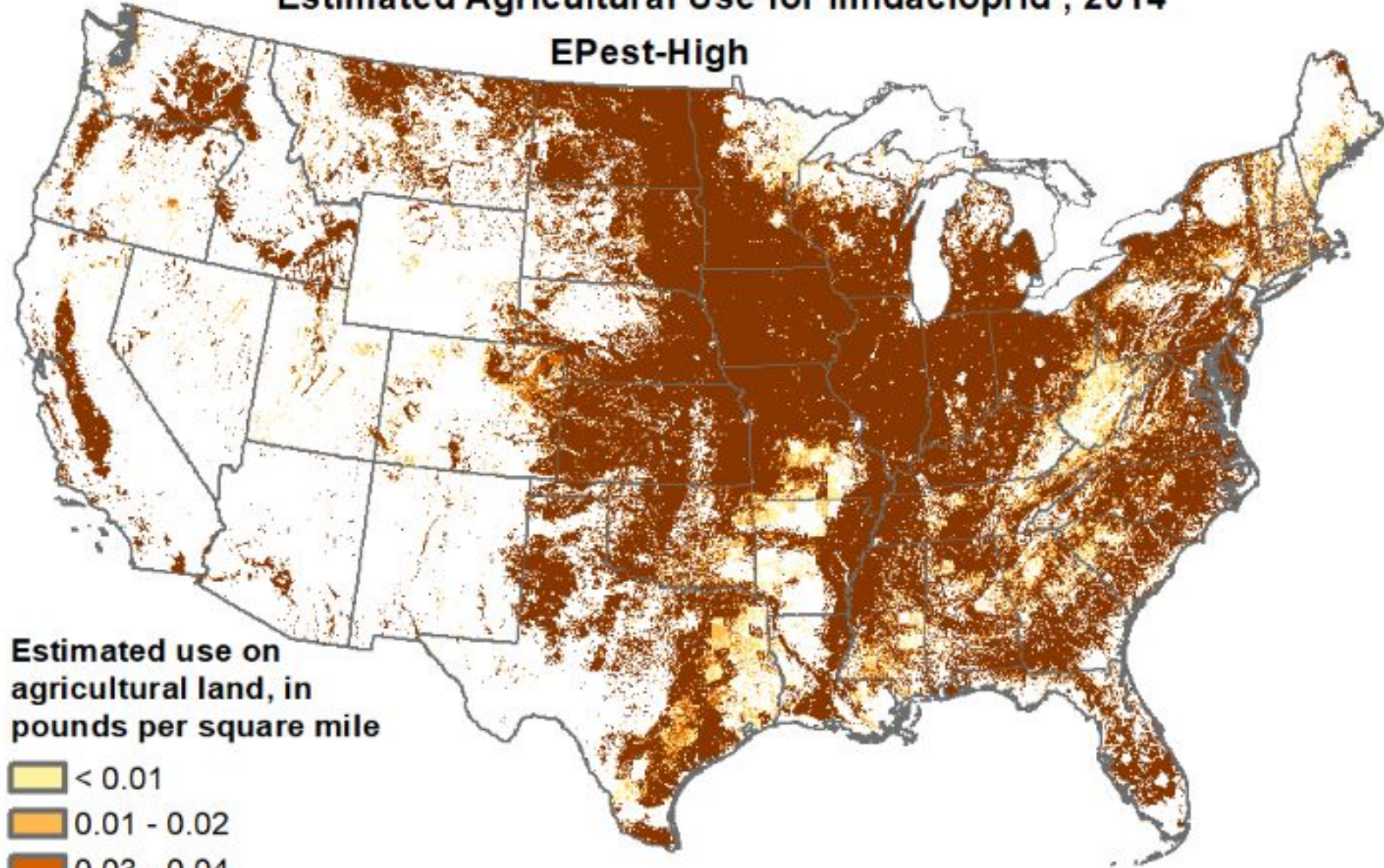
- “Systemic,” meaning they permeate the plant – leaves, roots, fruit, pollen, nectar, etc.
- Persist up to several years in soil.
- Move easily in water (e.g., rain or lawn watering) into surface water supplies.

3. They are everywhere.

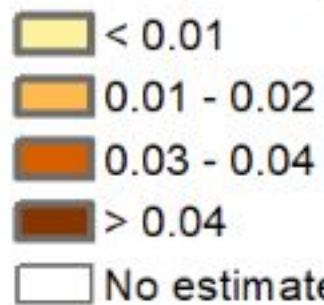
- Most popular insecticides in the U.S. – farms, but also lawns, home gardens, and commercial landscapes.

Estimated Agricultural Use for Imidacloprid , 2014

E Pest-High



**Estimated use on
agricultural land, in
pounds per square mile**



[nature](#) > [news](#) > article

News | Published: 29 June 2017

Largest-ever study of controversial pesticides finds harm to bees

[Daniel Cressey](#)

[Nature](#) (2017) | [Cite this article](#)

2730 Accesses | 1 Citations | 799 Altmetric | [Metrics](#)

Scientists say the industry-funded work confirms that neonicotinoids are harmful, but manufacturers question its conclusions.



Bees are harmed by neonicotinoid pesticides, according to a large-scale field study. Credit: Frank

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- Woodcock et al., Country-specific effects of neonicotinoid pesticides on honey bees and wild bees (2017)

[nature](#) > [nature sustainability](#) > [articles](#) > article

Article | [Open access](#) | Published: 27 August 2024

Impact of pesticide use on wild bee distributions across the United States

[Laura Melissa Guzman](#) , [Elizabeth Elle](#), [Lora A. Morandin](#), [Neil S. Cobb](#), [Paige R. Chesshire](#), [Lindsie M. McCabe](#), [Alice Hughes](#), [Michael Orr](#) & [Leithen K. M'Gonigle](#)

Nature Sustainability (2024) | [Cite this article](#)

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Abstract

The decline of many wild bee species has major consequences for pollination in natural and agro-ecosystems. One hypothesized cause of the declines is pesticide use; neonicotinoids and pyrethroids in particular have been shown to have pernicious effects in laboratory and field experiments, and have been linked to population declines in a few focal species. We used aggregated museum records, ecological surveys and community science data from across the contiguous United States, including 178,589 unique observations from 1,081 bee species (33% of species with records in the United States) across six families, to model species occupancy

New 'Detective Work' on Butterfly Declines Reveals a Prime Suspect

Agricultural insecticides were a key factor, according to a study focused on the Midwest, though researchers emphasized the importance of climate change and habitat loss.

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RESEARCH ARTICLE

Insecticides, more than herbicides, land use, and climate, are associated with declines in butterfly species richness and abundance in the American Midwest

Braeden Van Deynze , Scott M. Swinton, David A. Hennessy, Nick M. Haddad, Leslie Ries

Published: June 20, 2024 • <https://doi.org/10.1371/journal.pone.0304319>

[See the preprint](#)

Article	Authors	Metrics	Comments	Media Coverage	Peer Review
					

Abstract

Introduction

Methods

Results

Discussion

Supporting information

Acknowledgments

References

Reader Comments

Abstract

Mounting evidence shows overall insect abundances are in decline globally. Habitat loss, climate change, and pesticides have all been implicated, but their relative effects have never been evaluated in a comprehensive large-scale study. We harmonized 17 years of land use, climate, multiple classes of pesticides, and butterfly survey data across 81 counties in five states in the US Midwest. **We find community-wide declines in total butterfly abundance and species richness to be most strongly associated with insecticides in general, and for butterfly species richness the use of neonicotinoid-treated seeds in particular.** This included the abundance of the migratory monarch (*Danaus plexippus*), whose decline is the focus of intensive debate and public concern. Insect declines cannot be understood without comprehensive data on all putative drivers, and the 2015 cessation of neonicotinoid data releases in the US will impede future research.



FEATURE

The Insect Apocalypse Is Here

What does it mean for the rest of life on Earth?



Article | Published: 10 August 2020

Neonicotinoids and decline in bird biodiversity in the United States

Yijia Li, Ruiqing Miao & Madhu Khanna 

Nature Sustainability **3**, 1027–1035(2020) | [Cite this article](#)

1907 Accesses | **680** Altmetric | [Metrics](#)

Abstract

Neonicotinoid insecticides are being widely used and have raised concerns about negative impacts on non-target organisms. However, there has been no large-scale, generalizable study on their impact on biodiversity of avian species in the United States. Here we show, using a rich dataset on breeding birds and pesticide use in the United States, that the increase in neonicotinoid use led to statistically significant reductions in bird biodiversity between 2008 and 2014 relative to a counterfactual without neonicotinoid use, particularly for grassland and insectivorous birds, with average annual rates of reduction of 4% and 3%, respectively. The corresponding rates are even higher (12% and 5%, respectively) when the dynamic effects of bird population declines on future population growth are considered.

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nature reviews



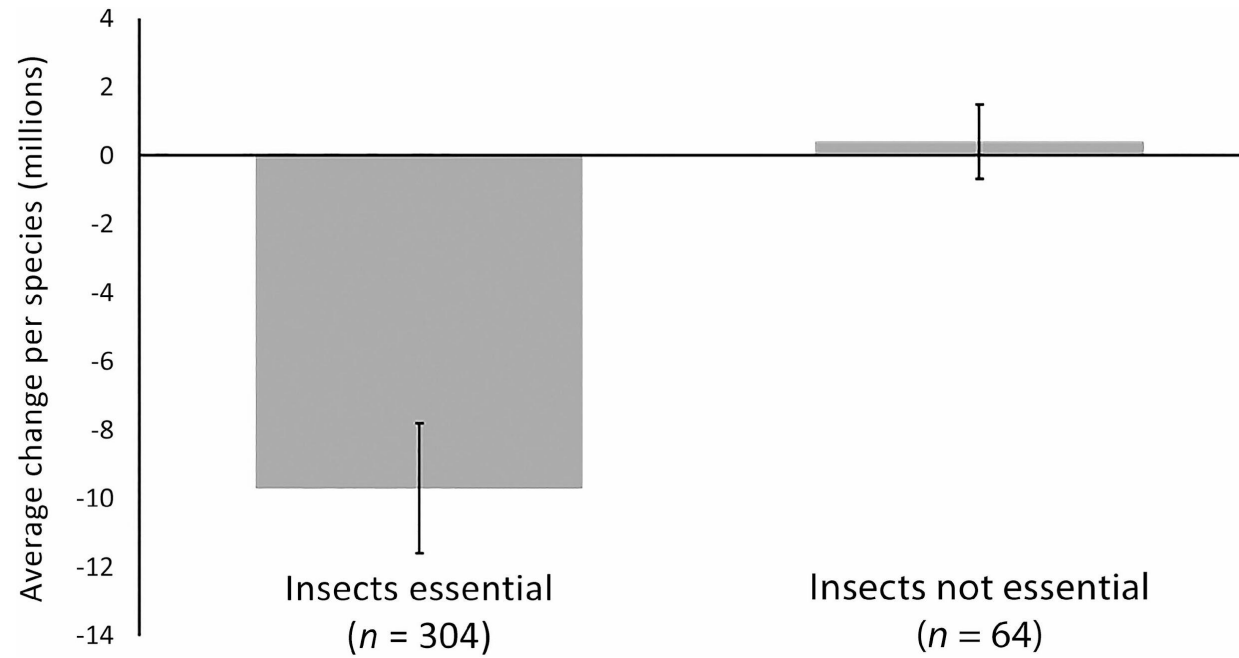
Nearly 3 Billion Birds Gone

A new study finds steep, long-term
losses across virtually all groups
of birds in the U.S. and Canada

Rosenberg et al. (2019)



Figure 1. The average change in population size over the last 50 years of terrestrial North American bird species for ...



Tallamy & Shriver (2021)

FOOD FOR THOUGHT

Controversial Pesticides Are Suspected Of Starving Fish

November 2, 2019 · 7:57 AM ET

Heard on Weekend Edition Saturday



DAN CHARLES



3-Minute Listen

+ PLAYLIST

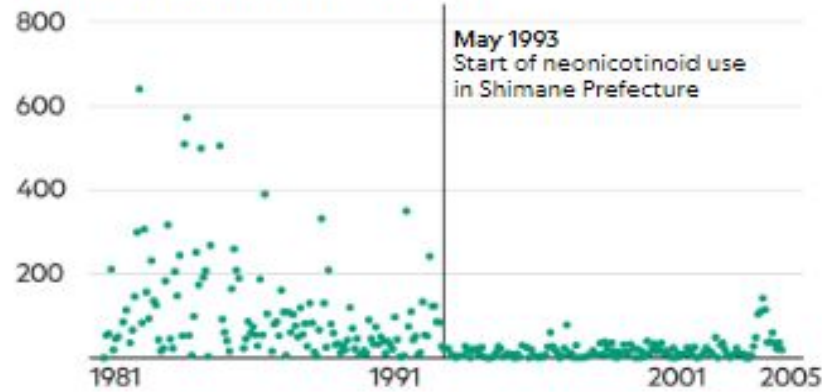




Matt Wilson/Jay Clark, NOAA

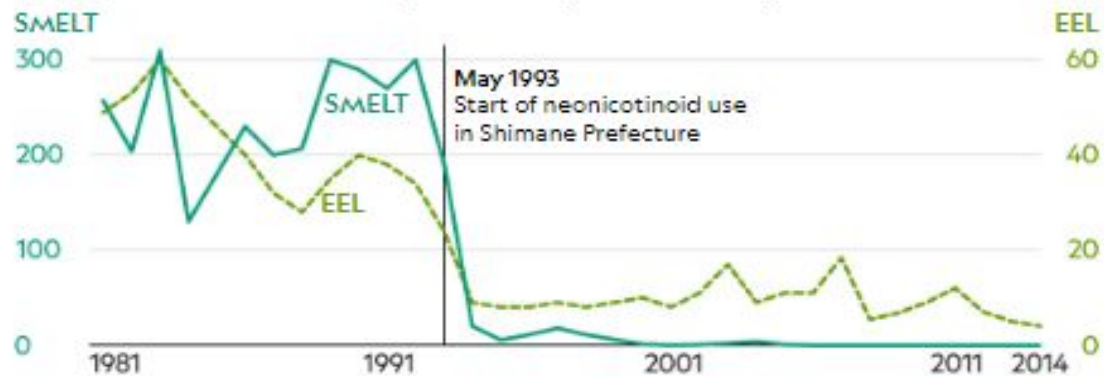
Runoff containing neonicotinoids from fields and paddies was linked to a dropoff of zooplankton biomass in Lake Shinji.

Monthly measurement of zooplankton in micrograms carbon per liter present in water from Lake Shinji



Populations of commercial smelt and eel in Lake Shinji, which were reliant on zooplankton and benthos as a source of food, began to collapse.

Tons of smelt and eel, caught annually in Lake Shinji



Expert Blog

EPA: Neonics Likely Driving 200+ Species Toward Extinction

U.S. EPA's unprecedented findings confirm that widespread neonic pesticide use threatens critical pollinators, other wildlife, and whole ecosystems.

May 15, 2023



Lucas Rhoads

Staff Attorney, Pollinator Initiative, Nature Program

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An endangered Kameron blue butterfly resting on a dandelion flower. | Joel Trick/USFWS

| ENVIRONMENT |

Huge decline in songbirds linked to common insecticide

Neonics—pesticides introduced to plants at the seed stage—act like an appetite suppressant for birds, making them lose weight within hours.



Eng et al. (2019)



NEONICOTINOIDS ON THE LANDSCAPE: EVALUATING AVIAN EXPOSURE TO TREATED SEEDS IN AGRICULTURAL LANDSCAPES

Charlotte Roy, Da Chen¹, Julia Ponder², Mark Jankowski², and Pam Coy

SUMMARY OF FINDINGS

Neonicotinoid pesticides [e.g., imidacloprid (IMI), thiamethoxam (TMX), thiacloprid (THIA), clothianidin (CLO)] are commonly applied to agricultural seeds (e.g., corn, soybean, wheat, sunflower) and are known to cause lethal and sub-lethal effects in birds. Neonicotinoid-treated seeds could be available to wildlife through spillage or exposure to treated seeds near or at the soil surface after planting (de Leeuw et al. 1995, Pascual et al. 1999, Lopez-Antia et al. 2016). Using several lines of evidence, we examined sub-lethal exposure and the potential for exposure of wildlife to these pesticides in agricultural landscapes of Minnesota in 2016 and 2017. We documented exposed seeds at the soil surface in plots at 35% of 71 fields sampled after planting. We also quantified the rate of seed spills during planting season and documented 329 seed spills in the 76 townships surveyed in the spring. We documented birds and mammals eating treated seeds through field studies with trail cameras. We quantified consumption of treated seeds for 11 species of birds and 9 species of mammals, and in many cases we estimated that more than 25% of the LD₅₀—the amount of ingested substance to kill 50% of a test sample—was ingested. Seed exposure experiments conducted under environmental conditions indicated that neonicotinoids are persistent on the seed surface for as long as 30 days in the environment, so wildlife can ingest neonicotinoids on treated seeds for at least 30 days after planting.

We also conducted laboratory experiments using domestic chickens (*Gallus gallus domesticus*) to identify non-lethal and lethal sampling methods that could lead to measurement of individual- and population-level exposure, including residues in the excreta and blood of birds. Mean residue concentrations in chickens dosed in the lab were highest in the brain. In decreasing order of concentration, residues were also detected in liver, spleen, muscle, blood, kidney, then feces. Residues in chicken fecal samples collected in the lab had the highest frequency of detection in all tissues tested.

Finally, we collected field samples from prairie grouse leks and from hunter-harvested birds to evaluate whether wild birds were exposed to sub-lethal doses. Seventy-three of 82 (89%) liver samples collected from sharp-tailed grouse (*Tympanuchus phasianellus*) and 32 of 45 (71%) greater prairie-chickens (*Tympanuchus cupido*) contained concentrations above the Method Limit of Quantification (MLOQ) for at least 1 neonicotinoid. Similarly, 95 of 109 (87%) sharp-tailed grouse fecal pellets and 51 of 59 (86%) fresh greater prairie-chicken fecal pellets collected from leks have been analyzed and had concentrations above the MLOQ for ≥1 neonicotinoid. Most of the detected concentrations were <10 ng/g, which explains why earlier

ENVIRONMENT

As Pesticide Turns Up in More Places, Safety Concerns Mount

A growing body of research is challenging the assumption that neonicotinoids are safer and less likely to spread than other pesticides

By Jim Daley on April 30, 2019



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ENVIRONMENT

E.U. Expected to Vote on Pesticide Ban after Major Scientific Review

March 1, 2018 — Declan Butler and Nature magazine

Effects in Deer

Berheim et al., (2019)

- Decreased jawbone length
- Decreased body and organ weight (liver, spleen, genitals)
- Decreased thyroxine levels
- Increased fawn mortality
- Lethargy
- Some neonics in control group



Data show increasing insecticide levels in Minnesota deer

Dan Gunderson Moorhead, Minn. August 23, 2022 1:24 PM



Two deer near Duluth, Minn. ■ Andrew Krueger | MPR News

A second year of testing for neonicotinoid insecticides in white tailed deer in Minnesota found the chemical more widespread and at higher levels than in previous sampling.

Researchers found the insecticide in 61 percent of 799 deer spleens tested in 2019. But the chemical was found in 94 percent of 406 samples collected in 2021.

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Increasing Neonic Levels

- 2019 – Minnesota Dept. of Natural Resources (MDNR) found neonics in 61% of deer, with 29% above levels associated with birth defects and higher rates of death for fawns in Berheim et al. (2019)
- **2021 – MDNR testing found neonics in 94% of deer with 64% at levels associated with higher rates of birth defects/death.**



Human Health

- CDC finds half of Americans exposed to neonics on any given day (2016 data). Ospina et al. (2019)
- **2022 study of 171 pregnant women across the country finds neonics in >95%, with increasing frequency and levels over course of study (2017-2020) and higher rates in Hispanic women. Buckley et al. (2022)**
- Exposure linked to:
 - Birth defects in heart and brain
 - Autism-like symptoms
 - Decreased sperm quantity and quality
 - Decreased testosterone, altered insulin regulation, and changes in fat metabolism



US news

Most common US pesticide may affect brain development similarly to nicotine

Neonicotinoid exposure could be linked to long-term health effects like ADHD and reduced motor skills, review finds

Tom Perkins

Sat 19 Oct 2024 10.00 EDT

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Despite industry science that shows the danger of neonicotinoids, experts allege the EPA might set limits that is 'not protective of children'. Photograph: Edwin Remsberg/VW Pics/Universal Images Group via Getty Images

Industry research reviewed by independent scientists show that exposure to the nation's most common pesticides, neonicotinoids, may affect developing brains the same way as nicotine, including by significantly shrinking brain tissue and neuron loss.

Exposure could be linked to long-term health effects like ADHD, slower

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Sass et al., Neonicotinoid pesticides: evidence of developmental neurotoxicity from regulatory rodent studies (2024)

		Acetamiprid	Clothianidin	Imidacloprid	Thiacloprid	Thiamethoxam
Brain tissue thinning	High dose	Yes	Yes	Yes	Yes	Yes
	Mid dose	No data	Partial data	No data	No data	Yes
	Low dose	No data	No data	No data	No data	Yes
Decreased auditory startle reflex	High dose	Yes	Yes			
	Mid dose	Yes	Yes			
	Low dose	Yes				
Decreased motor activity	High dose		Yes	Yes		
	Mid dose			Yes		
	Low dose					
Learning and behavior effects	High dose				Yes	
	Mid dose				Yes	
	Low dose					
Delayed sexual maturation	High dose				Yes	Yes
	Mid dose				Yes	Yes
	Low dose					Yes



Occurrence of neonicotinoid insecticides in finished drinking water and fate during drinking water treatment

Environmental Science & Technology Letters

By: Kathryn L. Klarich, Nicholas C. Pflug, Eden M. DeWald, Michelle L. Hladik , Dana W. Kolpin , David M. Cwiertny, and Gergory H. LeFevre

<https://doi.org/10.1021/acs.estlett.7b00081>



Links

- More information: [Publisher Index Page \(via DOI\)](#), Publicly accessible after 4/5/2017 (public access data via [CHORUS](#))
- Download citation as: [RIS](#) | [Dublin Core](#)

Abstract

Neonicotinoid insecticides are widespread in surface waters across the agriculturally-intensive Midwestern US. We report for the first time the presence of three neonicotinoids in finished drinking water and demonstrate their general persistence during conventional water treatment. Periodic tap water grab samples were collected at the University of Iowa over seven weeks in 2016 (May-July) after maize/soy planting. Clothianidin, imidacloprid, and thiamethoxam were ubiquitously detected in finished water samples and ranged from 0.24-57.3 ng/L. Samples collected along the University of Iowa treatment train indicate no apparent removal of clothianidin and imidacloprid, with modest thiamethoxam removal (~50%). In contrast, the concentrations of all neonicotinoids were substantially lower in the Iowa City treatment facility finished water using granular activated carbon (GAC) filtration. Batch experiments investigated potential losses. Thiamethoxam losses are due to base-catalyzed hydrolysis at high pH conditions during lime softening. GAC rapidly and nearly completely removed all three neonicotinoids. Clothianidin is susceptible to reaction with free chlorine and may undergo at least partial transformation during chlorination. Our work provides new insights into the persistence of neonicotinoids and their potential for transformation during water



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Toxic Pesticides Contaminate Target's Baby Food

September 18, 2024

Lab tests reveal residues of 12 highly hazardous pesticides in baby food from Target's Good & Gather line



WASHINGTON – A [new investigation](#) led by Friends of the Earth found an alarming number of pesticide residues in baby food manufactured and sold by **Target (NYSE: TGT)** under its house brand **Good & Gather**. Lab tests of two items - the non-organic apple and the pear fruit purees for babies - revealed the presence of 21 pesticides, including 12 classified as highly hazardous to human health or the environment.

Neonicotinoid pesticides were present in 100% of the baby food samples tested. These chemicals have been linked to birth defects of the heart and brain, learning disorders, ADHD, autism spectrum disorder, damage to the nervous system, and hormone disruption. Neonicotinoids are also among the most ecologically disastrous pesticides since DDT. U.S. agriculture has become nearly [48 times more toxic to insects](#), including essential pollinators like bees, since the introduction of neonicotinoids. And they are a

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Unequal Risks/Impacts

- **Higher detections of neonics in the bodies of pregnant Hispanic women.**
- Eating organic produce greatly reduces risk of exposure through food, but may not be available or affordable for many families.
- Advanced filtration systems can remove neonics from water at the tap, but can be expensive.
- Lack of pollinators already lowering yields for many crops. **If trends continue many of the most nutritious foods may become unaffordable.**