Scott McArt
Associate Professor
Department of Entomology
Cornell University

Outline

1) New York risk-benefit report on neonicotinoid insecticides

2) Peer-reviewed literature since the NYS report

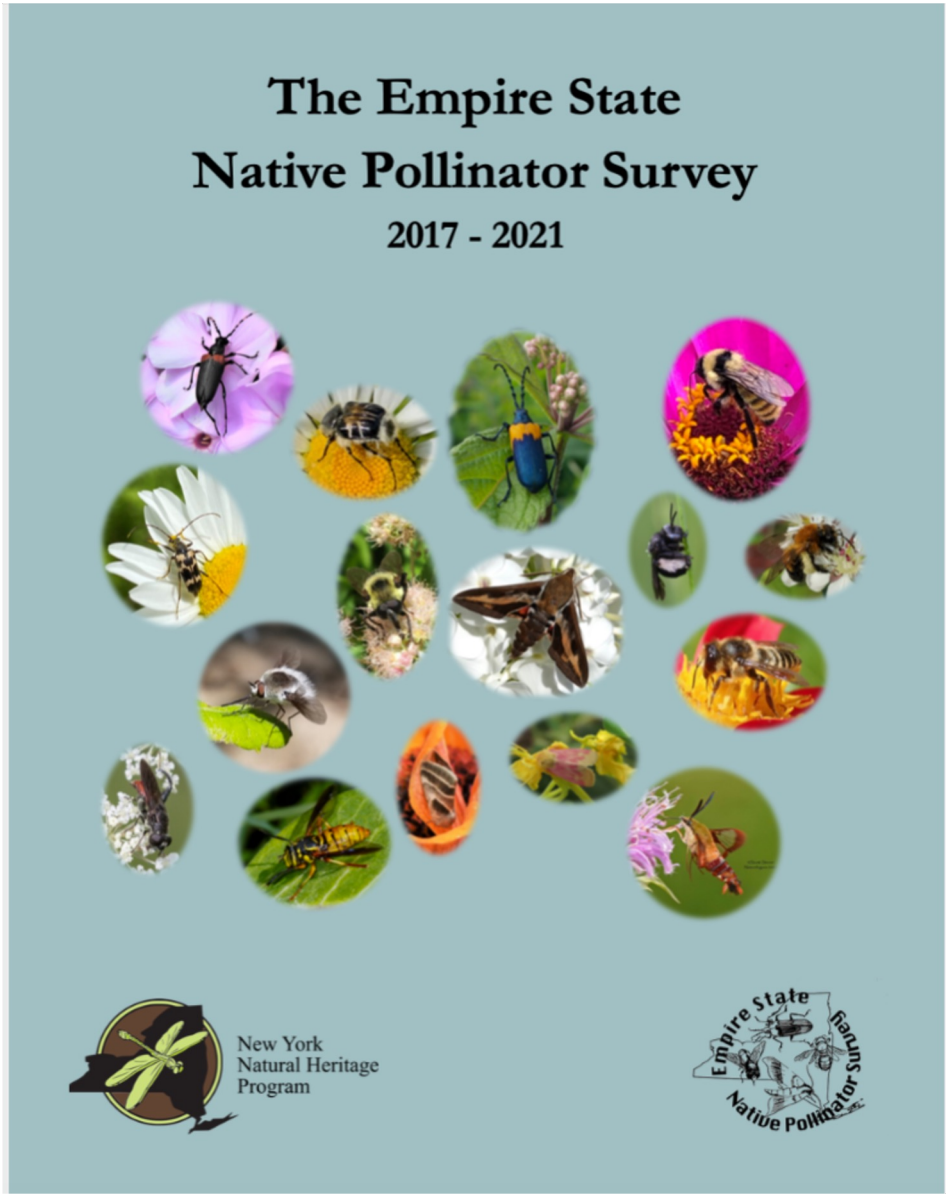
3) Corn & soybean yield in locations with neonic restrictions in place

Outline

1) New York risk-benefit report on neonicotinoid insecticides

2) Peer-reviewed literature since the NYS report

3) Corn & soybean yield in locations with neonic restrictions in place



“Using conservative criteria, 38% of New York’s native pollinators are at risk of extirpation from NY.”

https://www.nynhp.org/projects/pollinators/

Pollinators are having problems for multiple reasons

Pests & Pathogens

Agrochemicals

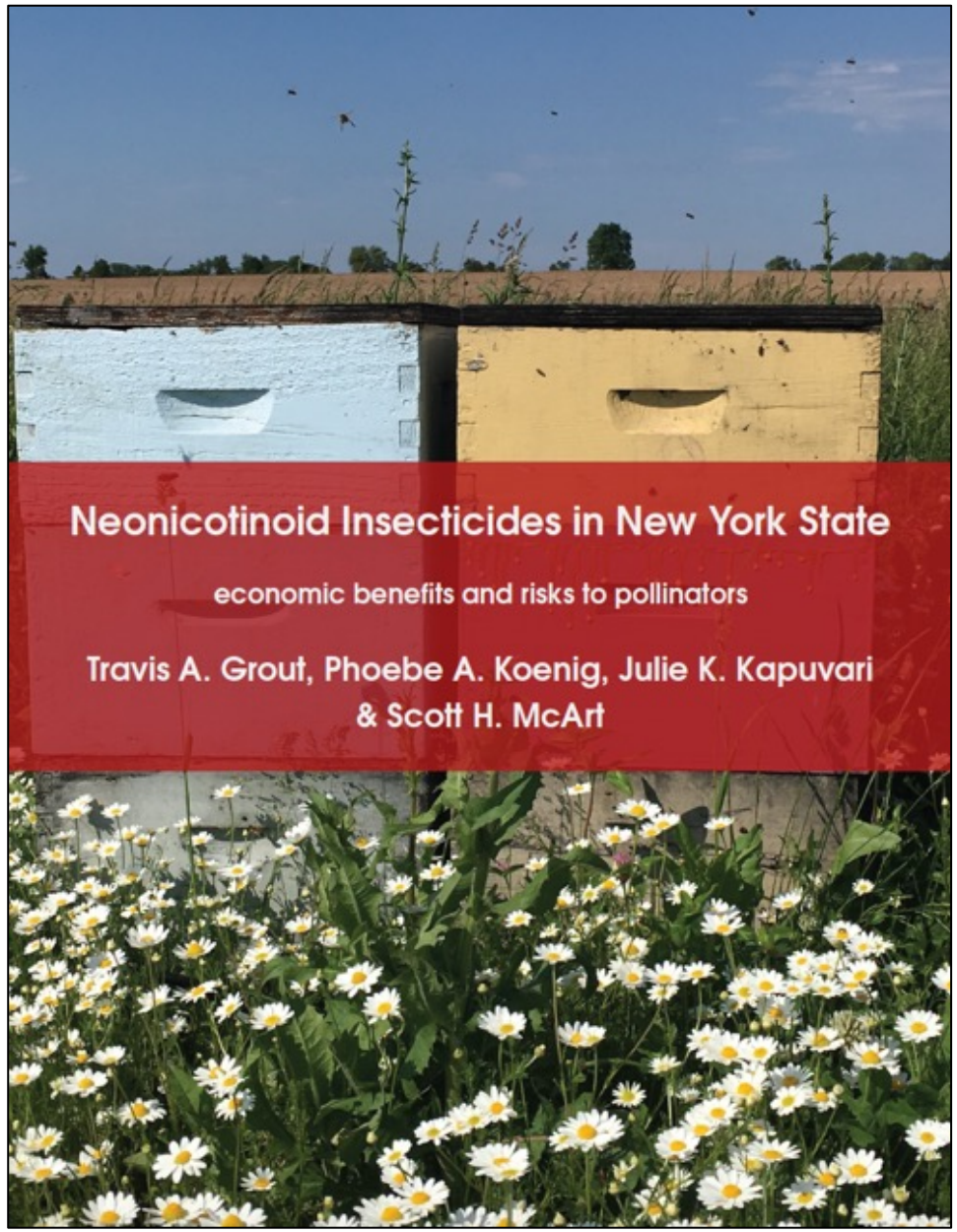
Climate Change

Management Practices

Habitat

Restrictions on neonicotinoid insecticides due to unacceptable risk to managed honey bees & wildlife

- **2013:** European Union prohibits use of neonics on pollinator-attractive outdoor crops
- **2017:** Ontario (Canada) restricts use of neonics on corn & soybean seeds
- **2018:** European Union prohibits use of neonics on all outdoor crops
- **2019:** Quebec (Canada) restricts use of neonics on corn & soybean seeds



432-page risk-benefit analysis

- Commissioned by Cuomo administration in 2018
- Side-by-side analysis of economic benefits and risks to pollinators in
  - **Field Crops** (corn, soybean, wheat)
  - **Fruit Crops** (e.g., apple, blueberry)
  - **Vegetable Crops** (e.g., squash, pumpkin)
  - **Ornamentals, Turf, & Landscape Management** (e.g., golf courses, ornamental plant nurseries)
  - **Conservation & Forestry**

Grout et al. 2020

https://cornell.app.box.com/v/2020-neonicotinoid-report

Notes from the Lab:

The Latest Bee Science Distilled

by Scott McArt and Travis Grout

Neonicotinoid insecticides: When there's risk to bees, when there are economic benefits to users, and when there are viable replacements

Neonicotinoid insecticides. If you're like many people who we interact with, you just read those two words and already have an opinion. Perhaps such a strong opinion that there's little point to us writing more.

But for those brave souls who are willing to wade into the science on neonicotinoids (neonics, for short), here's your chance. We just published a 432-page report in which we comprehensively synthesized all literature on risk to pollinators (>400 peer-reviewed studies regarding exposure to and effects from neonics) and economic benefits to farmers/applicators (>5,000 paired neonic/control field trials) for each context in which neonics are used. In addition, we summarized all application contexts in which neonicotinoid insecticides could be reliably replaced by alternative chemical insecticides or non-chemical pest control technologies or techniques.

So, for our thirty-third Notes from the Lab, we're going to summarize the main take-home messages from **"Neonicotinoid insecticides in New York: Economic benefits and risk to pollinators,"** written by us and freely available for download at: **https://pollinator.cals.cornell.edu/pollinator-research-cornell/neonicotinoid-report/**.

Why did we write this report? Two reasons. First, like many of you, we've been surprised by the lack of a comprehensive synthesis on this topic that's relevant to policy makers. A synthesis that quantifies risk to pollinators ***and*** benefits to farmers/applicators for each context in which neonics are used. There is potentially risk to pollinators from every chemical insecticide, and there are potentially economic benefits to users for every chemical insecticide. But how much risk is there from neonics? And how large are the benefits?

Second, here in New York, we have a governor and state agencies that are committed to ensuring our Pollinator Protection Plan (PPP) is more than just a list of guidelines. In addition to surveying wild pollinators, improving habitat, working with beekeepers to improve management practices, and many other actions, there is real money being put toward research on poorly understood or controversial topics, including pesticides. Since the state's PPP was initiated in 2016, New York has allocated $1.2 million to applied research so we can improve our understanding of factors shaping pollinator health. And that includes neonicotinoids.

Why is this report unique? The scope of the report is limited to direct economic benefits to users and risk to pollinators. Thus, it is intended to complement existing studies and risk assessments, particularly the comprehensive reviews of neonicotinoid active ingredients conducted by the U.S. Environmental Protection Agency (USEPA). At the same time, the report is unique (and hopefully useful for policy makers!) since it summarizes new analyses and quantifies benefits to users and risk to pollinators in a side-by-side manner for the five major application contexts in which neonics are used: field crops (corn, soybean, wheat); fruit crops (e.g., apple, strawberry, blueberry); vegetable crops (e.g., squash, pumpkin); ornamentals, turf, & landscape management (e.g., golf courses, ornamental plant nurseries); and conservation & forestry (e.g., control of hemlock woolly adelgid in forests).

OK, let's get to it. What did we find regarding risk to pollinators? For risk, lots of exposure data exist for field crops, while less is known regarding neonicotinoid exposures in tree fruits, vegetables, and turfgrass & ornamentals settings. And no exposure data exist that are relevant to pollinators in conservation & forestry settings. This means we have better insight about risk in field crops compared to all other settings.

Taking an LOEC approach to quantifying risk (i.e., using Lowest Observable Effects Concentrations from the peer-reviewed literature for neonic impacts on honey bees to set the bar for what's defined as risk), the 4-panel figure in Figure 1 shows when risk occurs in each setting. All the blue data points above the red line indicate risk, while all the data below the red line indicate no risk. In and near corn and

4-page summary in *American Bee Journal*

https://blogs.cornell.edu/mcartlab/files/2020/09/09-McArt-article_September2020.pdf

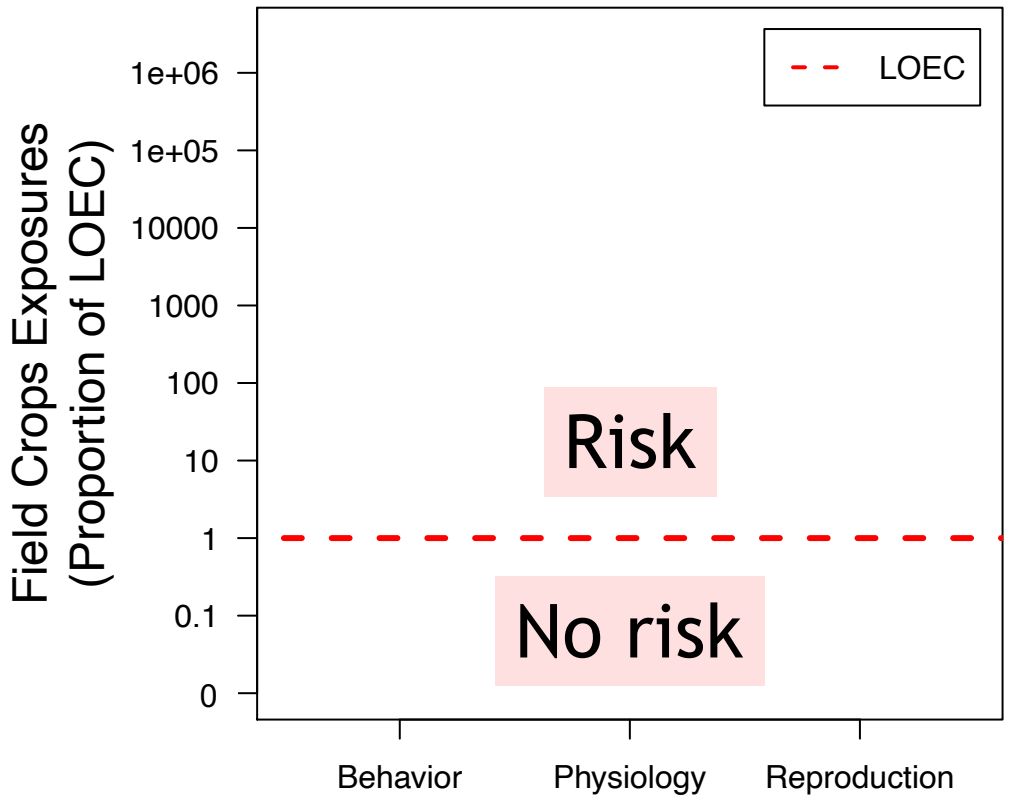
Methods for risk-benefit report

- Compiled every relevant study published in the peer-reviewed and University extension literature

- Risk to pollinators: 327 peer-reviewed studies
  - 169 quantitative neonic exposure assessments (44 studies)
  - 283 studies of quantitative effects of neonics on bee physiology, behavior, or reproduction

- Benefits to growers: >5,000 paired neonic vs. control field trials that assessed impacts on pest populations, crop damage, or yield

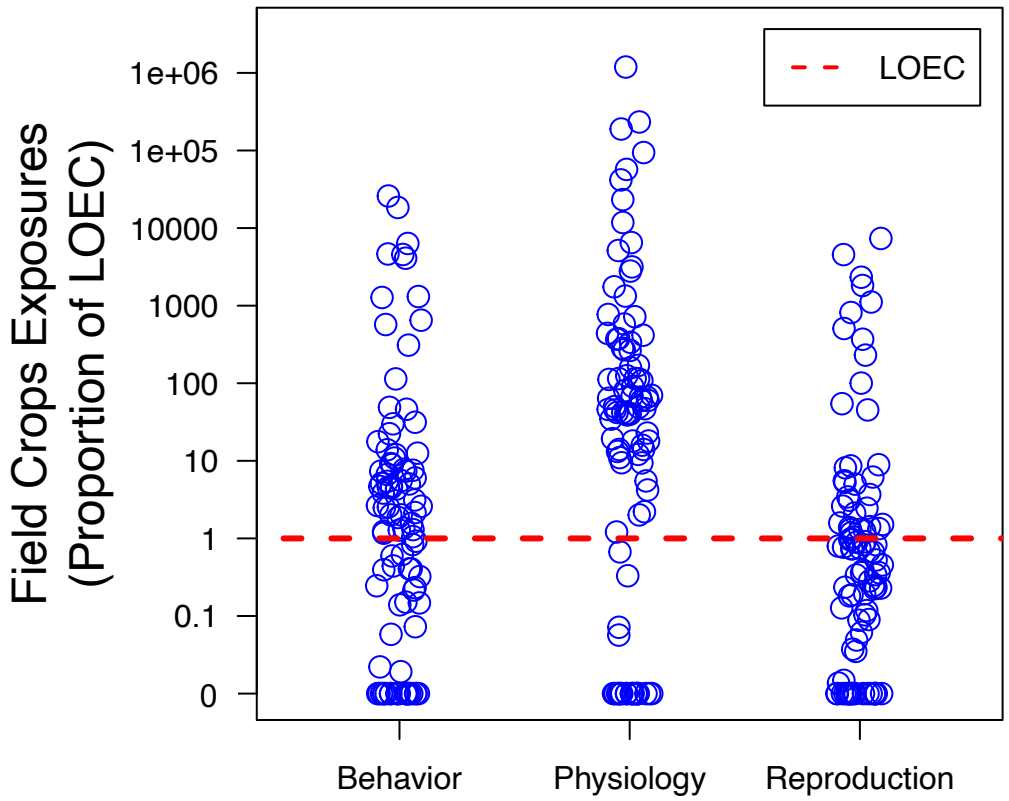
Risk to pollinators near corn & soybean fields?



Grout et al. 2020

https://cornell.app.box.com/v/2020-neonicotinoid-report

Frequent risk to pollinators near corn & soybean fields



Exposures predicted to impact

Physiology: 74%

Behavior: 58%

Reproduction: 37%

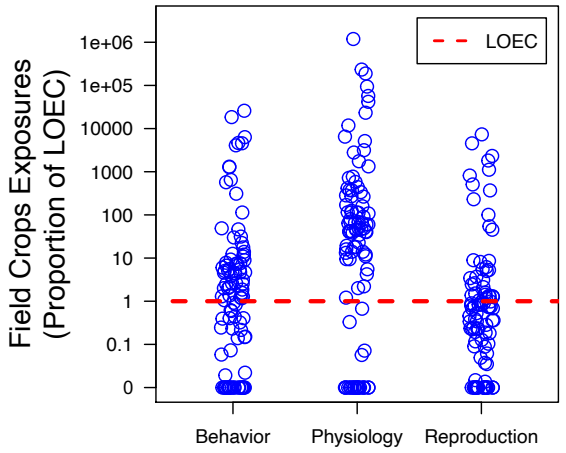
Grout et al. 2020

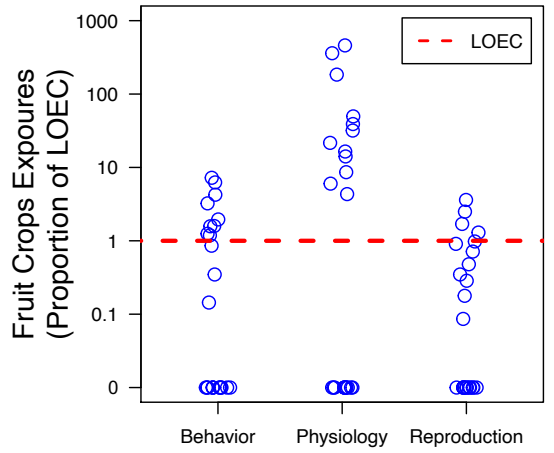
https://cornell.app.box.com/v/2020-neonicotinoid-report

Less data exist for fruits, vegetables, turf & ornamentals

Field crops (***n* = 96**)
74% physiology
58% behavior
37% reproduction

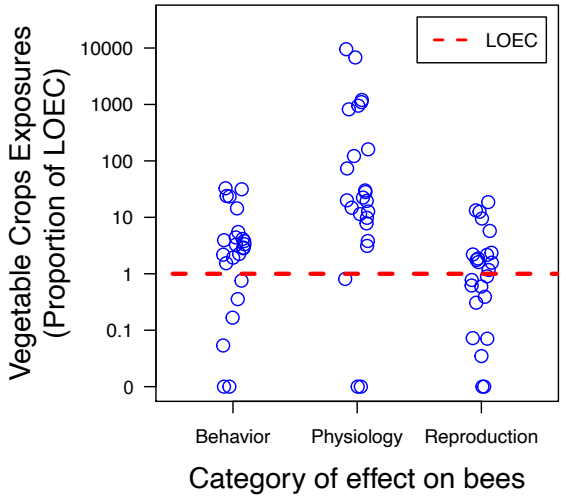
Clearest result

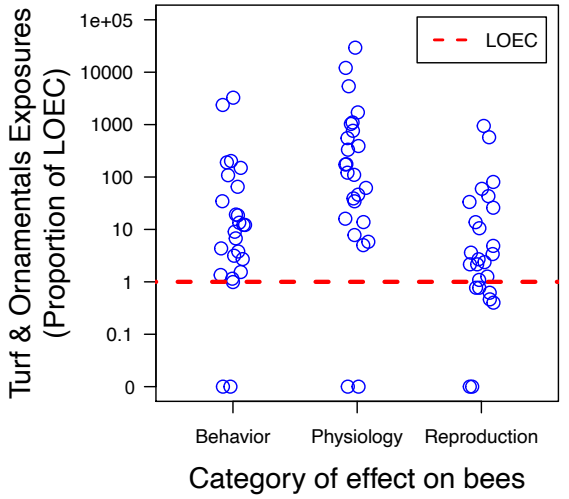




Fruit crops (***n* = 24**)
50% physiology
38% behavior
17% reproduction

Vegetables (***n* = 24**)
88% physiology
75% behavior
54% reproduction



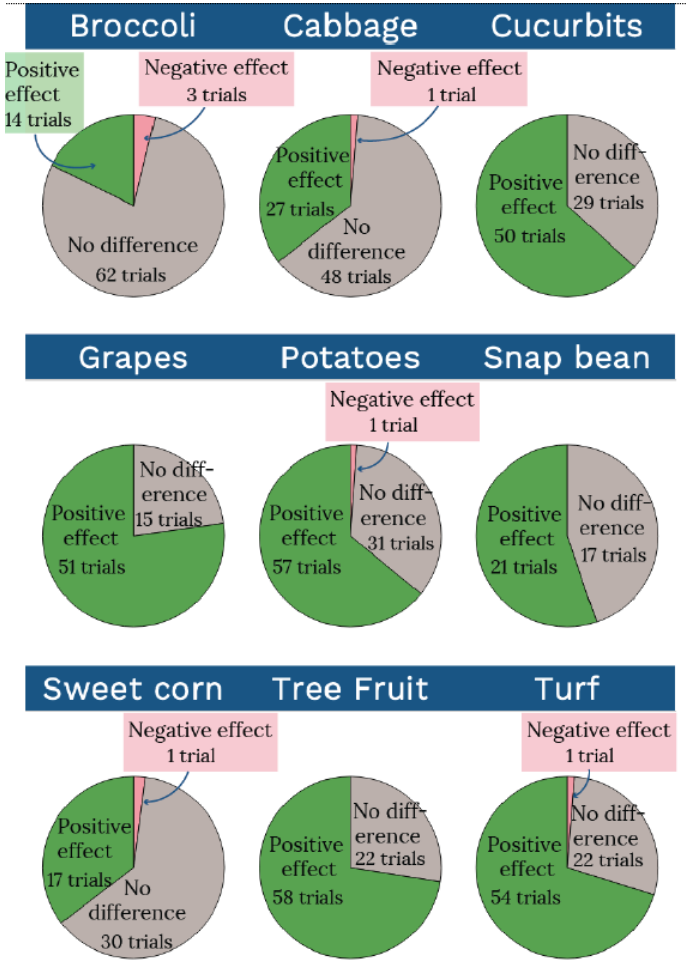


Turf & Ornamentals (***n* = 25**)
92% physiology
88% behavior
72% reproduction

Grout et al. 2020
https://cornell.app.box.com/v/2020-neonicotinoid-report

Good evidence for benefits of neonics on fruits, vegetables, and turf management

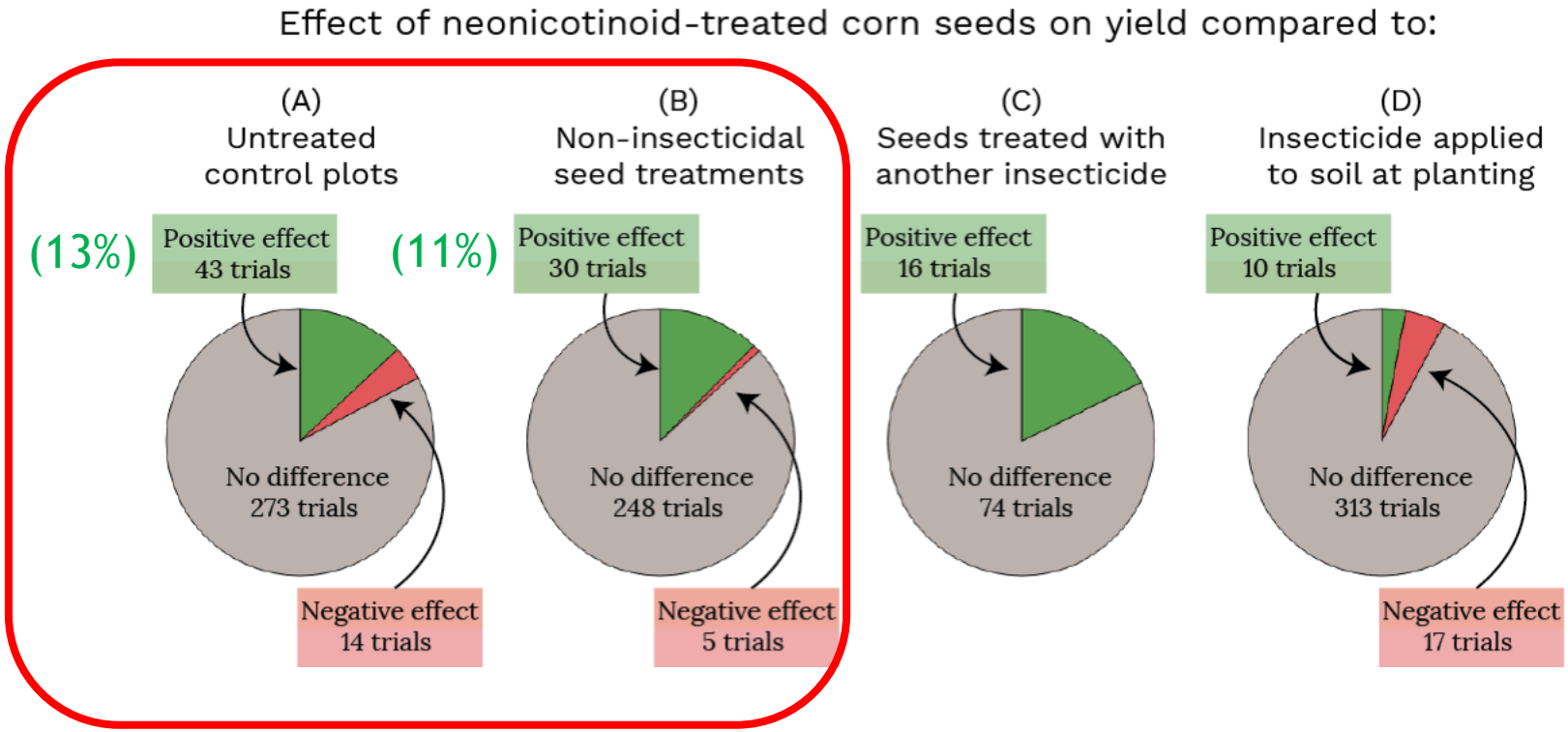
- Compared to no-insecticide controls, neonicotinoid-based products generally improve pest control, crop damage, or yield
- Effective chemical alternatives are available for most common pests
  - New chemistries such as anthranilic diamides
  - Old chemistries such as pyrethroids, organophosphates



Grout et al. 2020

https://cornell.app.box.com/v/2020-neonicotinoid-report

Limited evidence of benefits from neonic-treated corn seeds

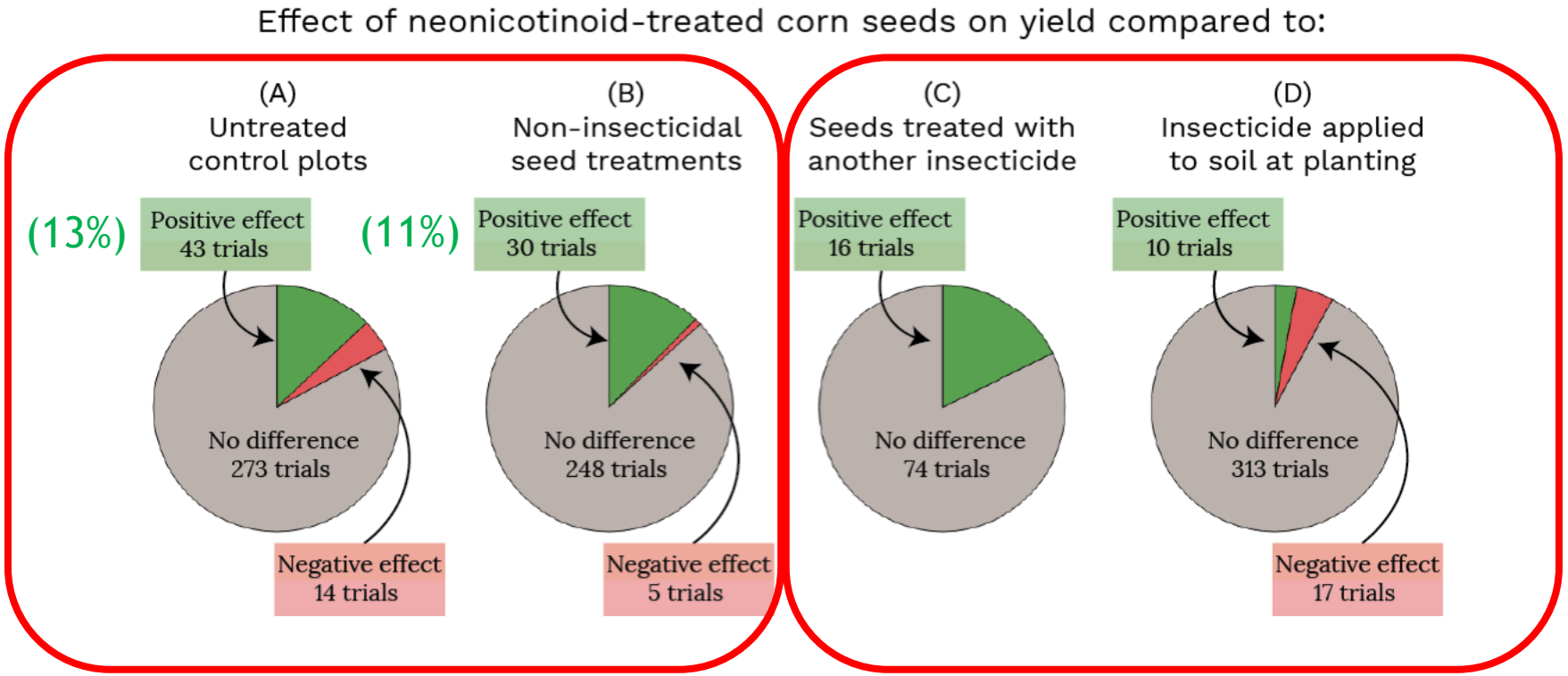


- 12% of trials observe increase in yield compared to controls
- ~50% of these trials make up for cost of seed treatment to experience economic benefit

Grout et al. 2020

https://cornell.app.box.com/v/2020-neonicotinoid-report

Limited evidence of benefits from neonic-treated corn seeds



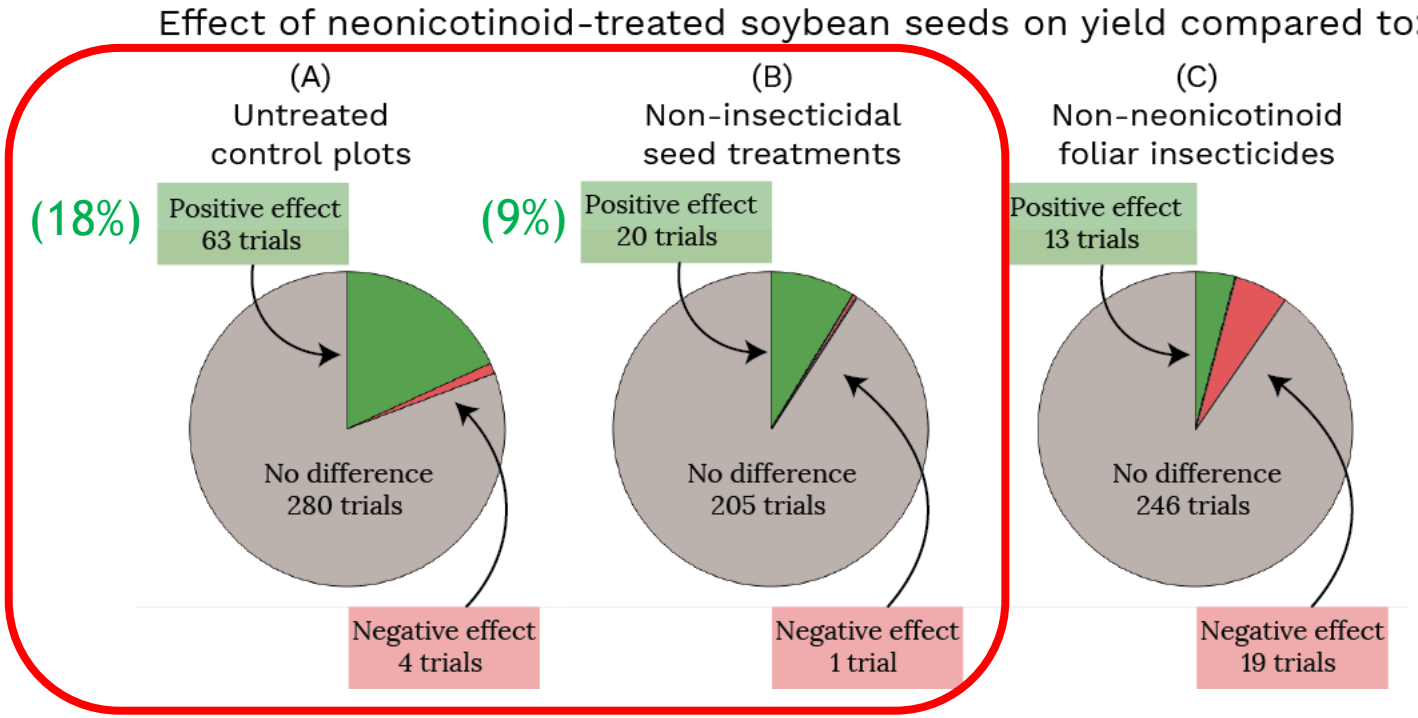
- 12% of trials observe increase in yield compared to controls
- ~50% of these trials make up for cost of seed treatment to experience economic benefit

- Anthranilic diamide seed treatments are viable replacement for neonics. Soil applications are also viable replacement.

Grout et al. 2020

https://cornell.app.box.com/v/2020-neonicotinoid-report

Limited evidence of benefits from neonic-treated soybean seeds

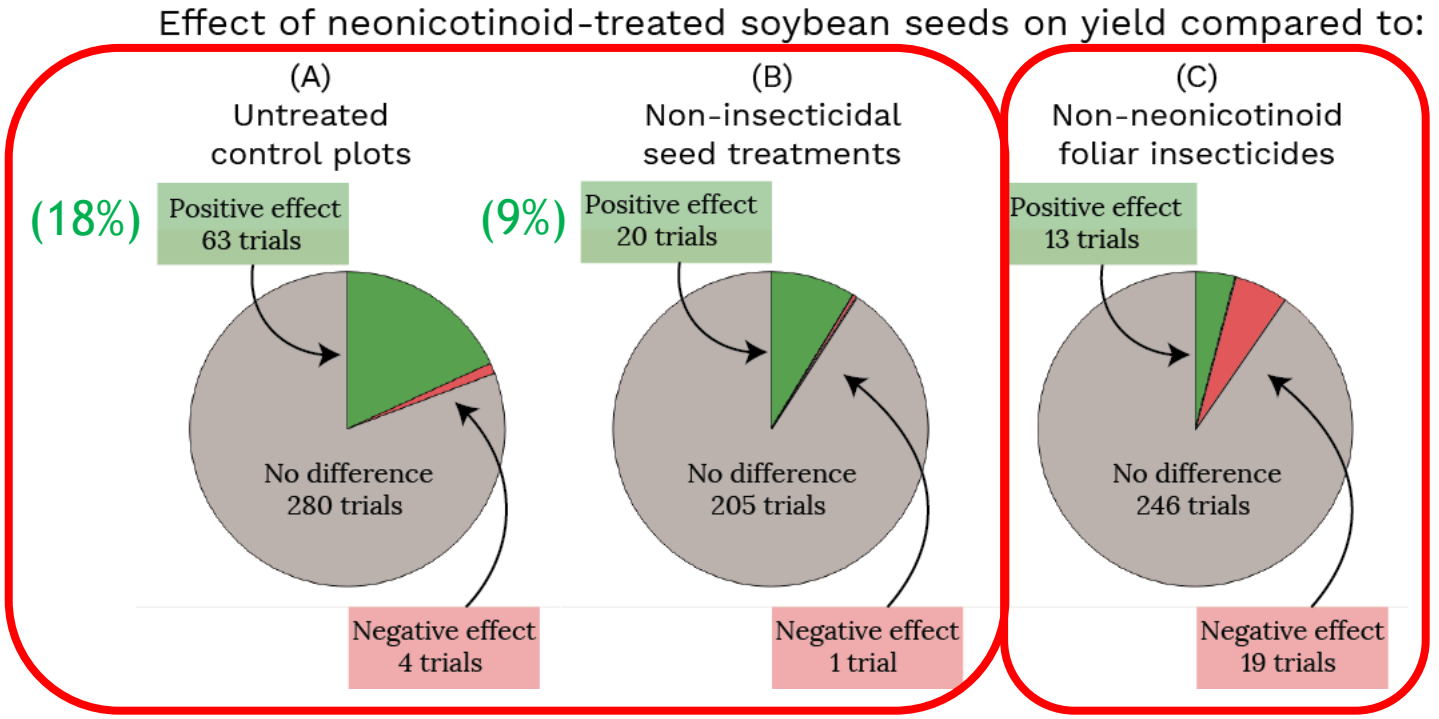


- 14% of trials observe increase in yield compared to controls
- ~50% of these trials make up for cost of seed treatment to experience economic benefit

Grout et al. 2020

https://cornell.app.box.com/v/2020-neonicotinoid-report

Limited evidence of benefits from neonic-treated soybean seeds



- 14% of trials observe increase in yield compared to controls
- ~50% of these trials make up for cost of seed treatment to experience economic benefit

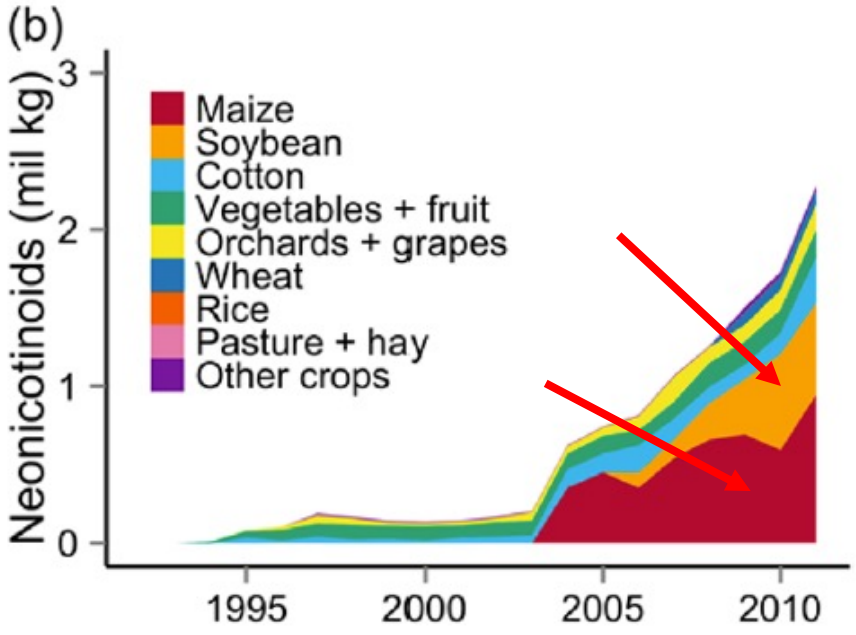
- Several non-neonic foliar sprays are effective. Similar to corn, anthranilic diamide seed treatments are viable replacement for neonics.

Grout et al. 2020

https://cornell.app.box.com/v/2020-neonicotinoid-report

Most neonic usage in USA is via corn & soybean seed treatments

- 79-100% cornfields and majority of soybean fields are planted with neonic seed treatments



Douglas & Tooker 2015 *Env. Sci. & Tech.*; Douglas et al. 2020 *Sci. Reports*

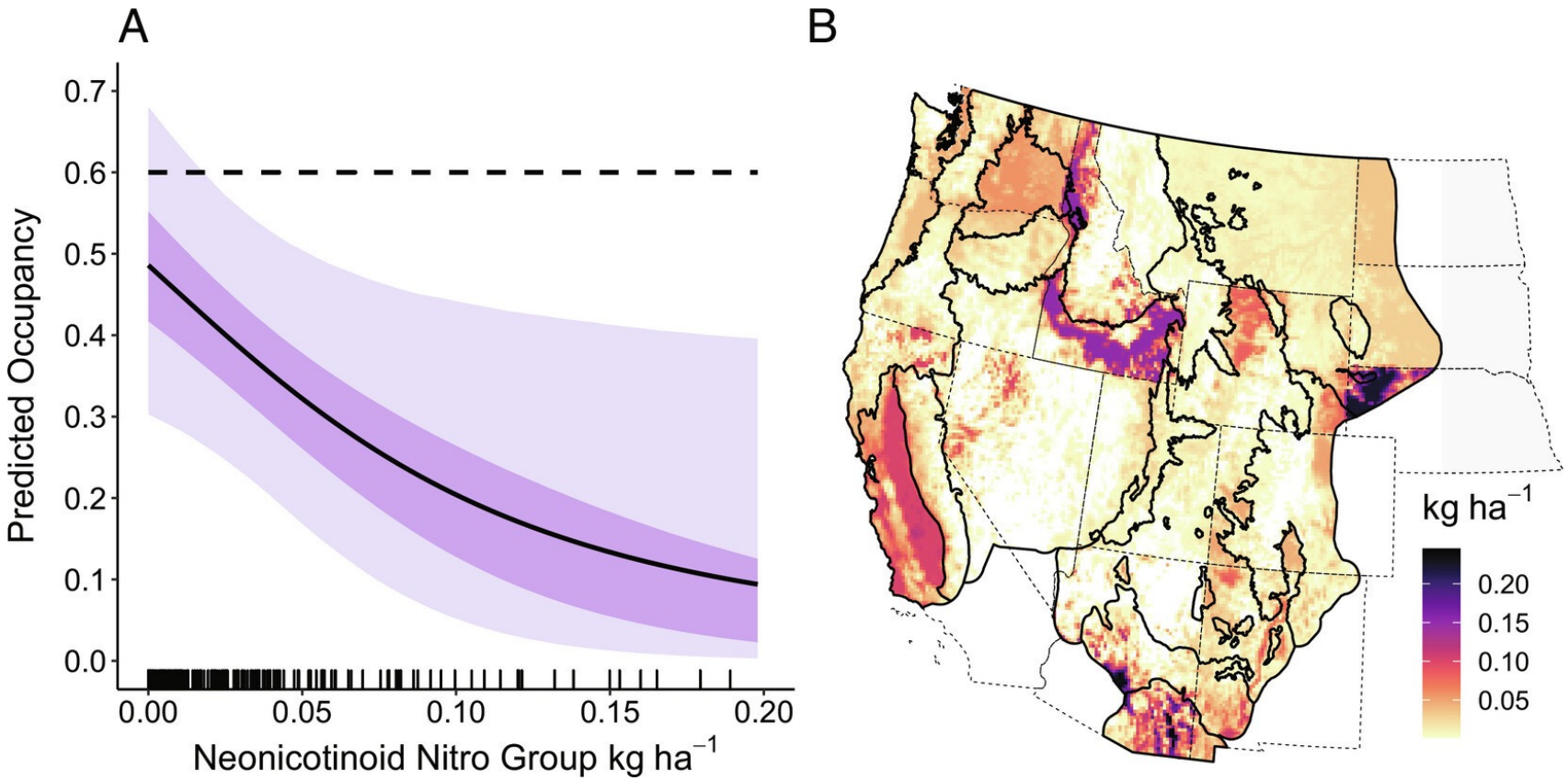
Outline

1) New York risk-benefit report on neonicotinoid insecticides

2) Peer-reviewed literature since the NYS report

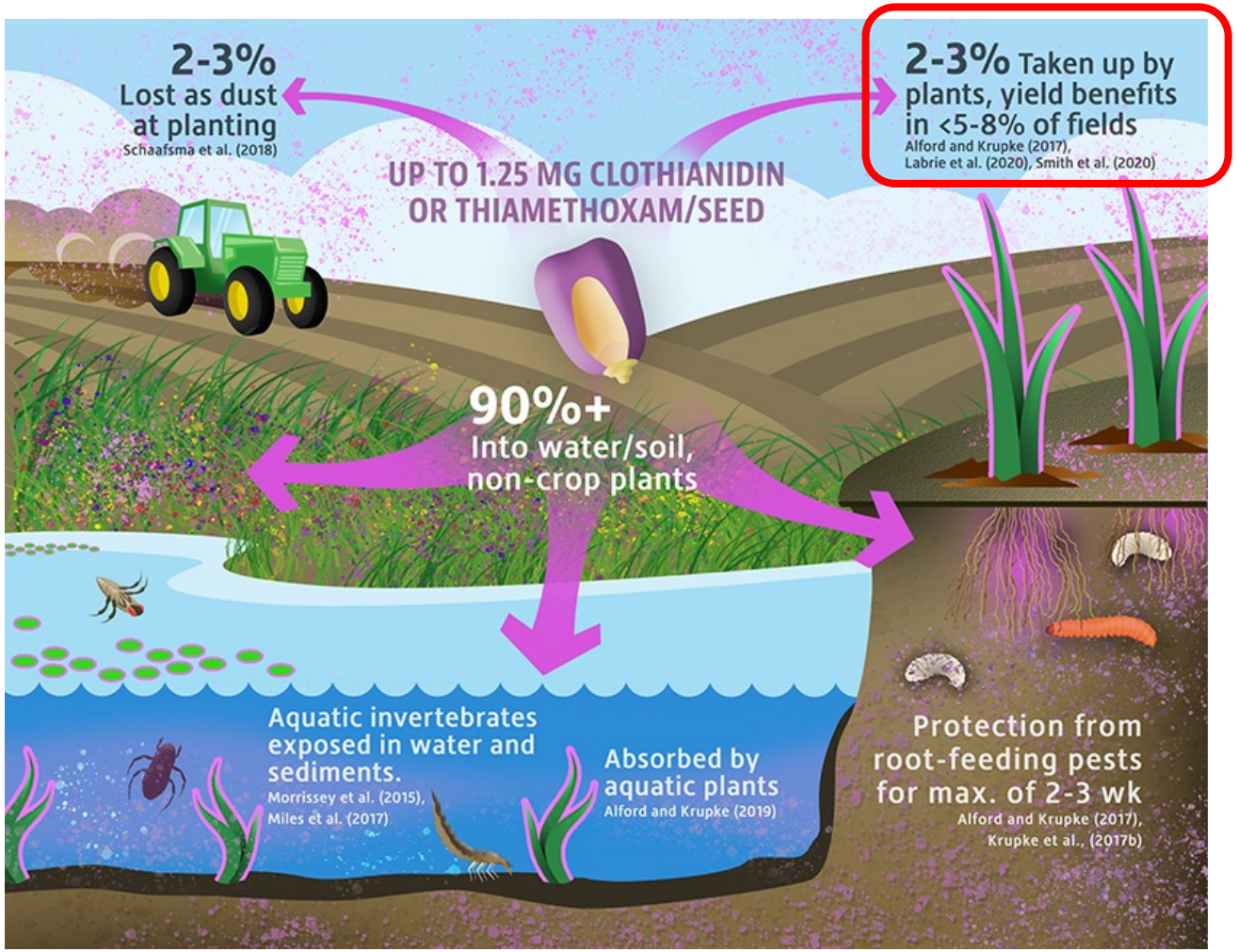
3) Corn & soybean yield in locations with neonic restrictions in place

Neonic usage predicts decline of the western bumble bee (*Bombus occidentalis*)



Janousek et al. 2023 *Proc Nat Acad Sci*
https://doi.org/10.1073/pnas.2211223120

Largest studies ever conducted on neonic seed treatments show benefits in <5-8% of corn & soybean fields



Purple represents fate of neonicotinoid treatment in crop plants and the environment

Krupke & Tooker 2020 *Front. Sust. Food Syst.* https://doi.org/10.3389/fsufs.2020.595855

Labrie et al. (2020) study from Quebec

PLOS ONE

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

Impacts of neonicotinoid seed treatments on soil-dwelling pest populations and agronomic parameters in corn and soybean in Quebec (Canada)

Geneviève Labrie, Annie-Ève Gagnon, Anne Vanasse, Alexis Latraverse, Gilles Tremblay

Published: February 26, 2020 • https://doi.org/10.1371/journal.pone.0229136

Article | Authors | Metrics | Comments | Media Coverage

Four years of paired neonic-treated vs. control fields

- 84 corn & soybean sites
- <5% sites experience yield benefit from neonic-treated seeds

Labrie et al. 2020 *Plos One* https://doi.org/10.1371/journal.pone.0229136

Smith et al. (2020) study from Ontario

JOURNAL ARTICLE

Quantifying Early-Season Pest Injury and Yield Protection of Insecticide Seed Treatments in Corn and Soybean Production in Ontario, Canada FREE

Jocelyn L Smith ✉, Tracey S Baute, Arthur W Schaafsma

Journal of Economic Entomology, Volume 113, Issue 5, October 2020, Pages 2197–2212, https://doi.org/10.1093/jee/toaa132

Published: 11 July 2020 **Article history** ▾

Four years of paired neonic-treated vs. control fields

- 129 corn sites, 31 soybean sites
- 8% corn sites experience yield benefit from neonic-treated seeds
- 6% soybean sites experience yield benefit from neonic-treated seeds
- Financial cost of neonics recouped in 3-4% of fields

"These data highlight an opportunity for reducing input costs, environmental loading, and nontarget effects without adverse outcomes for Ontario producers." **- Smith et al. (2020)**

Smith et al. 2020 *J. Econ. Ento.* https://doi.org/10.1093/jee/toaa132

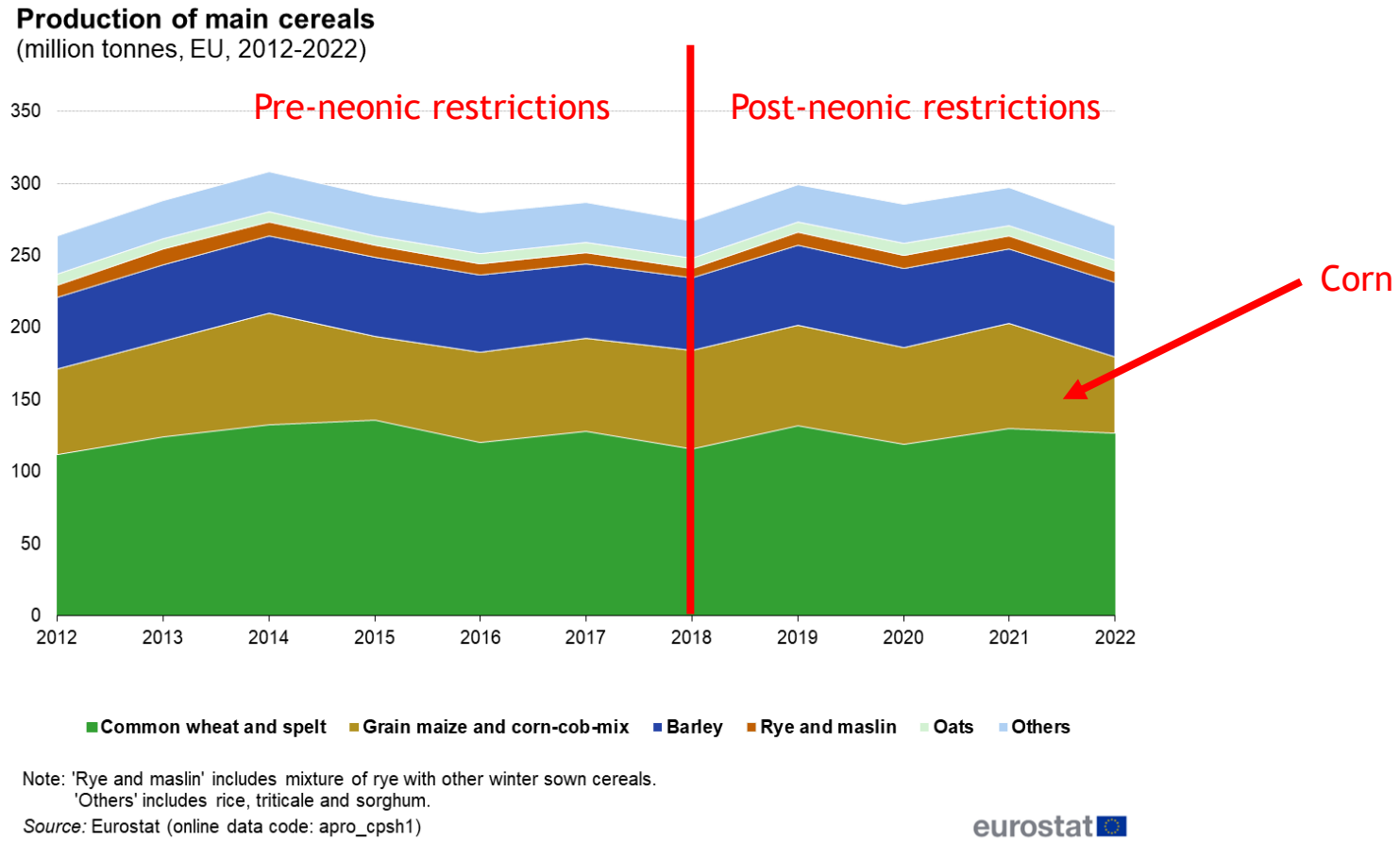
Outline

1) New York risk-benefit report on neonicotinoid insecticides

2) Peer-reviewed literature since the NYS report

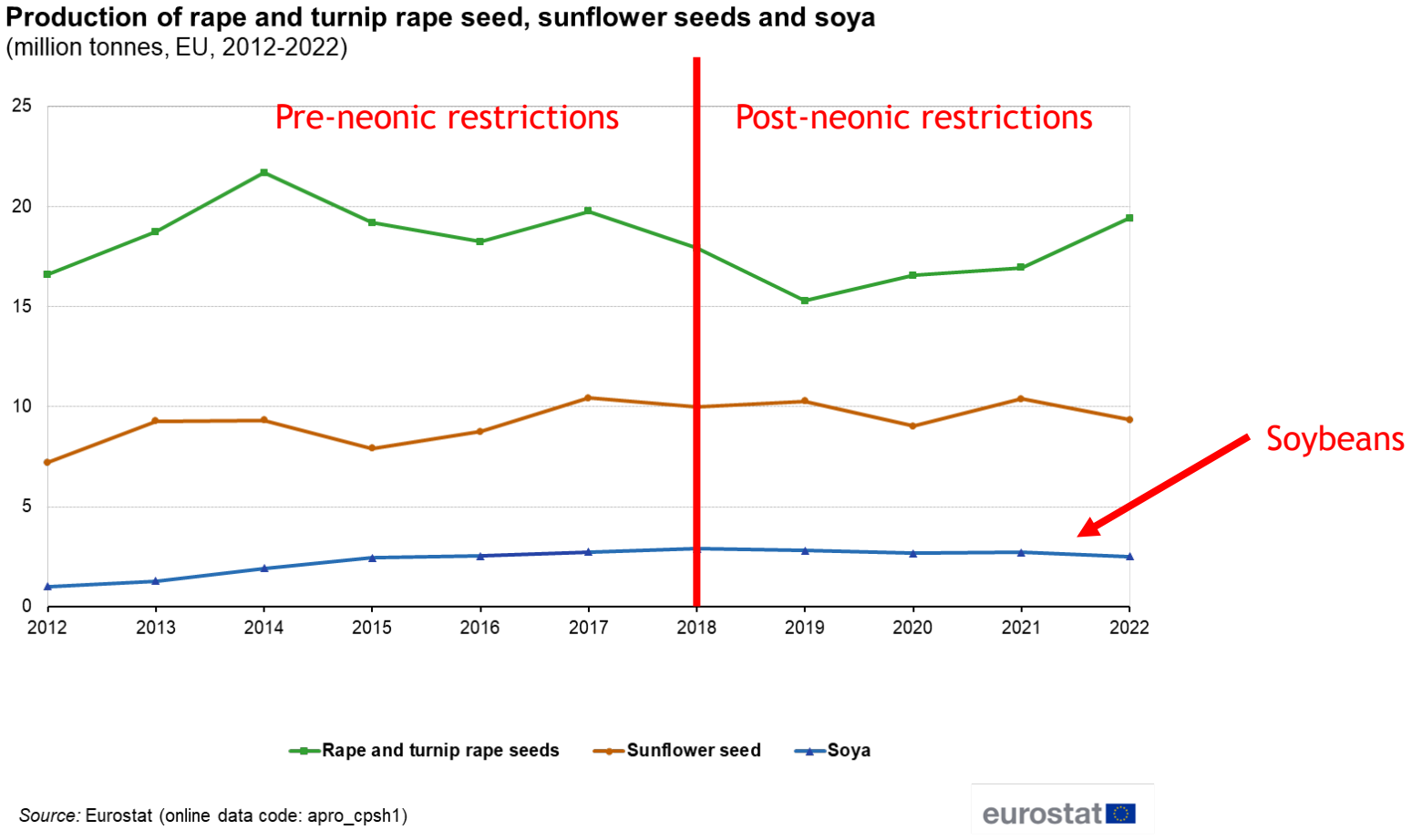
3) Corn & soybean yield in locations with neonic restrictions in place

Corn yield has not changed in the EU since restrictions on neonics



Eurostat Agricultural Production - Crops.
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agricultural_production_-_crops#Cereals

Soybean yield has not changed in the EU since restrictions on neonics



Eurostat Agricultural Production - Crops.
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agricultural_production_-_crops#Cereals

Corn & soybean yield have *increased* in Ontario since restrictions on neonic seed treatments

Year	Average corn yield (bushels per acre)	Total corn production (metric tonnes)		Year	Average soybean yield (bushels per acre)	Total soybean production (metric tonnes)
2011	152	7,722,000		2011	47.6	3,189,700
2012	153.2	8,598,300		2012	48.3	3,401,900
2013	160.5	9,007,300		2013	45.9	3,238,600
2014	160.4	7,600,000	Pre-neonic restrictions	2014	45.5	3,791,100
2015	169	8,928,500		2015	46.8	3,728,500
2016	156.4	8,382,400		2016	45.5	3,429,200
2017	167	8,738,000		2017	45.6	3,796,600
2018	166	8,767,900	Post-neonic restrictions	2018	51.4	4,200,500
2019	158.4	8,640,600		2019	44.1	3,708,200
2020	163.9	8,908,800		2020	50.7	3,908,700
2021	175.2	9,722,436		2021	51.9	3,955,870
2022	166	9,440,801		2022	48	3,996,015
2023	170.9	9,632,314		2023	51.4	4,036,036

Statistics Canada, Table 32-10-0359-01
https://doi.org/10.25318/3210035901-eng

Please be wary of disinformation

Since releasing our risk-benefit report in 2020, numerous people have attempted to sow doubt on the science, including:

- Scientists representing Bayer
- Scientists representing BASF
- Scientists representing the Competitive Enterprise Institute
- CropLife America
- The New York Agribusiness Association
- The New York Post
- The New York Farm Bureau

Questions?

McArt Lab

Wee Hao Ng
Wayne Anderson
Kate LeCroy
Maureen Page
Angélica Sanchez
David Sossa
Maria Van Dyke
Christina Zhao
Tomas Quezada
Kaitlin Deutsch
Tobias Mueller
Leah Valdes
Ben DeMoras
Talli Weiss
Lauren Cody

@McArtLab

http://blogs.cornell.edu/mcartlab/

NIH National Institutes of Health

USDA United States Department of Agriculture National Institute of Food and Agriculture