Protecting honeybees and wild bees from neonicotinoid pesticides? As environmentalists and politicians lobby for bans, science takes a backseat

There has been a recent surge in the number and intensity of campaigns by environmental groups lobbying to ban many farm pesticides, which they claim is causing widespread declines in the global bee population. In June, the New York State legislature passed a first-in-the-nation bill that would cut by 80-90% the use of neonicotinoids, a class of pesticides that has become enormously popular among farmers. The bill is sitting on the governor's desk, while pressure from activists to sign the measure into law is escalating. It's one of many bills being debated in legislatures around the country and in Europe, as advocacy environmental groups step up their campaigns to ban one of the most popular pesticides used by farmers globally — and one without a viable replacement.

"Neonics—the most widely used insecticides in the country—are best known for their lead role in mass losses of bees and other pollinators," claims the Natural Resources Defense Fund in a news release celebrating the bill's passage.


soybean planting on bill horan farm
Credit: DTN

Facts behind the claims

There have been no "mass losses" of honeybees linked to neonicotinoids, anywhere in the world. Global honeybee populations are now at record highs. It's estimated there are about 80-100 million managed beehives. According to the UN's Food and Agriculture Organization, the number of bee colonies worldwide reached 101.6 million in 2021, a 47% increase since 1990.

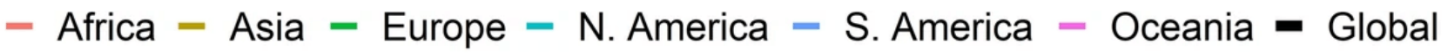
The steady increase doesn't mean there are no health challenges. Moved from farm to farm in trucks, health is always an issue for managed bee populations, which are a form of livestock. There have also been periodic outbreaks of "colony collapse disorder" (CCD) in which a disproportionately large percentage of managed honeybees die over a winter or two. However, and despite claims by many advocacy groups, CCD is a unique phenomenon; it is not the same as colony health issues caused by infestation from *varroa* mites and *Nosema* parasites', nutrition, diseases and in some cases by farm chemicals.

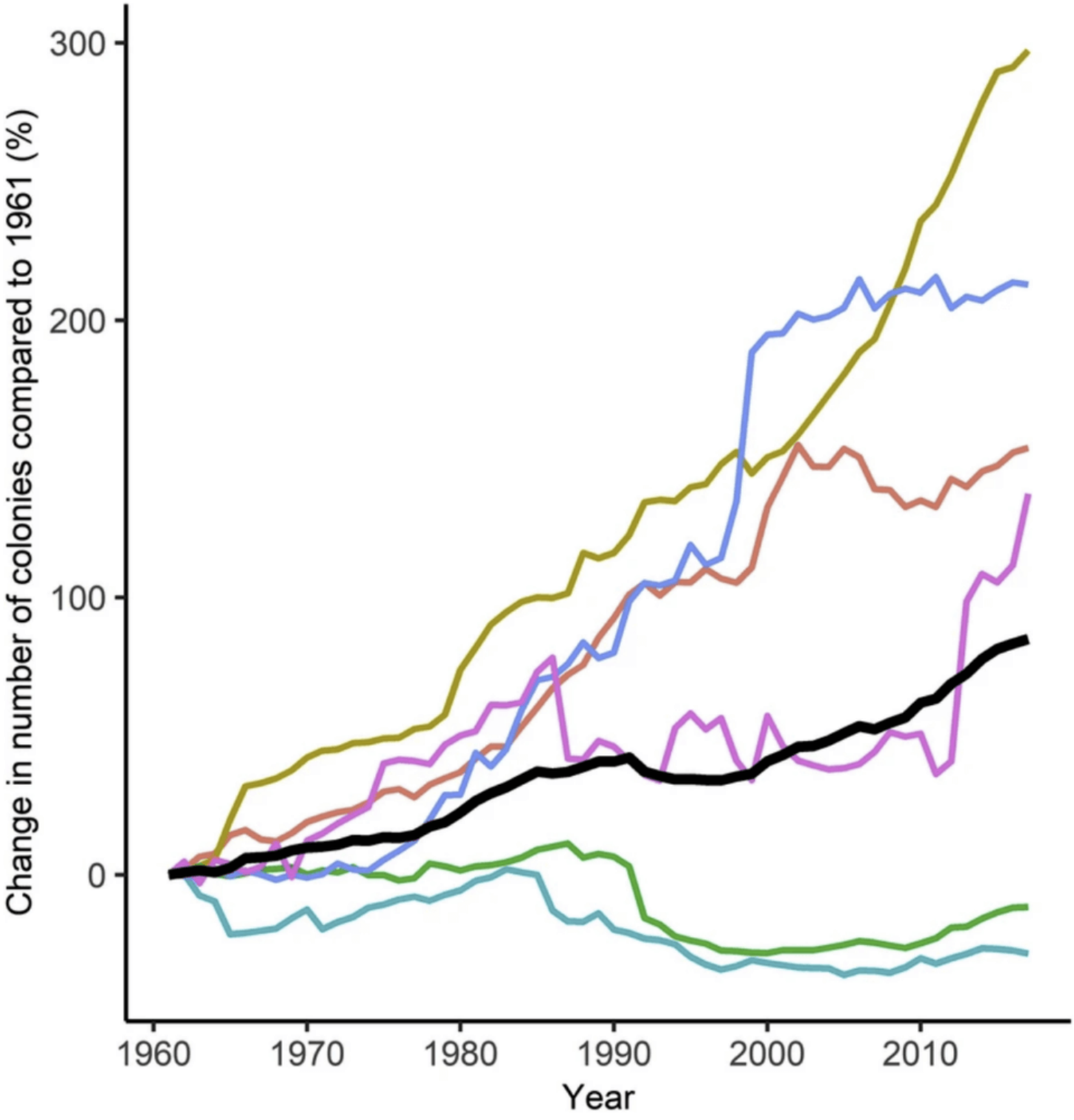
As the Environmental Protection Agency and many independent studies document, CCD is a unique and still unexplained phenomenon with no known connection to chemical usage. There are reports of periodic occurrences going back a century and a half, well before the use of synthetic pesticides. CCD was documented as early as 1869, in the UK in 1906, and in the US in 1918-19 and 1965, The most recent CCD outbreak, over the winter in 2006-2007, led to a record low number of US honeybee colonies followed by a rebound. Honey colonies in North America jumped from 2.3 million in 2000 to 2.7 million twenty years later, according to the USDA. Despite claims by NRDC and other environmental activists, bees have not undergone "mass losses" caused by pesticides, neonicotinoids in particular.

Taking a longer view, from 1961 to 2017, the trend is even more sanguine. A 2022 trend study in NatureResearch Scientific Reports found:

> ….there have been increases in the number of managed honey bee colonies (85.0%), honey production (181.0%) and beeswax production (116.0%). The amount of honey produced per colony increased by 45.0%, signifying improvements in the efficiency for producing honey.

In 2022, Nature Scientific Report charted the number of bee colonies over roughly the same period. They have trended steadily upward in most countries, and the global numbers, represented below in black, are at all-time high.




Change in number of colonies compared to 1961 (%)
300
200
100
0
1960
1970
1980
1990
2000
2010
Year

What about activist claims that neonicotinoids are devastating bee populations?

Activists point out (and it's reflected in the chart above) that bee hive numbers have fallen over the last 60 years in North America and Europe, where farmers have widely used the pesticide. But that's cooking the books. While hive numbers in those two regions did fall sharply beginning in the mid to late 1980s, that was well before neonics were introduced into the market. The steep drop coincides with the invasion in both regions in the mid-to-late 1980s by the deadly varroa mite, which the USDA and entomologists believe is the main driver of bee health problems. As for neonics, the ones blamed by activists for "killing bees" were not widely used in the US until the mid-to-late 1990s and were not approved for use in Europe until 2005 — in both regions, well after the recovery began in hive numbers. There have been almost no varroa mite infestations in Africa, Asia South America or Oceania where hive growth has been steadily rising.

Globally, crunching FAO data, Germany's independent Statistisches Bundesamt" concludes,"Beekeeping and apiculture have … increased significantly worldwide in recent decades", documenting a 47% increase in bee hives since 1990 alone to a record global high.

Many experiments have reasonably confirmed that bees are weakened by exposure to chemicals, including insecticides used to target varroa mites. Neonics are not used to ward off or kill mites. There have been numerous small laboratory studies that do suggest that neonics might cause bees harm based on one or another set of circumstances. That's the basis for the concerns and legislation. But far more robust field studies — at least 18 so far — have consistently shown the opposite: little to no observable adverse effects at the colony level from field-realistic exposures.

The hard facts have not prevented neonics from becoming a hot political issue. Advocacy groups and now many politicians repeatedly claim that neonicotinoids are "killing bees" but don't provide links to definitive research; the NRDC news release links only to news articles, but not one peer reviewed study. A US House measure introduced in 2021 with 38 co-sponsors states that neonics "are a key factor in the decline of bees." That's false; the UN FAO and independent studies document that there has been a steady increase in the number of bees and hives since the class of pesticides was introduced.

Why the discrepancy between the findings of the mainstream entomology community and claims by politicians and advocacy organizations? Sloppy, and perhaps ideologically-driven, science. According to a 2022 paper in Nature Scientific Reports: synthesizing dozens of field and laboratory studies:

> Headlines of honey bee colony losses have given an impression of large-scale global declineof the bee population that endangers beekeeping and that the world is on the verge of mass starvation. However, the stories are usually based on research reports limited to one or few countries with observations over a relatively short period of time. A large proportion of cited scientific literature on honey bee mortality originates from Europe and North America, creating some sort of publication bias. Further, the research reports are focused on managed honey bees, *Apis mellifera* in particular, with little or no information on non-managed bees.

What about wild bees?

Here the issue becomes grayer, more nuanced. As the Nature article makes clear, there is "little or no information on non-managed bees… [E]xtrapolation of findings from these reports to the global bee population is somewhat inaccurate."

There are about 4,000 species of wild bees in the US and an estimated 20,000 worldwide. Wild bees are ecologically important and key to parts of our food supply. Honeybees can't pollinate tomatoes, eggplants, and peppers, for example. They require "buzz pollination" in which bees vibrate their bodies to shake pollen free — a behavior that bumblebees and some other native species can by honeybees cannot. Except for a handful of species, few wild bee species live in hives or colonies like honeybees, so they are more vulnerable. After all, they don't enjoy the limited defenses of the colony against adverse pesticide effects, so the prospect of dire consequences to wild bees from chemicals does seem somewhat plausible.

Because data are almost nonexistent, almost anything could be claimed about their health status and the supposed harm from pesticide exposure. Who could persuasively demonstrate otherwise? Let's review the little that scientists know about wild bee health.

The vast majority of wild bee species, at least in North America, live in habitats — mostly near deserts — where they never come near agricultural crops to risk appreciable exposure to farm chemicals. How many species are in 'high spray' areas? According to a Nature Communications study, only 2% of wild bee species account for 80% of all crop visits by wild bees. And these wild bee species — which obviously face the greatest chemical exposure — are by and large thriving.

Evidence from studies in the United Kingdom and the Netherlands, both population-dense countries, indicate that particular wild bee species once considered to be in decline are now rebounding; at least up to a certain point. Likewise, a 2013 study in the Proceedings of the National Academy of Sciences that analyzed U.S. native bee populations over a 140-year period found that of the 187 U.S. native bee species analyzed individually, only three experienced steep declines. All three of these were of the genus Bombus (bumblebees). Otherwise, according to the research, "despite marked increases in human

population density and large changes in anthropogenic land use, aggregate native species richness declines were modest outside of the genus Bombus."

The genus Bombus is known to have suffered from pathogens introduced, in all likelihood, from managed bumblebee or honeybee operations. There is well-documented spread, or "spillover," from managed honeybees to wild bee populations. But it's not from pesticides.; it's from disease. Dense colonies of honeybees can be reservoirs for viruses and other microbes. University of Vermont researchers have demonstrated that health spillover originates from bumblebees foraging among flowers previously visited by honeybees infected by viral diseases, like from the varroa mite.

Another contributing factor is climate change. A 2015 article in Science determined that climate change is endangering various bumblebee species in North America, but the "effects are independent of changing land uses or pesticide applications." Urbanization and other human development may also contribute to the loss of wild bee habitats, this and numerous other studies have found.

Considering the challenges to wild bees, it's perhaps understandable that alarms are being rung about threats to honeybees. But the evidence of widespread threats to wild bees linked to farm chemicals is almost non-existent. Why don't environmental groups represent the issues more factually? It's likely that at least part of the reason is that creating scares about pollinators have become a potent fund-raising tool.

Urbanization and wild bees

As the world becomes more urbanized, fast-evolving habitats in cities, suburbs and ex-urbs may well be pitting European honeybees against wild bees. A 2017 study in *Ecosphere* by German scientists looked at 24 agricultural landscapes in seven European countries. They found that habitat "richness" (a higher number of plant species), enhances the bees' ability to pollinate. "Our findings demonstrate that landscape properties affect plant and bee communities in both direct and indirect ways," the researchers concluded.

That kind of interaction is increasingly less common as urban sprawl increases, particularly in people-dense Europe and sections of North America. A 2022 study from York University in Toronto used whole genome sequencing on one species of wild bee (*Ceratina calcarata*). It showed decreased genetic diversity and elevated inbreeding in urban environments. Dense areas also seemed to increase pathogen diversity, which meant that bees were exposed to many different types of pathogens. Green spaces that included shrubs and scrubby plants did boost bee diversity, although marginally.

Kit Prendergast, a bee researcher in Western Australia, has conducted a number of studies looking at competition between wild and European honeybees in Australian suburbs and cities. In her 2021 study

published in the *Biological Journal of the Linnean Society,* she found that competition can take numerous forms, and honeybees don't always dominate their wild cousins. Also, native richness could vary year over year. This all makes sense when using an ecological lens: competition occurs when resources are limited. Honeybees outcompeted native bees, which have higher food requirements. The disparity was enhanced when there were insufficient resources to sustain both the introduced honeybee competitors and the indigenous native bees.

"Competition all relates to the amount of resource required by each competitor, and the size of the population of each competitor," Prendergast told us in an email interview.

In most cities in Europe, there are many gardens with rich sources of flowers. But many of these flowers are exotic and few are native plants. Her study revealed that more flower species actually gave honeybees a competitive edge.

Honeybees not only compete with native bees, they disrupt native pollination networks. Again, these impacts are exacerbated in urban gardens, whereas coexistence is more likely in natural vegetation patches. In 2023, Prendergast published a study in *Pacific Conservation Biology* that showed native plants in more natural habitats got more visits from native bees. She also identified 10 "most visited" native plants that attracted wild bees in the city of Perth, Australia, known for its biodiversity. These included:

- *Jacksonia furcellata, J. sericea, J. gracillima* and *J. sternbergiana*— mostly leafless broom-like flowering shrubs or small trees
- *Melaleuca lanceolata*, and *M. huegelii*—commonly known as paperbarks, honey-myrtles or tea-trees, members of the myrtle family
- *Corymbia callophyla* and *C. ficifolia*— commonly known as marri, flowering plants that are also in the myrtle family
- *Gompholobium aristatum*—known as glory peas or wedge-peas, plants in the pea family
- *Thryptomene saxicola*—flowering shrubs in the myrtle family

Obviously, native plants vary by region. What thrives in Western Australia won't in Northern Australia, or in California, Ontario or southern France. And, especially in cities, exotic plants (like salvia or basil) are better than bare ground.

Another rarely mentioned problem for native bees is the explosion in the numbers of amateur beekeepers, many of whom believe they are doing their part to 'save the bees'. Often their hobby does just the opposite. Too many times, "backyard beekeepers" accidentally let honeybees swarm, and many of those bees become feral. They then become yet another source of competition for wild bees. They also overtake hollows needed by native fauna like parrots, owls and possums.

"There is still so much we don't know," wrote Prendergast. "But we know enough to make changes that will benefit bees: no more land clearing, reduce meat consumption to reduce your land and carbon footprint, plant more native flowers, and leave beekeeping to those who do it for a living."

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