BIGGER THAN BEES:
HOW NEONICS CONTAMINATE WATER, THREATEN ECOSYSTEMS, AND CAUSE HUMAN HEALTH CONCERNS IN NEW YORK

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You’ve heard the buzz—bees are dying in record numbers in New York State and around the globe. Scientists increasingly identify the widespread use of bee-toxic neonicotinoid insecticides, or “neonics,” as a leading culprit.¹

But these findings fail to paint the full picture of how a new class of pesticides went from unknown to ubiquitous in a generation, contaminating New York’s soil and water on an unprecedented scale and hollowing out ecosystems from the bottom up. Today, neonics contaminate not only New York’s environment, but also New Yorkers themselves. Half of the U.S. population are exposed every day, and scientific studies continue to link neonic exposure with potential human health harms.² Moreover, the vast majority of neonics used in agriculture are designed to tackle pest problems that simply don’t exist, wasting farmers’ money and sometimes even reducing crop yields by damaging soil health and beneficial insects.

This report looks at that bigger picture—at the true costs neonics impose for little or no benefit to farmers and residents. It also looks at steps the state can take right now to curb the use of these dangerous pesticides.

**WHAT ARE NEONICS?**

Neonics are neurotoxic insecticides—pesticides that kill insects by permanently binding to, overstimulating, and ultimately destroying their nerve cells.³ Insects poisoned with neonics often exhibit twitching, followed by paralysis and then death.⁴ Even at minute doses, neonics weaken critical functions, such as an insect’s immune system, navigational ability, stamina, memory, and fertility—making it harder or impossible for them to survive.⁵

Unlike older, conventional insecticides, neonics are “systemic,” designed to be absorbed by plant tissues in order to make the plant itself—including its nectar, pollen, and fruit—toxic. This allows neonics to be applied in new ways in addition to spraying. For example, they are commonly applied as a coating on a plant’s seed that gets absorbed by the plant as it grows. Similarly, neonics can be injected into a plant or applied as a “drench” to its roots. Often the levels applied are high enough to make some plants toxic to insects for years.⁶

There are six major neonic chemicals approved for outdoor use in the United States—acetamiprid, clothianidin, dinotefuran, imidacloprid, sulfoxaflor, and thiamethoxam—and they appear in thousands of products.
NEONICS ARE TOXIC, PERSISTENT, AND EVERYWHERE

Neonics have been around only since the mid 1990s but have already caused considerable ecological damage, most noticeably as a leading contributor to plummeting bee and other insect populations across the globe.⁷ There are three reasons why neonics are particularly destructive.

First, neonics are extremely toxic to insects. The typical neonic coating on just one corn seed can contain enough active ingredient to kill a quarter-million bees or more.⁸ Since neonics were first introduced, U.S. agriculture has become 48 times more harmful to bees and other insects, with an estimated 92 percent of the total toxic load attributable to neonics alone.⁹

Second, neonics can stay in the soil for long periods of time and are easily carried by rain or irrigation water. In fact, they can travel considerable distances, contaminating water and soil as they move and making nontarget plants, which absorb the neonics through their roots, toxic to insects too.¹⁰ Once the common neonic imidacloprid has contaminated water, says the U.S. Environmental Protection Agency (EPA), long-term exposure to only 10 parts per trillion—like 10 grains of sand in an Olympic-size swimming pool—is enough to harm aquatic insects and other invertebrate species.¹¹

Third, neonics are wildly popular—appearing in lawn and garden bug sprays, fertilizers, flea and tick treatments for pets and livestock, and agricultural pesticides. Today neonics are the most widely used insecticides in the United States, contaminating soil and water across the country and building up in areas of year-after-year use.¹²
NEONICS’ USE IN NEW YORK HAS SOARED DESPITE DEC CONCERNS

Since the New York Department of Environmental Conservation (DEC) first registered the neonic imidacloprid in 1995, neonic use in New York has grown dramatically, matching increases seen other states.\textsuperscript{[3]} In 2014, the last year for which reliable data are available, state-certified pesticide applicators and farmers used an estimated 141,000 to 152,000 pounds of neonic products, almost certainly making them the most popular insecticides in the state.\textsuperscript{[4]} And because these numbers fail to account for use of the hundreds of state-approved neonic consumer products—such as home and garden treatments, insecticide-laced fertilizers, and bug sprays—they very likely underestimate the full neonic load entering New York’s soil, water, and plants.

Recognizing their risks, DEC has attempted to limit the use of neonic products in the state, but to little effect. From 2005 to 2007 the agency refused to approve outdoor pesticides containing the neonic dinotefuran or clothianidin, citing concerns that they could harm bees and contaminate water.\textsuperscript{[15]} However, DEC broadly approved products containing the neonic imidacloprid and thiamethoxam, even though they are similarly toxic and similarly likely to pollute water.\textsuperscript{[16]} Both chemicals have been used in ever-increasing quantities since\textsuperscript{[17]}. Even DEC’s attempted prohibition on outdoor clothianidin products has proved ineffective. In 2014 an estimated 38,000 pounds of clothianidin reached New York farm fields, making it the dominant neonic used in agriculture.\textsuperscript{[18]} This is because clothianidin is most commonly used as a coating on crop seeds—which, due to a loophole in federal and state laws, is treated as exempt from DEC’s normal regulation of pesticides.\textsuperscript{[19]}

NEONICS KILL BEES

While this report does not focus on the impacts of neonic products on bees, it should be mentioned that a large and growing body of scientific evidence links neonic use to the massive bee losses seen both here and around the globe. This includes findings from two comprehensive, worldwide academic assessments of neonic impacts on pollinators, Cornell University research, and even a major pesticide-industry-funded field study—the largest to date.\textsuperscript{[20]} In New York, beekeepers have lost more than 40 percent of their bee colonies nearly every year for the past decade, suggesting the possibility of similar catastrophic losses for the state’s 400-plus species of wild bees.\textsuperscript{[21]} Future bee losses could jeopardize the state’s pollination-dependent crops, which contribute an estimated $1.2 billion annually to the state’s agricultural economy.\textsuperscript{[22]} Off the farm, 87.5 percent of flowering plants need pollination by bees and other pollinators to reproduce, so the loss of bees could lead not only to the destruction of the food system as we know it, but also to the collapse of whole ecosystems.\textsuperscript{[23]}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{chart.png}
\caption{Neonics are almost certainly the most popular insecticides in New York State.}
\end{figure}
In light of the overwhelming scientific evidence, regulatory agencies around the world, including the EPA, the European Food Safety Agency, and Canada’s Pest Management Regulatory Agency, have recognized the numerous risks that neonic use poses to bees.²⁴

**BIGGER THAN BEES: NEONICS HARM BIRDS, BUTTERFLIES, AND OTHER WILDLIFE**

While plummeting bee populations have attracted national attention, growing evidence now illuminates neonics’ harms to wildlife on a broader scale.

Like bees, populations of other beneficial insects across the globe have rapidly declined in the time since neonics were first introduced—a trend sometimes called the “insect apocalypse”—and new research is increasingly identifying neonics as a leading cause.²⁵ For example, recent studies have connected neonics use with significant declines in butterflies, which can encounter harmful or deadly neonics levels in farm fields or nearby wild plants that can absorb neonics and stay toxic for years.²⁶ Contaminated soil itself may also pose a hazard to populations of ground-dwelling insects and organisms.²⁷ And, as discussed below, neonics devastate aquatic insect populations.

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Neonicotinoids</th>
<th>Other Insecticides</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2014</td>
<td>200,000</td>
<td>150,000</td>
</tr>
</tbody>
</table>

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

As losses of insects multiply, insect-eating animals suffer too. Birds appear particularly vulnerable. Ninety-six percent of land-based birds feed insects to their young, and many species also rely, in whole or in part, on insect food sources as adults. In the Netherlands, researchers have linked declining populations of insect-eating birds to the introduction of neonics—even in areas with exceptionally low neonic levels in water (only 20 parts per trillion). Additionally, France has seen steep declines in farmland birds over the past 17 years, and North America has lost an estimated 29 percent of its bird population—roughly three billion birds—in the past 50 years. Neonics are suspected to play a key role in both of these declines as well. One thing most of the declining species have in common is a dietary dependence on insects.

Neonics also harm birds directly. Eating just one neonic-treated seed is enough to kill some songbirds. At nonlethal doses, neonics can damage birds’ immune and reproductive systems, cause rapid weight loss, and impair navigation and migration ability—all reducing the likelihood of their surviving and reproducing in the wild. With hundreds of millions of acres of U.S. farmland sown with neonic-treated seeds every year, birds are constantly at risk—particularly when, as commonly occurs, piles of seed are left out in the open or planted shallowly enough for birds to eat. At least one assessment has made the case that bats can also be harmed directly or indirectly.

Neonics may even harm large mammals exposed through contaminated water or otherwise. A new study has reported a link between neonics and birth defects in white-tailed deer—including decreased body and organ weight and decreased jawbone length—and higher death rates for fawns. Surprisingly, some of the “control” group—deer purposely not exposed to neonics in the study—were found to have neonics in their organs anyway, demonstrating just how difficult it can be to avoid neonic exposure in the real world.

**NEONICS CONTAMINATE NEW YORK WATER AND DESTROY AQUATIC ECOSYSTEMS**

Neonics contaminate water supplies across the United States, and New York water is no exception. Federal and state water testing over the past 15 years has shown that the neonic imidacloprid frequently appears in surface waters throughout the state. And recent testing of Long Island groundwater found imidacloprid in roughly 30 percent of samples, making it one of the most commonly detected pesticides on the island.

The results not only reveal widespread neonic contamination but also suggest its likely devastating impact on the state’s rivers, lakes, and coastal areas. More than 90 percent of the previously mentioned imidacloprid detections exceeded the EPA's long-term exposure benchmark for harm to aquatic invertebrates, and more than 37 percent of detections exceeded the benchmark by 10 times or more. Overall, New York’s water testing results indicate a very high probability that neonics are causing ecosystem-wide damage.

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Ecosystem damage often starts in the small streams and waterways that support diverse aquatic life and provide rich feeding grounds for other species. Aquatic insects and other invertebrates awash in neonic-contaminated water can succumb to daily low-level exposures over time or be wiped out suddenly by large influxes of neonic after a rainfall or following planting or pesticide applications. Those losses, in turn, can starve populations of birds, fish, and amphibians, eventually affecting predator species like hawks and mammals. For instance, a recent study in Japan found that fish populations collapsed shortly after the introduction of neonic treatments in nearby rice fields. Neonics levels later measured near those fields match those commonly seen in New York water. In addition to the ecological impacts, diminishing trout, salmon, and wild bird populations are certain to harm New York’s multibillion-dollar tourism and recreation industries.

While the existing test results alone lead us to expect these ripple effects, neonic water contamination in New York is almost certainly worse than the data suggest. Much of the state’s past water testing has not been sensitive or frequent enough to detect harmful neonic levels. Further, almost all state water monitoring programs test only for imidacloprid, despite the fact that other EPA-registered neonic chemicals share similar toxicity profiles and have properties that make them even more likely to end up in water supplies. Imidacloprid accounts for about half of the recorded neonic use in New York. This means total neonic water contamination may be double that or worse.

**NEONICS GET INTO FOOD AND DRINKING WATER AND MAY HARM HUMAN HEALTH**

The use of neonic has grown exponentially, in large part because they are thought to be safer for humans than the older, acutely toxic insecticides they replaced. However, emerging research now links neonic exposures to elevated risk of developmental and neurological damage in humans, particularly in infants and young children. These include malformations of the developing heart and brain, and a cluster of symptoms including memory loss and tremors. Japanese researchers also recently identified neonics in the urine of newborn babies, indicating that they can pass from a pregnant mother to her developing fetus. This is especially alarming given the emerging data linking prenatal neonic exposures to adverse developmental effects.
People are commonly exposed to neonics through food and water. Fruits, vegetables, and processed foods frequently contain neonics; a recent national survey detected the pesticides in 80 percent of spinach and 73 percent of applesauce samples tested. And because neonics are absorbed into treated foods, washing does not remove them, making it virtually impossible for consumers to avoid exposure.

Worse yet, neonics can break down in water, forming chemicals that are several hundred times more toxic to people than the original neonic chemical. And since conventional drinking water treatment generally fails to remove neonics or these break down products, researchers frequently find neonics in tap water in places like Iowa City and southern Ontario, where neonics have entered the drinking water supply. While more testing needs to be conducted in New York, results suggest that the risk of contaminated drinking water may be highest on Long Island (where imidacloprid alone showed up in nearly a third of recent samples) and in areas that get their drinking water from surface water, such as New York City.

**DOLLARS AND CENTS: MOST USES OF NEONICS DON’T ADD UP**

In both New York and around the country, most of the neonics now contaminating the environment provided little to no economic benefits to the people who used them.

For example, 73 percent of all agricultural neonic use in New York by weight is used on corn and soybean seeds. Nationwide, up to half of soybean seeds and virtually all conventional corn seeds are treated with a neonic coating. However, these coatings target early-season pests—such as wireworms, white grubs, and seedcorn maggots—that seldom reach economically damaging levels in northern climates. At the same time, they provide little to no protection against greater threats like corn rootworm and soybean aphid. Independent research has shown soybean and corn seed treatments rarely or marginally benefit yields and, in some cases, may actually decrease yields by killing predators of insect pests (i.e., the “good bugs”). Seed treatments are wasteful too—even under ideal conditions, typically no more than 2-5 percent of the active neonic chemical enters the growing plant as intended, leaving the other 95-98 percent to accumulate, persist, and migrate in soil and water or be released as airborne “seed dust.”

Emerging research now links neonic exposures to elevated risk of developmental and neurological damage in humans, particularly in infants and young children.

Half of the U.S. general population is exposed to neonics on a regular basis.
Other preventive neonic applications—i.e., use of neonics regardless of whether a pest problem exists or will materialize—are also widely used in agriculture, even as emerging research suggests they may actually hamper crop production. For example, ongoing research at Purdue University finds that melon crops preventatively treated with neonics and other insecticides generally had decreased yields compared to crops treated with non-neonics only “as needed,” likely because of the associated loss in bee and other insect populations needed to pollinate the crop.

New research likewise indicates that conventional use of insecticides, including neonics, may hurt farmers’ bottom lines. On canola crops, for example, a survey of nearly 300 farm fields found that increasing insecticide use decreased bee populations, failed to increase yields, and ultimately reduced farmer profits by increasing costs. And a study of northern Great Plains farms found that fields using neonics and other conventional insecticide treatments had 10 times the insect pressure and fewer profits compared with those employing regenerative farming methods, likely due to lower input costs, more “good bugs” that keep pest populations under control, and better crop marketability. In other words, farmers using neonics may be paying more money, seeing more pests, and enjoying fewer profits as a result.

Neonics are also overused off the farm, driven in part by the way in which neonic products are packaged and approved. Manufacturers often add neonics to fertilizers and other home and garden products. The EPA also allows use of many consumer neonic products at much higher concentrations than those approved for agricultural products, in some cases up to 120 times higher. That means that, even when used as directed, neonic applications in a backyard or on a golf course can put dozens of times more neonics into the environment than those on a typical farm field.

**A BETTER WAY: ALTERNATIVES TO NEONICS**

For nearly all uses, neonics are replaceable—with the best and most cost-effective alternative often being nothing.

For example, neonic corn and soybean seed treatments could be eliminated with no real effect on production because they target pest problems that largely don’t exist in northern growing regions like New York State. Eliminating preventative neonic uses for some of the state’s top fruit and vegetable crops could also save farmers money by reducing input costs and preserving the pollinators that increase crop yields.

Where pests do pose a significant problem, replacements exist. A recent comprehensive review of nearly 3,000 case studies by French government researchers concluded that, in 96 percent of cases, neonics can be replaced with effective alternatives, and, in 78 percent of cases, at least one effective non-chemical alternative was available. Nonchemical alternatives to neonics include time-honored agroecological practices like diverse crop rotations, cover cropping, and introducing natural enemies of crop pests (again, those “good bugs”). Even where insecticides are used, non-synthetic or less-harmful synthetic substitutes exist, such as organic and minimum-risk pesticides.

Like farmers, homeowners have better choices too. Many organic and less ecologically harmful alternatives—such as neem oil concentrate, diatomaceous earth powder, or beneficial nematodes and insects—are easily purchased at garden retailers or on the internet. Even conventional lawn-care brands now increasingly offer neonic-free alternatives.

**WHILE THE WORLD ACTS, THE UNITED STATES WAITS**

In response to recent science, countries across the globe have acted. In 2018 Europe approved a ban on all outdoor uses of three major neonic chemicals to protect bees and other pollinators. And after discovering widespread neonic water contamination similar to that found in New York, Canada’s Pest Management Regulatory Agency proposed banning outdoor uses of the same three neonics, citing unacceptable risks to aquatic ecosystems. France, meanwhile, has banned all outdoor neonic use.

In contrast, neonic protections in the United States have stalled. In 2013 the EPA added a “bee hazard” warning to many neonic product labels and placed some limits on using the products during plant blooming times. But these measures fail to address the broader environmental harms caused by neonics migrating through soil, water, and plants or the risks of neonics entering food or drinking water. Even bees, it appears, have yet to see tangible benefits from EPA’s efforts, with colony losses remaining at historic highs.

Even obvious money-wasting neonic uses remain commonplace, often because of the near-monopoly power exercised by modern agrochemical giants. Just four companies now control roughly 70 percent of global seed and chemical markets, often giving farmers no choice but to buy a neonic-treated seed. For example, as mentioned earlier, nearly all conventional corn seeds are neonic-treated before they reach the soil. Even where farmers have options, they are commonly advised to purchase neonic-treated seeds by seed dealers or representatives with a financial interest in promoting products made by
the large agrochemical companies.\textsuperscript{81}

\textbf{SOLUTIONS: WHAT NEW YORK CAN DO}

With market failures and a lack of federal leadership, it is up to New Yorkers—particularly, the state’s elected leaders and agency officials—to take on neonic contamination and its harms. Fortunately, there are several steps that New York can take without further delay:

- **Banning Needless Neonic Uses**—Most neonics used in New York provide little to no benefit to users, and these and many others are easily replaced with safer alternatives. New York should ban harmful and unnecessary outdoor uses—which include neonic treatments on corn and soybean seeds as well as nonagricultural or “cosmetic” uses.

- **Hitting “Pause” on Other Harmful Neonic Uses**—Across the state, neonics contaminate water, harm wildlife, and enter New Yorkers’ bodies. While more information on neonics’ full range of environmental impacts continues to come in, New York should act to protect its residents against these known harms by imposing a moratorium on other outdoor neonic uses.

- **Addressing Systemic Insecticides**—Neonics are relatively recent arrivals on the pesticide market, but new chemicals that may cause similar harms are being developed all the time. New York lawmakers should establish a framework for addressing and regulating these “systemic insecticides” that would empower DEC to take swift protective action if they are found to have the same harmful qualities as neonics.

- **Investing in Better Agricultural Practices, Not Just Replacement Chemicals**—Neonic contamination and its impacts are the result of an agricultural system dominated by large agrochemical corporations that use the full weight of their influence to ensure farming depends on chemical inputs rather than more sustainable methods. While agroecological practices can help break this harmful and expensive chemical dependency, farmers are often at a loss for unbiased pest-control information or may be unable to reduce chemical use because of manufacturers’ near-monopoly control of seed markets. New York should invest in researching, publicizing, and incentivizing agroecological best practices that reduce environmental and human health harms while increasing farm profitability. Legislators and regulators should also remove barriers caused by the monopolistic practices of large seed and chemical manufacturers.
ENDNOTES


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