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Neonicotinoids and Pollinator Health

In connection with 2018 Vermont House Bill 688 (H.688), "An Act Relating to Pollinator Protection," this report provides background information on neonicotinoids, discusses their effect on both wild and managed pollinators, considers other proposed and passed state laws, and delves into options for working with University of Vermont (UVM) Extension. H.688 proposes regulating the sale and application of neonicotinoids in Vermont to protect pollinators, species vital to maintaining prosperous ecosystems and agricultural systems.[1] The bill would mandate that the Secretary of the Vermont Agency of Agriculture, Food, and Markets (VAAFM) create an "Integrated Pest and Pollinator Management Program" through work with a university with agricultural expertise.[2] This report primarily considers the effect of neonicotinoids on bees, although pollinators include species of ants, bats, beetles, birds, butterflies, and flies.[3] To complete this report, the authors consulted peer-reviewed, scholarly articles, state and federal government documents, website content, and state legislation. Additionally, the team conducted phone interviews and email exchanges with UVM researchers.

Overview of Neonicotinoids

The United States Environmental Protection Agency (EPA) defines a pesticide as "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest."[4] More specifically, insecticides are pesticides that "are formulated to kill, harm, repel, or mitigate one or more species of insect."[5] Neonicotinoids are categorized as insecticides; however, the terms insecticide and pesticide are used interchangeably in this report. Originally developed in the 1980s, neonicotinoids are now one of the most widely used insecticides in the

[1] "H.688: An act relating to pollinator protection," Vermont General Assembly, accessed February 25, 2018, https://legislature.vermont.gov/bill/status/2018/H.688.
[2] "H.688: An act relating to pollinator protection."
[3] "Pollinators," U.S. Department of Agriculture, accessed February 20, 2018, https://www.fs.fed.us/wildflowers/pollinators/.
[4] "What is a Pesticide?," U.S. Environmental Protection Agency, accessed February 25, 2018, https://www.epa.gov/minimum-risk-pesticides/what-pesticide.
[5] "Insecticides," National Pesticide Information Center, last modified November 27, 2017, http://npic.orst.edu/ingred/ptype/insecticide.html.

world.[6] They are typically used in agricultural systems for crops like corn, as liquid spray applied on horticultural crops, or for residential garden use.[7] In the late 1990s, widespread recognition of the potential dangers of neonicotinoids grew as large losses of honeybees were reported throughout Western Europe.[8] A study conducted in 2008 suggested that neonicotinoids incited a honeybee colony poisoning incident in France.[9] In 2005, scientists discovered that certain types of neonicotinoids can accumulate over time and remain in soil "over months or years;" they are also easily leached into groundwater due to their high solubility.[10]

The systemic nature of neonicotinoids is a defining characteristic, both in explaining their popularity as an insecticide and their danger to nontarget organisms.[11] Systemic pesticides are absorbed and carried to the leaves, roots, flowers, nectar, and pollen of plants.[12] Because neonicotinoids "are highly toxic to many classes of insects," the plant tissues are wholly protected from "a number of sap-feeding insects/arthropods."[13]

Recent research on neonicotinoids finds robust evidence of their lethal and sublethal effects on honeybees and bumblebees, and some evidence of their impacts on pollination. Additional evidence indicates that neonicotinoids may impact survival and reproduction rates of wild pollinators.[14] The effects of sublethal exposure to bees include "reduce[d] learning, foraging ability and homing ability."[15] Surveys conducted by the National Institutes of Health examined links between neonicotinoids and endocrine disruption in bees, as well as more general linkages between neonicotinoids and bee population declines.[16]

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[6] Dave Goulson, "An Overview of the Environmental Risks Posed by Neonicotinoid Insecticides," *Journal of Applied Ecology* 50, no. 4 (June 2013): 977-987, http://dx.doi.org/10.1111/1365-2664.12111; Jean-Marc Bonmatin et al., "Environmental Fate and Exposure; Neonicotinoids and Fipronil," *Environmental Science and Pollution Research* 22, no.1 (January 2015): 35-67, https://doi.org/10.1007/s11356-014-3332-7.

[7] Goulson, "Overview of the Environmental Risks," 978.

[8] Maarten Bijleveld van Lexmond et al., "Worldwide Integrated Assessment on Systemic Pesticides: Global Collapse of the Entomofauna: Exploring the Role of Systemic Insecticides," *Environmental Science and Pollution Research* 22, no. 1 (January 2015): 1-4, https://doi.org/10.1007/s11356-014-3220-1.

[9] Marie-Pierre Chauzat et al.,"A Case Report of a Honey Bee Colony Poisoning Incident in France," *Journal of Apicultural Research* 49, no. 1 (December 2009): 113-15, https://doi.org/10.3896/IBRA.1.49.1.22.

[10] Bonmatin et al., "Environmental Fate," 37.

[11] Bonmatin et al., 35.

[12] "Systemic Pesticides," Info, Task Force on Systemic Pesticides, accessed February 18, 2018, http://www.tfsp.info/systemic-pesticides/.

[13] Bonmatin et al., "Environmental Fate," 36.

[14] Maj Rundlöf et al., "Seed Coating with a Neonicotinoid Insecticide Negatively Affects Wild Bees," *Nature* 521 (May 2015): 77-80, http://dx.doi.org/10.1038/nature14420.

[15] Goulson, "Overview of the Environmental Risks," 83.

[16] Danica Baines et al., "Neonicotinoids Act Like Endocrine Disrupting Chemicals in Newly-Emerged Bees and Winter Bees," *Scientific Reports* 7, no. 1 (September, 2017), https://doi.org/10.1038/s41598-017-10489-6; Thomas J. Wood and Dave Goulson, "The Environmental Risks of Neonicotinoid Pesticides: A Review of the Evidence Post 2013," *Environmental Science and Pollution Research* 24, no. 21 (2017): 7285-7325, https://doi.org/10.1007/s11356-017-9240-x. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5533829/; Richard Schmuck and Gavin Lewis, "Review of Field and Monitoring Studies Investigating the Role of Nitro-Substituted Neonicotinoid Insecticides in the Reported Losses of Honey Bee Colonies (Apis mellifera)," *Ecotoxicology* 25, no. 9 (September 2016): 617-629, https://doi.org/10.1007/s10646-016-1734-7.

Managed Versus Wild Pollinators

Honeybees are a managed species in the United States; beekeepers maintain them across the country.[17] Effective management of bees includes supplemental feeding, inspecting the hive, replacing queen bees, and collecting surplus nectar.[18] Honeybees are primarily used to pollinate agricultural crops and are vital to the prosperity of the global food system. Therefore, most data collected on pollinator decline is specific to honeybees, including federal data. The EPA "relies on honeybees" when conducting risk assessments for pesticides.[19] This leaves significant gaps in data surrounding native pollinators, which will be referred to as 'wild pollinators.'[20]

There are 275 species of wild bees in Vermont, including 18 species of bumblebees native to the state.[21] Wild pollinators are shown to pollinate crops twice as effectively as honeybees.[22] There are other environmental benefits to wild pollinators—they have co-evolved with native plants, so some species are specialized pollinators of specific plants.[23]

The genetic diversity of pollinators in Vermont creates more resilience, whereas relying on a single species like the honeybee makes the ecosystem vulnerable (i.e., colony collapse disorder).[24] Despite the strength from genetic diversity, wild pollinators in Vermont are now exhibiting signs of vulnerability—a recent study found that of 18 species studied in the state, five are extinct and three more are threatened.[25] Meanwhile, honeybee colony numbers appear to have increased overall due to effective management. All of this demonstrates that pollinator health in Vermont should not be evaluated based only on honeybee populations, overlooking wild pollinators.

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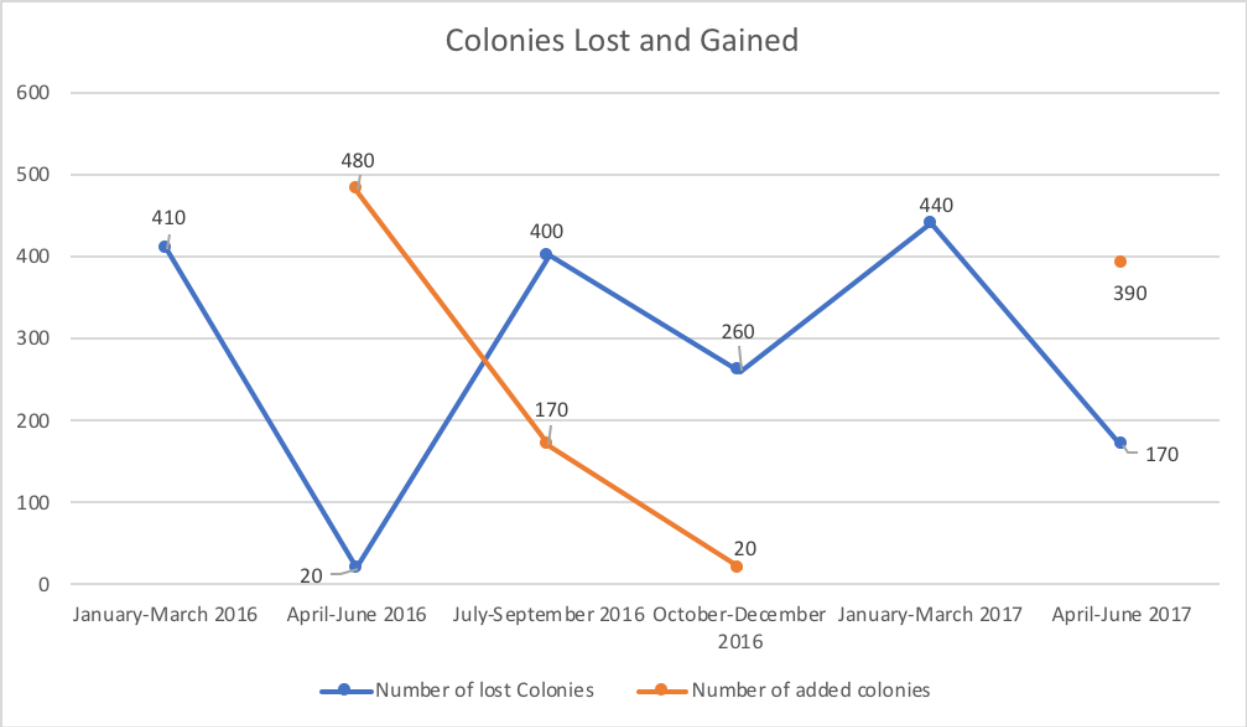
[17] "Managed Bees as Crop Pollinators," Cornell College of Agriculture and Life Sciences, accessed February 19, 2018, https://pollinator.cals.cornell.edu/pollinator-conservation/managed-bees-crop-pollinators.
[18] "Getting Started: Honey Bee Management," University of Georgia College of Agricultural & Environmental Sciences, accessed February 20, 2018, http://www.caes.uga.edu/departments/entomology/research/honey-bee-program/bees-beekeeping-pollination/getting-started-topics/getting-started-honey-bee-management.html.
[19] U.S. Environmental Protection Agency Office of Pesticide Programs, "Guidance for Assessing Pesticide Risks to Bees" (Washington, D.C., 2014), 2, https://www.epa.gov/sites/production/files/2014-06/documents/pollinator_risk_assessment_guidance_06_19_14.pdf
[20] Simon G. Potts et al., "The Assessment Report on Pollinators, Pollination, and Food Production: Summary for Policymakers," Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Bonn, Germany, 2016), 1-40, https://www.ipbes.net/sites/default/files/downloads/pdf/spm_deliverable_3a_pollination_20170222.pdf.
[21] Bumble Bees of Vermont," iNaturalist, last modified December 21 2012, https://www.inaturalist.org/check_lists/77549-Bumble-Bees-of-Vermont; Vermont Pollinator Protection Committee, "Vermont's Pollinator Protection Committee: Report to the Vermont Legislature as Required by Act 83 of the 2016 Session" (Montpelier, VT, 2017), http://agriculture.vermont.gov/sites/ag/files/pdf/apiary/Pollinator%20Protection%20Report-FINAL.pdf.
[22] Lucas A. Garibaldi et al., "Wild Pollinators Enhance Fruit Set of Crops Regardless of Honey Bee Abundance," *Science* 339 (2013): 1608, https://www.uvm.edu/~ngotelli/Bio%20264/Garibaldi.pdf.
[23] Vermont Pollinator Protection Committee, B-3.
[24] Brenda B. Lin, "Resilience in Agriculture through Crop Diversification: Adaptive Management for Environmental Change," *BioScience* 61, no. 3 (March 2011): 183-193, https://doi.org/10.1525/bio.2011.61.3.4; Vermont Agency of Agriculture, Food, and Markets, "Neonicotinoid Pesticides, Safety and Use" (Montpelier, VT, 2015), http://pss.uvm.edu/beeclover/Articles/NEONICOTINOID_PESTICIDES_Report_Final.pdf.
[25] Vermont Pollinator Protection Committee, B-4.

Vermont Colony Collapse Data

Honeybee hive and colony collapse, the "phenomenon that occurs when the majority of worker bees in a colony disappear and leave behind a queen," has received significant news media attention.[26] The United States Department of Agriculture has published data regarding colony loss and growth in Vermont from 2016 and 2017, as seen in Figure 1.[27] This data on Vermont honeybee colonies shows estimates for January 1, April 1, July 1, and October 1, as well as trend data over this span of time, seen in Figure 2.

Figure 1. Honeybee colonies lost and gained across Vermont

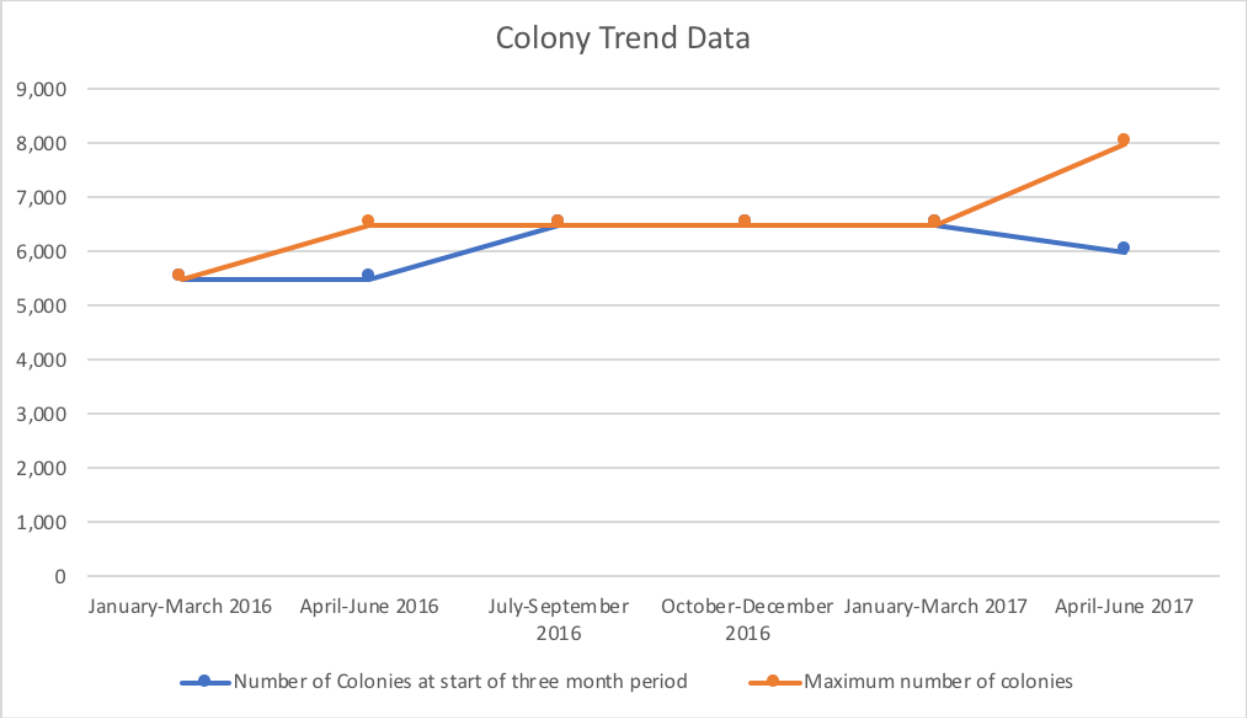


Source: "Honey Bee Colonies," U.S. Department of Agriculture, National Agricultural Statistics Service, accessed March 7, 2018, http://usda.mannlib.cornell.edu/usda/current/BeeColonies/BeeColonies-08-01-2017.pdf.

[26] Michael Wines, "A Sharp Spike in Honeybee Deaths Deepens a Worrisome Trend," *New York Times*, May 13, 2015, https://www.nytimes.com/2015/05/14/us/honeybees-mysterious-die-off-appears-to-worsen.html; "Colony Collapse Disorder," Pollinator Protection, U.S. Environmental Protection Agency, last modified December 27, 2017, https://www.epa.gov/pollinator-protection/colony-collapse-disorder.

[27] National Agricultural Statistics Service, Agricultural Statistics Board, "Honey Bee Colonies," U.S. Department of Agriculture (Washington, D.C., 2017), http://usda.mannlib.cornell.edu/usda/current/BeeColonies/BeeColonies-08-01-2017.pdf.

Figure 2. Line graph of trends across Vermont Honeybee Colony data



Source: "Honey Bee Colonies," U.S. Department of Agriculture, National Agricultural Statistics Service, accessed March 7, 2018, http://usda.mannlib.cornell.edu/usda/current/BeeColonies/BeeColonies-08-01-2017.pdf.

Use of Neonicotinoids in Vermont

In Vermont, a significant amount of neonicotinoid application comes from treated seed, which has been shown to be of concern to pollinators' health.[28] Treated seeds have been dressed with either wet or dry forms of the neonicotinoid before they are sold to consumers.[29] Because the application of the pesticide occurs before it enters the state, it is exempt from Vermont's existing pesticide regulations.[30] Treated seed is considered to have fewer impacts on insects compared to spray-on pesticides, due to its capacity to reduce drift of the insecticide from its source to pollinator-attractive plants.[31] But treated seed has been found to reduce the density of wild bees, disrupt the nesting of solitary bees (bees that do not live in colonies), and hurt colony growth and reproduction of species of bumblebee.[32] Bees and other pollinators are exposed through dust created by application of treated seeds, consumption of residues in pollen and nectar of treated seeds, and through fluid released by treated corn.[33] In the case of

[28] VT Agency of Agriculture, "Neonicotinoid Pesticides, Safety and Use," 5; Maj Rundlöf et al., "Seed Coating," 77.
[29] Rishi P. Singh, Pagadala V. Prasad, K. Raja Reddy, "Climate Change: Implications for Stakeholders in Genetic Resources and Seed Sector," *Advances in Agronomy* 61 (2015): 117-180, https://doi.org/10.1016/bs.agron.2014.09.002.
[30] VT Agency of Agriculture, "Neonicotinoid Pesticides, Safety and Use," 5.
[31] Bonmatin et al., "Environmental Fate," 37.
[32] Maj Rundlöf et al., "Seed Coating," 77.
[33] European Commission Implementing Regulation (EU), "Amending Implementing Regulation (EU) No 540/2011, As Regards the Conditions of Approval of the Active Substances Clothianidin, Thiamethoxam and Imidacloprid,

mass bee death around corn fields in Italy, Germany, Austria, Slovenia, the USA, and Canada, bees have been found to have high levels of seed-treated neonicotinoids in and on their bodies.[34] VAAFM estimated the amount of treated seed used in the state is approximately 8,270 pounds per year.[35]

Still, the highest concentrations of neonicotinoids in nectar and pollen appear in response to direct application to soil and foliar applications (applying a liquid form of the pesticide directly on leaves).[36] In 2013 ,the EU stated that "the risk for bees from foliar applications is similar to the risk...for seed treatment...due to the systemic translocation of [imidacloprid] through the plant".[37] Imidacloprid is a neonicotinoid that accounts for 99.2 percent of all commercial usage in the state, and poses a great risk to bumblebees. [38] There is up to a 49 percent chance that bumblebees will reach the median lethal cumulative dose after two days of exposure, as opposed to a 16 percent chance for honeybees.[39] The majority of imidacloprid use is for ornamental and shade trees; the two most prevalent additional uses are golf courses and lawns.[40] Figure 3 illustrates the amount of imidacloprid in Vermont, highlighting the use of neonicotinoids on ornamental shade trees. The use of imidacloprid has generally increased over the past few years. The Vermont Agency of Agriculture's report on "Neonicotinoids, Pesticides, Safety and Use" notes that "since 1994, ornamental and shade trees use have accounted for 75% of imidacloprid use."[41] The sharp increase in usage in 2011 corresponds to a targeted treatment for gypsy moth.

and Prohibiting the use and Sale of Seeds Treated with Plant Protection Products Containing those Active Substances" *OJ L* 139 no. 485 (2013):12-26, http://eur-lex.europa.eu/eli/reg_impl/2013/485/ojURL?!; David Nuyttens, et al. "Pesticide-Laden Dust Emission and Drift from Treated Seeds during Seed Drilling: A Review," *Pest Management Science* 69, no. 5 (May 2013): 564–75, https://doi.org/10.1002/ps.3485; Krystyna Pohorecka, et al., "Effects of Exposure of Honey Bee Colonies to Neonicotinoid Seed-Treated Maize Crops," *Journal of Apicultural Science* 52 no. 2 (2013): 199-208, https://doi.org/10.2478/jas-2013-0029.

[34] L.W. Pisa, et al., "Effects of Neonicotinoids," 72.

[35] VT Agency of Agriculture, "Neonicotinoid Pesticides, Safety and Use," 5.

[36] Goulson, "Overview of the Environmental Risks," 983; George Kuepper, "Foliar Fertilization," *ATTRA Sustainable Agriculture*, 2003, https://attra.ncat.org/attra-pub/viewhtml.php?id=286.

[37] European Commission Implementing Regulation (EU), "Amending Implementing Regulation" 1.

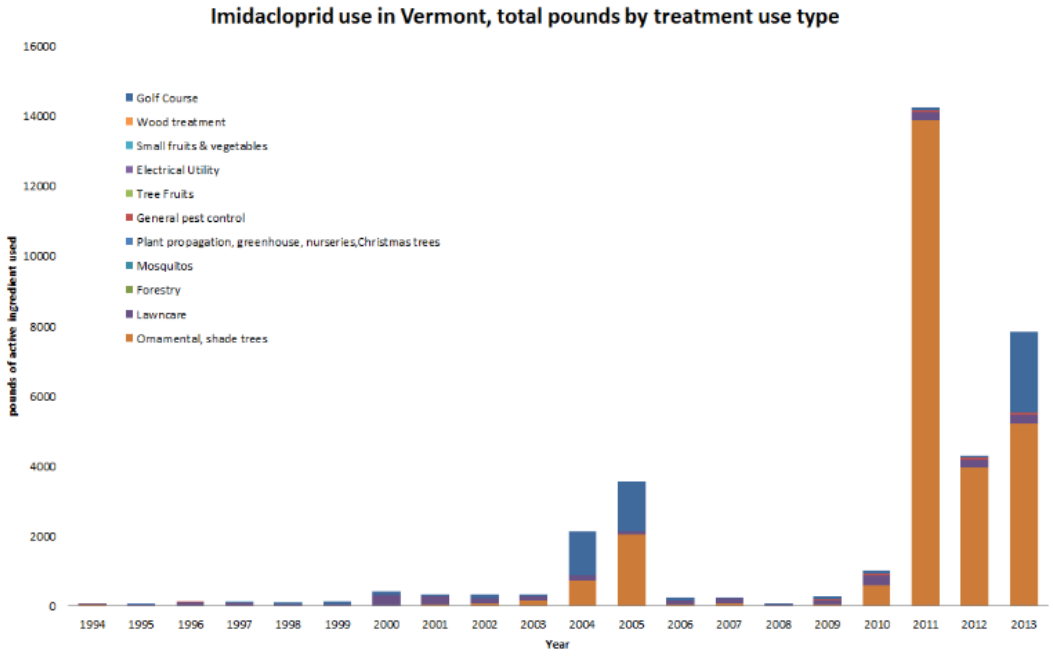
[38] VT Agency of Agriculture, "Neonicotinoid Pesticides, Safety and Use," 7.

[39] Francisco Sanchez-Bayo and Koichi Goka, "Pesticide Residues and Bees: A Risk Assessment," *PLoS* 9, no. 4 (April 2014): 1-16, https://doi.org/10.1371/journal.pone.0094482.

[40] VT Agency of Agriculture, "Neonicotinoid Pesticides, Safety and Use," 8.

[41] VT Agency of Agriculture, "Neonicotinoid Pesticides, Safety and Use," 7.

Figure 3. Imidacloprid Use in Vermont



Source: Vermont Agency of Agriculture, 2015 (Montpelier, VT)

UVM Research

UVM's research on neonicotinoids and pollinators includes work by Ph.D candidate Samantha Alger, who has focused on bee health and has provided testimony to the Vermont Legislature on two separate bills: H.236, "An Act to Ban the Use, Sale, or Application of Neonicotinoid Pesticides," and H.539, "An Act to Establish a Pollinator Protection Committee."[42] Alger has researched Vermont bee viral diseases, the role of plants in virus transmission, and the effects of pesticides on bee health and behavior, and she has been lead investigator for the Vermont portion of the National Honey Bee Survey, examining bee health and disease data.[43] Additional relevant research at UVM has been conducted at the Gund Institute for Environment by Leif Richardson, a postdoctoral fellow, and Taylor Ricketts, the director of the Institute.[44] Richardson and Ricketts released peer-reviewed studies that have gained attention worldwide in emphasizing bees' importance to human and environmental health, and current threats they are facing.[45] Many of the studies focus on declines in, and the importance of, wild pollinators, with an emphasis on finding ways to support native populations. Ricketts's work did this by

[42] Samantha Alger, "Bees Under Siege," *University of Vermont, College of Arts and Sciences Department of Biology Newsletter* (Burlington, VT, 2016), https://www.uvm.edu/sites/default/files/Department-of-Biology/UVMBioDeptNewsletter2016.pdf.
[43] Basil D. Waugh, "UVM Scientists Fight Bee Declines," *University Communications*, March 15, 2016, https://www.uvm.edu/newsstories/news/uvm-scientists-fight-bee-declines.
[44] Waugh, "UVM Scientists Fight Bee Declines."
[45] Waugh, "UVM Scientists Fight Bee Declines;" Lucas A. Garibaldi et al., "Wild Pollinators Enhance Crops," 1608; Jeremy T. Kerr et al., "Climate Change Impacts on Bumblebees Converge Across Continents," *Science* 349, no. 6244 (July 2015): 177-180, http://science.sciencemag.org/content/349/6244/177/tab-pdf.

quantifying the economic value that wild bees bring to our agricultural systems; he calculated their worth is over $310,000 per hectare where insects pollinate.[46] Charlie Nicholson, another UVM researcher, has conducted similar research on the economic value of wild bees specific to blueberry crops.[47] At UVM Extension, doctoral student Annie White is currently researching ways to emphasize wild pollinator habitats in the growing field of sustainable landscape design and ecological agriculture.[48]

Federal Legislation

On August 15, 2013, the EPA published a "Letter to Registrants on Pollinator Protection Labeling" that was sent to companies that hold registrations for pesticides containing certain neonicotinoids, such as clothianidin, dinotefuran, imidacloprid, and thiamethoxam.[49] This letter described necessary label changes to registered pesticides with these products, including the addition of a "Pollinator Protection Box" for neonicotinoids with outdoor foliar use directions (see Figure 4). [50]

On May 19, 2015, the EPA published a "Proposal to Mitigate Exposure to Bees from Acutely Toxic Pesticide Products."[51] In this proposal, the EPA discussed additional pesticide label requirements to protect bees from foliar application of toxic pesticides. This proposal was published in the Federal Register and received approximately 113,000 responses during a 90-day comment period. After taking into account the comments received, this rule was not enacted after the proposal state, but instead the EPA published a policy, "U.S. Environmental Protection Agency's Policy to Mitigate the Acute Risk to Bees from Pesticide Products" on January 12, 2017.[52]

The final policy includes adopting new language on labels to mitigate the acute risk to bees. "The EPA intends that all labels for products that (1) are applied as either a liquid or a dust; (2) are foliar applied outdoors to agricultural crop(s) that may utilize contract pollination services; and (3) have an application rate(s) that result in risk estimates exceeding the acute risk for

[46] Waugh, "UVM Scientists Fight Bee Declines;"Lucas A. Garibaldi et al., "Wild Pollinators Enhance Crops," 1608.
[47] Waugh, "UVM Scientists Fight Bee Declines."
[48] Waugh, "UVM Scientists Fight Bee Declines."
[49] U.S. Environmental Protection Agency Office of Chemical Safety and Pollution Prevention, "August 15, 2013 Letter to Registrants on Pollinator Protection Labeling" (Washington, D.C., 2013), https://www.epa.gov/sites/production/files/2013-11/documents/bee-label-info-ltr.pdf.
[50] U.S. Environmental Protection Agency, "August 15, 2013 Letter to Registrants"
[51] U.S. Environmental Protection Agency Office of Pesticide Programs, "Proposal To Mitigate Exposure to Bees From Acutely Toxic Pesticide Products" (Washington, D.C., 2015), https://www.federalregister.gov/documents/2015/05/29/2015-12989/proposal-to-mitigate-exposure-to-bees-from-acutely-toxic-pesticide-products-notice-of-availability; 80 FR 30644 https://www.gpo.gov/fdsys/pkg/FR-2015-05-29/pdf/2015-12989.pdf.
[52] U.S. Environmental Protection Agency Office of Pesticide Programs, "U.S. Environmental Protection Agency's Policy to Mitigate the Acute Risk to Bees from Pesticide Products" (Washington, D.C., 2017), https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0818-0477.

bees… be amended to reflect the acute risk mitigation language below."[53] This language is as follows:

> FOR FOLIAR APPLICATIONS OF THIS PRODUCT TO A CROP WHERE BEES ARE UNDER CONTRACT TO POLLINATE THAT CROP: Foliar application of this product is prohibited to a crop from onset of flowering until flowering is complete when bees are under contract for pollination services to that crop unless the application is made to prevent or control a threat to public and/or animal health as determined by a state, tribal, authorized local health department or vector control agency.[54]

In addition to the proposed labeling requirement, the EPA is undertaking pollinator risk assessments as part of a registration review process for neonicotinoids. This review is expected to be complete in 2022. In 2015, the EPA sent a letter to registrants of neonicotinoid pesticides informing them that the EPA is unlikely to accept applications for new uses of neonicotinoids until the review is complete.[55] This letter was sent to companies that submitted an application for a new outdoor use registration for products containing specific neonicotinoids, namely, imidacloprid, dinotefuran, clothianidin, or thiamethoxam.[56]

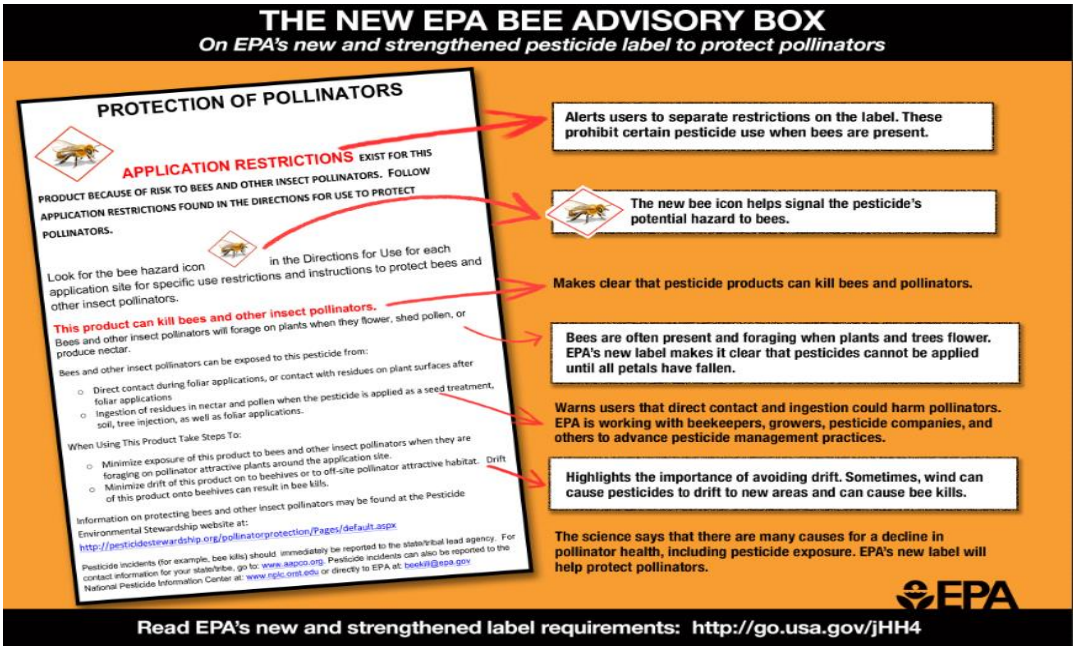


Figure 4. EPA's Pesticide Label to Protect Pollinators
Source: "August 15, 2013 Letter to Registrants on Pollinator Protection Labeling," U.S. Environmental Protection Agency, accessed March 7 2018, https://www.epa.gov/sites/production/files/2013-11/documents/bee-label-info-ltr.pdf.

[53] U.S. Environmental Protection Agency, "Policy to Mitigate the Acute Risk to Bees."
[54] U.S. Environmental Protection Agency, "Policy to Mitigate the Acute Risk to Bees."
[55] U.S. Environmental Protection Agency Office of Chemical Safety and Pollution Prevention, "April 2015 Letter to Registrants Announcing New Process for Handling New Registrations of Neonicotinoids" (Washington, D.C., 2015), https://www.epa.gov/sites/production/files/2015-04/documents/neonicotinoid-new-use.pdf.
[56] U.S. Environmental Protection Agency, "April 2015 Letter to Registrants."

While the federal government is conducting a review of the impacts of neonicotinoids, the U.S. Environmental Protection Agency's Policy to Mitigate the Acute Risk to Bees from Pesticide Products encouraged state action via the development of Managed Pollinator Protection Plans (MP3s). MP3s are a way for states to reduce pesticide exposure by taking local and state action. By the time this policy was published, 48 states had completed, or were in the process of creating, an MP3 plan.This policy describes MP3s as "examples of collaboration between stakeholders at the local level that can lead to broader awareness of needs and increased cooperation between stakeholders to reduce pesticide exposure for bees while maintaining the flexibility to protect crops."[57] These MP3s are a way for states to focus on pollinator health through a targeted local approach. An inventory maintained by the Association of American Pesticide Control Officials outlines each state plan, their process for stakeholder engagement, best management practices, and evaluation measures.[58]

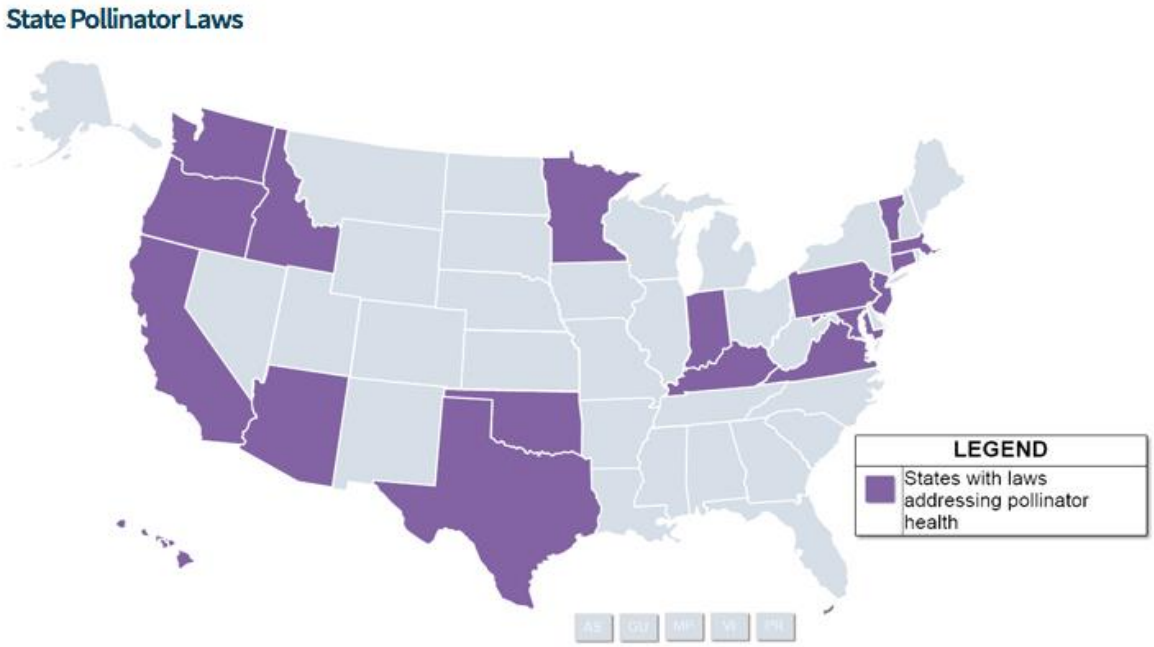
Importantly, although the EPA has published policy guidance for state plans and labeling of toxic pesticides, the report published on January 12, 2017 is not a regulation and is therefore not legally enforceable. Recognizing growing concern for pollinator health, states have chosen to enact pollinator protection legislation that is legally enforceable.

[57] U.S. Environmental Protection Agency, "Policy to Mitigate the Acute Risk to Bees."
[58] "Pollinator Protection," Association of American Pesticide Control Officials, accessed February 25, 2018, https://aapco.org/2015/07/20/current-topics/.

State Legislation

According to the National Conference of State Legislatures, as of May 2016 at least 18 states had enacted legislation stemming from concern over bee and other pollinator health (see Figure 5).[59]

Figure 5. State Pollinator Laws



Source: National Conference of State Legislatures, 2016 (Washington, D.C.)

Nine states had enacted legislation pertaining to pesticide exposure and protecting pollinators from its effects, with legislation often focusing on neonicotinoids.[60] Connecticut and Maryland recently passed landmark acts geared towards protection of pollinators.

Connecticut

The Connecticut bill, "An Act Concerning Pollinator Health," became law on May 6, 2016. This Act calls upon "the Commissioner of Agriculture, in collaboration with the Connecticut Agricultural Experiment Station and the Department of Energy and Environmental Protection" to "develop best practices for minimizing the airborne liberation of neonicotinoid insecticide dust from treated seeds and mitigating the effects of such dust on pollinators."[61] This Act also requires that after January 1, 2018, "the commissioner shall classify all neonicotinoids… that are

[59] "Pollinator Health," National Conference of State Legislatures, accessed February 18, 2018, http://www.ncsl.org/research/environment-and-natural-resources/pollinator-health.aspx.
[60] National Conference of State Legislatures, "Pollinator Health."
[61] Conn. Gen. Stat. §22a as amended by Public Acts, May, 2016, No. 16-17, https://www.cga.ct.gov/2016/ACT/pa/2016PA-00017-R00SB-00231-PA.htm.

labeled for treating plants, as restricted use…"[62] This is a marked distinction from the federal regulations, which classify and specify neonicotinoids as general use. Restricted use pesticides cannot be purchased or used by the general public; only a certified applicator or someone under the direct supervision of a certified applicator may use a restricted use pesticide. [63] Currently, neonicotinoids are not listed federally as restricted use pesticides, meaning that the general public can procure and use them.

Maryland

Similarly, Maryland passed the "Pollinator Protection Act of 2016" with the intention of preserving pollinator health in the state.[64] This Act prohibits "a person from selling, on or after January 1, 2018, a neonicotinoid pesticide unless the person also sells a restricted use pesticide, [and prohibits] a person from using a neonicotinoid pesticide on or after January 1, 2018, unless the person is a certified applicator or a person working under specified circumstances."[65] This is nearly identical to the stipulations in the proposed legislation in Vermont. Both the proposed Vermont legislation and the adopted Maryland legislation make exceptions for farmers and certified applicators in specific circumstances.

In addition to the Pollinator Protection Act of 2016, the State of Maryland is taking additional steps to protect pollinators. Maryland is an example of a state with strong Managed Pollinator Protection Plans (MP3). In Maryland, the goal of the MP3 is to establish a method for "beekeepers, agricultural producers, pesticide applicators, and landowners" to work together to find practices that both support crop production and beekeeping.[66] Maryland has also dedicated 49 acres on 53 different farms to be pollinator friendly habitat, thanks to a grant from the USDA.[67]

Legislation in other states

MP3s have been the source of state action to protect pollinators. In Delaware and Idaho, it is mandatory that all hives be registered with the state apiarist. Florida requires mandatory beekeeper registration and inspection. In Nevada, commercial aerial applicators must be notified of hives in an area. Oklahoma has a Pesticide Sensitive Location Viewer so that applicators can see the location of sensitive crops. Several other states that do not require

[62] Conn. Gen. Stat. §22a as amended by Public Acts, May, 2016, No. 16-17.
[63] 40 CFR 152.175, https://www.gpo.gov/fdsys/pkg/CFR-2011-title40-vol24/pdf/CFR-2011-title40-vol24-sec152-175.pdf.
[64] Md. Code, Com. Law §5-2A-01, http://mgaleg.maryland.gov/2016RS/bills/hb/hb0211E.pdf.
[65] Md. Code, Com. Law §5-2A-01.
[66] Department of Legislative Services, Office of Policy Analysis, "Pollinator Health and the Use of Neonicotinoids in Maryland" (Annapolis, MD, 2015), http://dls.maryland.gov/pubs/prod/NatRes/Pollinator-Health-and-the-Use-of-Neonics-in-MD-Rpt-Oct-2015.pdf.
[67] Department of Legislative Services, "Pollinator Health and the Use of Neonicotinoids in Maryland," 22.

registration have a system of voluntary registration. Additionally, several of these states have organized multiple stakeholder meetings.[68]

Other states have passed legislation to create committees to evaluate and understand the impacts of neonicotinoids. California Assembly Bill 1789, enacted in 2014, required the State Department of Pesticide Regulation to reevaluate neonicotinoids and better understand their effects on pollinator health.[69] In 2014, Vermont passed Vermont House Bill 869, requiring the Secretary of Agriculture, Food, and Markets to evaluate the effect of neonicotinoids on human health, the health of bees, and the health of other pollinators.[70] The passage of Act 83 in Vermont in 2016, creating a Pollinator Protection Committee, continued the investigation into the impacts of neonicotinoids on pollinator health. [71]

Key Recommendations from the Vermont Pollinator Protection Report and Other Literature

The Vermont Pollinator Protection Report was written by Vermont's Pollinator Protection Committee. The content of the report is "based on technical documents, expert opinions… and experts from whom the Committee took testimony."[72] The Committee reached consensus on recommendations including:

- The need for a buffer between an area of highly toxic pesticide use and a pollinator foraging area;
- A statewide program of Integrated Pest and Pollinator Management through UVM Extension should be established to learn and educate others on how to limit toxic pesticide use; and,
- Several moratoriums, including one on foliar applications of imidacloprid on ornamental plants that may attract pollinators.[73]

Further, there was "general agreement" that:

- VAAFM should classify all highly toxic pesticides that harm bees as restricted use products; and,
- VAAFM should consider creating a Pollinator Protection Fund, which would protect pollinator health but not have a negative impact on farmers.[74]

[68] Association of American Pesticide Control Officials, "State Mp3 Inventory," accessed February 25, 2018, https://aapco.files.wordpress.com/2016/06/master-mp3-inventory-june-2016-master-update-may-2016.pdf.
[69] CAL Food & Agric. Code §12838, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1789.
[70] Vermont H.869 Act 159 (2014), accessed February 26, 2018, https://legislature.vermont.gov/assets/Documents/2014/Docs/ACTS/ACT159/ACT159%20As%20Enacted.pdf.
[71] Vermont H.539 Act 83 (2016), accessed February 26, 2018, https://legislature.vermont.gov/assets/Documents/2016/Docs/ACTS/ACT083/ACT083%20As%20Enacted.pdf.
[72] Vermont Pollinator Protection Committee, 6-7.
[73] Vermont Pollinator Protection Committee, 6-7.
[74] Vermont Pollinator Protection Committee, 10.

The International Union for Conservation of Nature (IUCN)[75] created a multidisciplinary scientific task force which, over the past five years, has synthesized 1,121 published peer-reviewed studies. Based on the body of evidence analyzed, "The Task Force on Systemic Pesticides" recommended that, "regulatory agencies apply more precautionary principles and tighten regulations on neonicotinoids."[76] In fall 2017, the Task Force conducted a follow-up assessment and concluded that "overall, the negative impacts of neonicotinoids...on [insects] are translated in indirect impact for the entire ecosystems… The consequences of losing the [insects]… are thus far reaching and cannot be ignored any longer."[77]

Conclusion

Neonicotinoids are an extremely popular type of pesticide used for a variety of purposes, though they are considered dangerous due to their systemic nature and high solubility. Thus, pollinator specialists in Vermont have worked to provide recommendations for mitigating the risk to bees and other pollinators from neonicotinoids; this includes research from UVM regarding wild pollinator health, their economic value, and value of their pollination to agricultural yields. Additionally, the EPA is currently completing pollinator risk assessments for certain kinds of neonicotinoids, like imidacloprid, to review their impact on pollinators before approving new use registrations. State legislation on this topic ranges from classifying neonicotinoids as restricted use, to establishing regular stakeholder meetings to discuss pollinator health. While most states have MP3 plans, few states have strong legislation. This proposed bill, Vermont House Bill 688 (H.688), "An Act Relating to Pollinator Protection," echoes similar legislation recently passed in Maryland and Connecticut. To support this bill, pollinator research and expertise at UVM can be drawn on by the legislature in acting on pollinator protection in Vermont

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[75] The IUCN is an organization whose membership consists of environmental NGOs and national and international scientific associations as well as national governments and many individual national government agencies, with peer reviewed reports similar to publications of national scientific associations.

[76] Jereon van der Sluijs et al., "Conclusions of the Worldwide Integrated Assessment on the Risks of Neonicotinoids and Fipronil to Biodiversity and Ecosystem Functioning," *Environmental Science and Pollution Research* 22, no. 1 (January 2015): 148-154, https://doi.org/10.1007/s11356-014-3229-5.

[77] Lennard Pisa et al., "An Update of the Worldwide Integrated Assessment on Systemic Insecticides. Part 2: Impacts on Organisms and Ecosystems," *Environmental Science and Pollution Research* (November 2017): 1-49, https://doi.org/10.1007/s11356-017-0341-3.