William & Mary Environmental Law and Policy Review

Volume 39 (2014-2015)
Issue 2 Symposium Issue: The Role of Law and Government in Protecting Communities from Extreme Weather and Coastal Flood Risks: Local, Regional, and International Perspectives.

Article 4

February 2015

Buzzkill: How the EPA's Inaction Is Killing America's Bees

Kelsey Ott

BUZZKILL: HOW THE EPA'S INACTION IS KILLING AMERICA'S BEES

KELSEY OTT*

INTRODUCTION

In 1995, beekeepers across the country reported significant losses to their hive populations.[1] By 2006, the honey bees' mysterious deaths[2] reached such epidemic levels that scientists named the phenomenon "colony collapse disorder."[3] Normally beekeepers expect to lose about 15% of their hives in any given year from winter loss.[4] The USDA, however, reported recent apiary losses at a much greater rate than 15%; in 2009, 29% of honey bee colonies in the United States died.[5] In 2010, honey bee colony deaths rose to 34%.[6] The loss from 2012–2013 was even greater at 40–50% of all hives.[7] Today there are about 2.3 million managed honey bee colonies, down from nearly 6 million managed hives in the 1940s.[8]

---

* J.D. Candidate 2015, William & Mary Law School; B.G.S. 2010, University of Michigan. The author would like to thank the staff of ELPR for their support and editorial contributions.

[1] Rosemary Mason et al., *Immune Suppression by Neonicotinoid Insecticides at the Root of Global Wildlife Decline*, 1 J. ENVTL. IMMUNOLOGY & TOXICOLOGY 3, 4 (2014), *available at* http://www.stmconnect.com/sites/default/files/3-12%20%20JEIT-2014.pdf.

[2] *See* Appendix A for chart detailing the expected colony losses over the winter versus the actual colony losses from 2006 to 2013. Dennis vanEngelsdorp et al., *Preliminary Results: Honey Bee Colony Losses in the United States, Winter 2012–2013*, BEE INFORMED (May 1, 2013), http://beeinformed.org/2013/05/winter-loss-survey-2012-2013-2/ [hereinafter *Preliminary Results*], *archived at* http://perma.cc/66MK-3HN6.

[3] RENEE JOHNSON, CONG. RESEARCH SERV., RL33938, HONEY BEE COLONY COLLAPSE DISORDER, at Summary (2010), *available at* http://www.fas.org/sgp/crs/misc/RL33938.pdf.

[4] *See* vanEngelsdorp et al., *supra* note 2.

[5] CCD STEERING COMM., U.S. DEP'T OF AGRIC., COLONY COLLAPSE DISORDER PROGRESS REPORT, at Executive Summary (2010), *available at* http://www.ars.usda.gov/is/br/ccd/ccdprogressreport2010.pdf.

[6] *Id.*

[7] Michael Wines, *Mystery Malady Kills More Bees, Heightening Worry on Farms*, N.Y. TIMES (Mar. 28, 2013), http://www.nytimes.com/2013/03/29/science/earth/soaring-bee-deaths-in-2012-sound-alarm-on-malady.html?pagewanted=all&module=Search&mabReward=relbias%3As&_r=0, *archived at* http://perma.cc/2RX3-UQ24.

[8] Jeffery S. Pettis & Keith S. Delaplane, *Coordinated Responses to Honey Bee Decline in the USA*, 41 APIDOLOGIE 256, 256 (2010), *available at* http://www.apidologie.org/articles/apido/pdf/2010/03/m09140.pdf.

The disappearing honey bee affects far more than the availability of honey; about a third of the food supply in the United States relies on bees' pollination, including apples, broccoli, almonds, and blueberries.[9] The mysterious deaths associated with colony collapse disorder have created a shortage of managed honey bees, economically impacting crop producers and consumers. For example, in California, almond and blueberry farmers must now pay beekeepers double the traditional price per hive for pollination services because of the significantly limited honey bee supply.[10]

Scientists have found that many factors can cause colony collapse disorder, including pesticides, parasites, and pathogens;[11] however, because humans produce and use pesticides, pesticides should be the easiest single factor to control. Consequently, regulating pesticide production and use should be the most efficient method of curbing colony collapse disorder.

Scientific literature also suggests that pesticides decrease bees' immune systems, which increases their vulnerability to parasites and pathogens.[12] Reducing or eliminating pesticide use could therefore reduce colony collapse disorder deaths on multiple fronts: directly, by limiting the amount of toxicity-related deaths, and indirectly, by increasing—or, more specifically, not decreasing—the bees' immune systems. Pesticides' harmful ancillary effects further support the idea that controlling harmful pesticide use would be the most effective method of controlling colony collapse disorder.

Despite the grave consequences associated with colony collapse disorder and the ample scientific data linking pesticide use to hive deaths, the United States currently lacks any federal regulation or legislation limiting pesticide use around bees. In 2013, the Environmental Protection Agency ("EPA") issued a warning label, called the "bee hazard icon," on certain neonicotinoid pesticides to admonish users of its bee-killing properties.[13] This warning label, however, is solely informational and carries

---

[9] Hillary Rosner, *Return of the Natives: Reviving Native Bee Species Could Save Honeybees—and Our Agricultural System—From Collapse*, SCI. AM. (Sept. 2013 Issue); Jennifer Sass, *Why We Need Bees: Nature's Tiny Workers Put Food on Our Tables*, NATURAL RES. DEF. COUNCIL (Mar. 2011), http://www.nrdc.org/wildlife/animals/files/bees.pdf.

[10] Pettis & Delaplane, *supra* note 8, at 256 ("[F]or example, in almonds the fee per colony has risen from $75 to $150").

[11] COLONY COLLAPSE DISORDER PROGRESS REPORT, *supra* note 5.

[12] *Infra* Part I.

[13] *New Pesticide Labels Will Better Protect Bees and Other Pollinators*, Envtl. Protection Agency (Aug. 15, 2013), http://yosemite.epa.gov/opa/admpress.nsf/0/C186766DF22B37D485257BC8005B0E64, *archived at* http://perma.cc/GS96-746R.

no restrictions, prohibitions, or penalties.[14] Without teeth, the bee hazard icon is little more than a public service announcement asking pesticide users to comply.

Congress has also attempted to adopt legislation that would force EPA to confront colony collapse disorder with meaningful regulations, but these bills have routinely died in committee.[15] The bills that Congress has passed only fund research and reporting on colony collapse disorder and are noticeably void of solutions.[16]

After examining the science and history behind colony collapse disorder and discussing the shortcomings of alternative methods to curtailing it, this Note will advocate that an EPA regulation prohibiting neonicotinoid pesticides is the best solution to colony collapse disorder in the United States. As an actor empowered with national regulatory jurisdiction, EPA can simultaneously provide clear guidance to actors and avoid the collective action and game theory problems of free market solutions by issuing a neonicotinoid pesticide prohibition. The uniformity of such a ban would provide the certainty of reversing the colony collapse disorder trend to the extent that factors within the human population's control are contributing to the honey bee collapse.

I. COLONY COLLAPSE DISORDER EXPLAINED

A. History of Colony Collapse Disorder

Beekeeping is not a modern invention; the Egyptians began domesticating bees before 2600 BCE.[17] The practice then passed to the Greeks, who brought it to the Romans, who then introduced it to medieval Europe.[18] European colonists first brought the European Honey Bee, *Apis mellifera*, to the United States in the 17th century.[19] With the creation

---

[14] *See id.*

[15] *See* Saving America's Pollinators Act of 2013, H.R. 2692, 115th Cong. (died in committee, July 16, 2013); Farm, Nutrition, and Community Investment Act of 2007, S. 1424, 110th Cong. (died in committee, May 17, 2007); Pollinator Protection Act, H.R.1709, 110th Cong. (died in committee, Mar. 27, 2007).

[16] *See, e.g.*, 2008 Farm Bill, 122 Stat. 1651, 72044(h).

[17] Dennis vanEngelsdorp & Marina Doris Meixner, *A Historical Review of Managed Honey Bee Populations in Europe and the United States and the Factors that may Affect Them*, 103 J. INVERTEBRATE PATHOLOGY S80 (2010) [hereinafter *Historical Review*].

[18] *Id.*

[19] Tammy Horn, *Honey Bees: A History*, N.Y. TIMES (Apr. 11, 2008, 1:05 PM), http://topics.blogs.nytimes.com/2008/04/11/honey-bees-a-history/?module=Search$mabReward=relbias%3As, *archived at* http://perma.cc/R83H-LW2K.

of manmade apiary equipment, beekeeping became a viable industry in the 19th century.[20] Although the initial attraction to beekeeping was for honey cultivation, the bees' greatest value is their extremely efficient pollination abilities.[21]

Even though about 4,000 species of bees are native to the United States,[22] American beekeepers rely primarily on the European Honey Bee to pollinate crops.[23] Honey bees have larger populations than other bee species, with about thirty five hundred to over ten thousand foraging worker bees per colony.[24]

Unfortunately, this ancient practice has struggled significantly in the past couple decades due to colony collapse disorder. Since its high in 1947, the number of honey bee colonies in the United States has dropped by 61%.[25] Because identifying the cause of an individual hive's demise is difficult, the Congressional Research Service provided a list of common symptoms of colony collapse disorder that affect hives, including:

- Rapid loss of adult worker bees,
- Few or no dead bees found in the hive,
- Presence of immature bees (brood),
- Small cluster of bees with live queen present, and
- Pollen and honey stores in hive.[26]

Colony collapse disorder is particularly worrisome because United States beekeepers manage almost exclusively European Honey Bee colonies.[27] With farmers so dependent on a single species of bee, any potential threat to that species could be catastrophic; the bumblebee will not

---

[20] *Id.*
[21] *Historical Review*, *supra* note 17.
[22] BEATRIZ MOISSET & STEPHEN BUCHMANN, BEE BASICS: AN INTRODUCTION TO OUR NATIVE BEES 1 (2011), *available at* http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5306468.pdf.
[23] Jennifer Hopwood et al., *Are Neonicotinoids Killing Bees? A Review of Research Into the Effects of Neonicotinoid Insecticides on Bees, with Recommendations for Action*, XERCES SOC'Y FOR INVERTEBRATE CONSERVATION (2012), *available at* http://www.xerces.org/wp-content/uploads/2012/03/Are-Neonicotinoids-Killing-Bees_Xerces-Society1.pdf.
[24] *See Historical Review*, *supra* note 17, at S81.
[25] *Id.* at S80.
[26] RENÉE JOHNSON & M. LYNNE CORN, CONG. RESEARCH SERV., R43191, BEE HEALTH: BACKGROUND AND ISSUES FOR CONGRESS 2 (2014), *available at* http://www.fas.org/sgp/crs/misc/R43191.pdf.
[27] *See Historical Review*, *supra* note 17.

efficiently pick up pollinating where the European Honey Bee left off.[28] This is particularly problematic for managed hives because honey bees are "generalists," meaning that they pollinate a wide range of flowers.[29] Conversely, many native bees are "specialists," and only pollinate a few types of plants.[30] Furthermore, even if native bees, like the bumble bee, could effectively pollinate the plants traditionally pollinated by honey bees, colony collapse disorder adversely affects these bees, as well.[31] Although only responsible for about a fifth of the value of crops as European Honey Bees, native bees pollinate important domestic crops like squash and berries.[32]

B. Possible Causes of Colony Collapse Disorder

Unfortunately, colony collapse disorder does not appear to have a single cause; scientists believe that there are several interrelated reasons why colony collapse disorder occurs, including the varroa mite, nosema disease, monoculture, and pesticides.[33]

1. Varroa Mite

The parasitic varroa mite has already killed millions of bees.[34] Varroa mites create wing deformities in bees that quickly spread throughout the hive.[35] The varroa mite can also carry contagious viruses that affect honey bee gene expression.[36] Although the varroa mite clearly contributes to the recent increase in honey bee deaths, the USDA's 2010 progress report on colony collapse disorder found that varroa mites alone have not killed enough bees to fully explain the colony collapse disorder phenomenon.[37]

---

[28] Berry J. Brosi & Heather M. Briggs, *Single Pollinator Species Losses Reduce Floral Fidelity and Plant Reproductive Function*, 110 PROC. NAT'L ACAD. SCI. U.S. 13044, 13046 (2013); Zhiyuan Song & Marcus W. Feldman, *Adaptive Foraging Behavior of Individual Pollinators and the Coexistence of Co-flowering Plants*, 281 PROC. ROYAL SOC'Y 1, 7 (2013).
[29] Johnson & Corn, *supra* note 26, at 15; *Specialists vs. Generalists*, UC BERKELEY URBAN BEE LAB, http://www.helpabee.org/specialists-vs-generalists.html (last visited Jan. 15, 2015), *archived at* http://perma.cc/BY8C-5W56.
[30] *See Specialists vs. Generalists*, *supra* note 29.
[31] Moisset & Buchmann, *supra* note 22, at 30–31.
[32] Hopwood et al., *supra* note 23, at 2.
[33] *See Historical Review*, *supra* note 17, at S83.
[34] Stephen J. Martin et al., *Global Honey Bee Viral Landscape Altered by a Parasitic Mite*, 336 SCIENCE 1304 (2012).
[35] *Id.*
[36] *Id.*
[37] COLONY COLLAPSE DISORDER PROGRESS REPORT, *supra* note 5, at 1.

2. Nosema Disease

Nosema ceranae, a fungus, causes nosema disease in European honey bee hives worldwide.[38] Bees swallow spores of the fungus, which germinate and grow in the bees' stomach.[39] The fungus feeds on the host cell and can also infect adjacent healthy cells, further spreading the infection.[40] The disease easily spreads to other bees in the colony through the excrement of infected bees.[41] Although nosema infections can be devastating to hives, these incidents are usually isolated, and serious outbreaks are atypical, making *nosema ceranae* a relatively insignificant factor in colony collapse disorder.[42]

3. Monoculture

Monoculture and migratory beekeeping may be another factor causing colony collapse disorder. Bees can only collect pollen when plants bloom.[43] Consequently, when farmers plant a single crop for thousands of acres, like the giant California almond groves, bees only have a food source for that plant's particular blooming season.[44] After the crops finish blooming, local bees have no pollen left to forage, necessitating migratory beekeeping.[45] Trucking bees across the country creates stress and poor nutrition, leading to increased susceptibility to pesticides and diseases.[46] Although monoculture agricultural practices may account for some of the increased hive deaths, colony collapse disorder affects far more bees than those involved in migratory beekeeping.[47]

---

[38] Russell Goodman, *Nosema Disease of Honey Bees*, DEP'T ENV'T & PRIMARY INDUS. (Oct. 2009), http://www.depi.vic.gov.au/agriculture-and-food/pests-diseases-and-weeds/animal-diseases/bees/nosema-disease-of-honey-bees, *archived at* http://perma.cc/3TAN-2EYV.
[39] *Id.*
[40] *Id.*
[41] *Id.*
[42] *See id.*
[43] Dan Charles, *Wild Bees are Good for Crops, But Crops are Bad for Bees*, NAT'L PUB. RADIO (Mar. 1, 2013, 2:56 AM), http://www.npr.org/blogs/thesalt/2013/03/01/173167125/wild-bees-are-good-for-crops-but-crops-are-bad-for-bees, *archived at* http://perma.cc/92BM-VBCK.
[44] *Id.*
[45] Matina Donaldson-Matasci, *Honeybees and Monoculture: Nothing to Dance About*, SCI. AM. (June 7, 2013), http://blogs.scientificamerican.com/guest-blog/2013/06/07/honey-bees-and-monoculture-nothing-to-dance-about, *archived at* http://perma.cc/Y5VB-4N23.
[46] *Id.*
[47] *See Historical Review*, *supra* note 17, at S83.

4. Pesticides

More recently, scientists have focused on the promulgation of pesticides in modern agriculture and their link to colony collapse disorder.[48] Too much pesticide exposure can lead to lethal toxicity levels and directly cause bee death.[49] Scientists, however, have become increasingly interested in the indirect effects of pesticide exposure. For example, one study found that the mere presence of pesticides in the hive led to poor queen health, creating a less productive hive and an increased chance of a queenless colony.[50] Although there are dozens of different types of pesticides,[51] studies have primarily focused on neonicotinoids for their popularity and ill effects at even sublethal doses.[52]

C. Neonicotinoid Pesticides

EPA approved the first neonicotinoid, imidacloprid, in 1994 as an insecticide.[53] A derivative of nicotine, neonicotinoid pesticides work by binding to an insect's nicotinic receptors in the central nervous system, blocking nerve impulses.[54] Although neonicotinoids affect insects at a much lower dosage than mammals, researchers have already reported that the contemporary levels of this insecticide's use can be lethal to birds.[55] Even more troubling, the European Food Safety Authority believes neonicotinoids may affect neuron development in children and currently recommends additional studies to better understand this pesticide's full effect on humans.[56]

---

[48] *See, e.g.*, Erik Stokstad, *Field Research on Bees Raises Concern About Low-Dose Pesticides*, 335 SCIENCE 1555, 1555 (2012).
[49] *See Historical Review*, *supra* note 17, at S87.
[50] *See id.* at S89.
[51] *See* J. ROUTT REIGART & JAMES R. ROBERTS, RECOGNITION AND MANAGEMENT OF PESTICIDE POISONINGS 33–89 (5th ed. 1999), *available at* http://www.epa.gov/oppfead1/safety/healthcare/handbook/handbook.pdf (describing many different types of insecticides).
[52] Dan Charles, *Are Agriculture's Most Popular Insecticides Killing Our Bees?*, NAT'L PUB. RADIO (Mar. 25, 2013, 6:08 PM), http://www.npr.org/blogs/thesalt/2013/03/27/175278607/are-agricultures-most-popular-insecticides-killing-our-bees, *archived at* http://perma.cc/2H73-5DCU.
[53] Pierre Mineau & Cynthia Palmer, *The Impact of the Nation's Most Widely Used Insecticides on Birds*, AM. BIRD CONSERVANCY, 12 (Mar. 2013), http://www.abcbirds.org/abcprograms/policy/toxins/Neonic_FINAL.pdf.
[54] Meriel Watts, *Highly Hazardous Pesticides: Neonicotinoids*, PESTICIDE ACTION NETWORK ASIA & PAC. (Nov. 1, 2011), http://www.panap.net/sites/default/files/pesticides-factsheet-hhps-neonicotinoids.pdf.
[55] Mineau & Palmer, *supra* note 53, at 3.
[56] *EFSA Assesses Potential Link Between Two Neonicotinoids and Developmental Neurotoxicity*, EUR. FOOD SAFETY AUTH. (Dec. 17, 2013), http://www.efsa.europa.eu/en/press

There are seven different types of neonicotinoids, six of which are available in pesticide products.[57] Farmers can apply neonicotinoid pesticides directly to the plant or soil, or treat the seed itself before sowing.[58] Neonicotinoid particles can stay in the soil for months or years after application; consequently, untreated crops planted in the same soil as the previous year's treated crops can absorb the chemical residue from the last application.[59]

Even sublethal doses of neonicotinoids can cause significant damage to the hive. Studies have shown that low levels of neonicotinoid exposure have led to bee dysfunctions, defective navigation, and fewer queen bees.[60] Furthermore, scientists have found that exposure to neonicotinoid pesticides may lower bees' immune systems, making them more susceptible to harmful fungi and parasites, like the varroa mite and nosema disease.[61] In a recent study, researchers discovered that colony exposure to sublethal levels of imidacloprid significantly increased *nosema* growth compared to pesticide-free colonies.[62] Consequently, if crop producers simply decreased or ended neonicotinoid use altogether, they could thwart several different causes of colony collapse disorder simultaneously.

II. INEFFECTIVE SOLUTIONS TO COLONY COLLAPSE DISORDER

A. The Free Market

Considering that the farmers who apply neonicotinoid pesticides to their crops are the same farmers who rely upon the bees' pollination for their crops production and survival, it is tempting to believe that these farmers could solve the colony collapse disorder problem without government involvement. In theory, farmers would stop using neonicotinoids once the lack of pollinators affects their crop production more negatively than if they ceased applying neonicotinoid pesticides. This solution appears

---

/news/131217.htm, *archived at* http://perma.cc/P7KS-AA5Y; Danny Hakim, *European Agency Warns of Risk to Humans in Pesticides Tied to Bee Deaths*, N.Y. TIMES (Dec. 17, 2013), http://www.nytimes.com/2013/12/18/business/international/europe-warns-of-human-risk-from-insecticides.html, *archived at* http://perma.cc/DMX5-9U7H.

[57] Hopwood et al., *supra* note 23, at 3.

[58] *Id.*

[59] *Id.*

[60] Mason et al., *supra* note 1, at 8; Mickaël Henry et al., *A Common Pesticide Decreases Foraging Success and Survival in Honey Bees*, 336 SCIENCE 348, 348 (2012).

[61] *See* Mason et al., *supra* note 1, at 2.

[62] Jeffery S. Pettis et al., *Pesticide Exposure in Honey Bees Results in Increased Levels of the Gut Pathogen Nosema*, 99 NATURWISSENSCHAFTEN 153, 155 (2012).

simple enough, but the collective action[63] problem, coupled with the chemical properties of neonicotinoids, prevents this free market solution from becoming reality.

First, the competing interests of pesticide use and beehive health create a collective action issue. The same farmers who spray pesticides on bee pollinated crops also depend on those bees for their crops' production and survival.[64] If farmers continue to treat their crops with pesticides and bees continue to die off, the farmers will lose the very crops they are trying to protect due to lack of pollination. If, however, farmers collectively took action and decided to simultaneously stop applying pesticides, all farmers would be equally negatively affected. Pesticides provide protections for crops from harmful insects that can destroy plants,[65] so farmers obtain a greater crop production when using neonicotinoids.[66] But even assuming no alternative pest control methods existed, if all farmers faced decreased production levels, the decreased supply of bee-pollinated crops should lead to an equivalent increase in price.[67] Consequently, a nationwide decrease in bee-pollinated crop production should not severely impact farmers economically.

Unfortunately, curbing colony collapse disorder probably only requires a certain threshold of farmers to refrain from applying pesticides. This will incentivize farmers to become "free-riders," and continue to apply pesticides, taking advantage of increased production and a healthy

---

[63] In 1965, Mancur Olson first wrote about collective action theory in his book, The Logic of Collective Action. A collective action problem occurs when actors have an incentive to free-ride on the work of others. *See* Russell Hardin, *The Free Rider Problem*, STANFORD ENCYCLOPEDIA PHIL. (May 21, 2003), http://plato.stanford.edu/entries/free-rider/, *archived at* http://perma.cc/UK7X-5THA (defining the free-rider problem and discussing it in the context of the collective action theory). Examples of real-world collective action problems include: open source software, public radio, and climate change initiatives.

[64] Inadequate pollination causes deformities in some plants, like fruit. *Vegetable Gardening in Mississippi: Pollination*, MISSI. STATE UNIV. (Aug. 21, 2014), http://msucares.com/lawn/garden/vegetables/pollination, *archived at* http://perma.cc/UC5V-GVJW; *See Raspberries*, U.S. DEP'T AGRIC. (Apr. 7, 2009), http://www.ars.usda.gov/Research/docs.htm?docid=18366, *archived at* http://perma.cc/T4NX-SR72 (providing, under the heading "pollination," images of properly pollinated raspberries (left) versus inadequately pollinated raspberries (center and right)).

[65] E.C. Oerke & H.W. Dehne, *Safeguarding Production—Losses in Major Crops and the Role of Crop Protection*, 23 CROP PROTECTION 275, 275–76 (2004).

[66] *Id.* at 284.

[67] *See* Arnold C. Harberger, *Microeconomics*, *in* THE CONCISE ENCYCLOPEDIA OF ECONOMICS (2d ed. 2008), *available at* http://www.econlib.org/library/Enc/Microeconomics.html (describing the basic principles behind supply and demand), *archived at* http://perma.cc/GG6F-TPQW.

population of bees.[68] Because the system depends on a certain number of cooperating actors, a glut of free-riders would make any realized benefit unsustainable.

The unfortunate incentives created by colony collapse disorder's collective action issue are further exacerbated by a classic game theory problem.[69] The farmers who choose to cooperate will face the greatest costs. Those early adopters who stop spraying neonicotinoids on their crops first will face low production levels. Meanwhile, the free-riding farmers who defect and continue to treat their crops with neonicotinoids will benefit from increased crop production from the pesticide's insect protection. The cooperating farmer's lower crop production will lead to an overall decreased supply of bee-pollinated crops, consequently increasing the market prices. The free-riding defectors will obtain the greatest benefit with high crop production and slightly higher prices. Unfortunately, cooperating farmers will receive lower crop production and only a marginally increased price.

If all farmers cooperated, the more limited supply would lead to a greater increase in price that would more accurately reflect any crop loss from discontinued neonicotinoid use. Although cooperation provides the greatest overall benefit in this scenario, with imperfect information many farmers will choose to defect in fear of being the only cooperating actor and bearing all of the costs associated with compliance.[70]

The solubility and slow decay of neonicotinoid pesticides additionally complicate the collective action and game theory issues. Neonicotinoids are water soluble, meaning that the pesticide completely dissolves in

---

[68] Steven N. S. Cheung, *The Fable of the Bees: An Economic Investigation*, 16 J.L. & ECON. 11, 30–31 (1973). *See generally* Hardin, *supra* note 63 (defining the free-rider problem and providing examples).

[69] Game theory predicts human behavior in strategic decision-making. Game theory explains that if Actor A's defection creates a greater loss to Actor B than if both Actor A and B defected, then the actors may not cooperate even if their cooperation would produce the greatest overall benefit. *See generally* Thomas S. Ferguson, *Part III: Two-Person General-Sum Games*, *in* GAME THEORY III-1 (2d ed. 2014), *available at* http://www.math.ucla.edu/~tom/Game_Theory/bimat.pdf (explaining non-zero sum game theory scenarios with two actors).

[70] For example, suppose A and B both own apple orchards in Blackacre. If both A and B refrain from applying pesticides, they will have the same sustainable revenue, gaining the same benefit (Scenario 1). If both A and B defect, they will receive the same revenue, however the production levels will be unsustainable (Scenario 2). Finally, if A cooperates but B defects, A will have lower production levels than B, but will receive the same price per bushel, giving A less revenue than in Scenario 2 (Scenario 3). *See id.* at III-10–11 (giving an example of the classic "prisoner's dilemma" in game theory).

water, creating a homogenous solution.[71] Plants can easily absorb water soluble pesticides from the soil through their roots and leaves.[72] Furthermore, the typical half-life of neonicotinoids range from 200 to over 1000 days; this data suggests that significant concentrations of neonicotinoids may exist in the soil years after application.[73] Consequently, future untreated crops can absorb the water soluble neonicotinoids leftover from previous applications.[74] Even if farmers voluntarily abstained from applying neonicotinoid pesticides after noticing a decrease in crop pollination, colony collapse disorder could persist for years.

B. Tort and Property Laws

Traditionally, courts have looked at holding pesticide users liable for tort and property damages in the context of "pesticide drift," or when pesticides physically drift onto a neighbor's property.[75] However, bees are not easily confined and seek food across property lines.[76] Furthermore, unlike other foraging animals such as sheep and cattle, traditional methods of excluding animals, like erecting fences, will not bar bees from entry. So bees' primary exposure to pesticides derives not from the pesticide physically invading the bees' hive, but rather from the bees entering farmers' property and pollinating their pesticide-treated crops. The pesticide-drift cases do not adequately address the primary problem of colony collapse disorder: farmers applying pesticides properly to their own land. Unfortunately, partially due to the dearth of cases explaining the duty of care a pesticide-applying landowner owes to neighboring foraging bees, the standards courts apply to pesticide cases vary greatly by jurisdiction and provide little clarity.[77]

---

[71] Dave Goulson, *An Overview of the Environmental Risks Posed by Neonicotinoid Insecticides*, 50 J. APPLIED ECOLOGY 977, 979 (2013).
[72] *Id.* at 977.
[73] *Id.* at 979–80.
[74] *See id.* at 979.
[75] Melanie Triplett, Note, *Case Note: Torts—Buzz Off! Expanding the Scope of a Landowner's Duty to Honey Bees Flying Along the Fine Line of Trespassing in* Anderson v. State Department of Natural Resources, 32 WM. MITCHELL L. REV. 1489, 1490 (2006).
[76] *How Far Do Bees Fly? One Mile, Two Seven? And Why?*, CROWN BEES (June 2002), http://www.beesource.com/point-of-view/joe-traynor/how-far-do-bees-fly-one-mile-two-seven-and-why/, *archived at* http://perma.cc/7CUN-X87H; *see* James R. Hagler et al., *Foraging Range of Honey Bees,* Apis Mellifera*, in Alfalfa Seed Production Fields*, 11 J. INSECT SCI., no. 144, 2011 at 1, 6–7, *available at* http://jinsectscience.oxfordjournals.org/content/jis/11/1/144.full.pdf.
[77] *See* Triplett, *supra* note 75, at 1502–03.

Some states, like Oregon, have found pesticide application to be an ultrahazardous activity and apply a strict liability standard to damages caused by application.[78] Courts, however, have only applied this standard to the traditional pesticide-drift cases,[79] so it is unclear whether or not courts would use the same liberal liability standard in a case involving foraging honey bees.

Other states that have looked at foraging bees find that pesticide applicators have a statutory duty to follow the pesticide's labeling guidelines.[80] Although the Federal Insecticide, Fungicide, and Rodenticide Act's ("FIFRA") prohibition on using pesticides against the label instructions does not provide a private right of action,[81] many states have created their own similar regulation that grants individual plaintiffs this right.[82] For example, the Wisconsin Supreme Court found that, while pesticide application is not an ultrahazardous activity warranting a strict liability standard, because Wisconsin has a statute requiring compliance with labeling instructions, farmers who applied pesticide against the label instructions were found liable for the deaths of local honey bee colonies via a negligence per se standard.[83]

Some jurisdictions have chosen to apply a traditional negligence standard with pesticide applicators.[84] For example, the Minnesota Supreme Court found that landowners who have knowledge or notice of foraging honey bees on their property owe a duty of reasonable care when applying pesticides.[85] Unfortunately, the court did not explain what "reasonable care" means; it could be as simple as providing notice to local beekeepers, or as severe as a prohibition against spraying during blooming periods.[86] Furthermore, even though Minnesota has an online database where beekeepers are required to register their hives, it is the beekeeper's responsibility to inform all local farmers of the proximity of their apiaries.[87]

---

[78] Loe v. Lenhardt, 362 P.2d 312, 317–18 (Or. 1961).
[79] *See* Theodore A. Feitshans, *An Analysis of State Pesticide Drift Laws*, 9 SAN JOAQUIN AGRIC. L. REV. 37, 48, 51–53, 65, 82, 84 (1999).
[80] *See, e.g.*, Bennett v. Larsen Co, 348 N.W.2d 540, 549–50 (Wis. 1984).
[81] *See* Bates v. Dow Agrosciences, LLC, 544 U.S. 431, 448 (2005); Voss v. Saint Martin Co-op, 376 F. App'x. 662, 663 (8th. Cir. 2010).
[82] *See, e.g.*, WIS. STAT. ANN. § 94.70(3)(g) (West 2013) (prohibiting the "'u]se [of] any pesticide in a manner inconsistent with its labeling except as authorized by the department.").
[83] Bennett, 348 N.W.2d 540, 549–50 (Wis. 1984).
[84] Anderson v. State Dep't of Natural Res., 693 N.W.2d 181 (Minn. 2005).
[85] *Id.* at 192.
[86] *Id.*
[87] *Id.* at n.3.

Furthermore, in a negligence action, beekeeper plaintiffs may find it difficult to prove the nexus between the pesticide application and the subsequent honey bee deaths.[88] As discussed in Part I, neonicotinoid pesticides can lower bees' immune systems, making them more vulnerable to other lethal parasites and fungi. It may be difficult for a beekeeper to prove that, although their colony ultimately died from the varroa mite, neonicotinoid exposure was the proximate cause of the hive's demise. Additionally, because even sublethal doses of neonicotinoids affect bees adversely, it is unclear what threshold of exposure courts would require when determining cause.[89]

Courts have also applied private nuisance, trespass, and vicarious liability theories when dealing with damages from modern pesticide use.[90] Many variations throughout and even within jurisdictions make enforcement and deterrence confusing and inefficient.[91] Relying on private tort and property actions as they currently stand will not create the necessary incentives to stop neonicotinoid use and control colony collapse disorder. Even in states that find the landowner liable for pesticide applications, with so many different common law rules and legal standards to follow, farmers are probably unaware of their duties to bees that forage on their property.

C. State Regulation

Some states have issued their own regulations to combat colony collapse disorder in the absence of common law. Agricultural giant California currently has the most stringent laws, prohibiting farmers from spraying bee-pollinated crops with certain pesticides during bloom times.[92] Additionally, farmers must notify local beekeepers before spraying these pesticides.[93] Unfortunately, this regulation is not a prohibition, just a limitation. Considering neonicotinoids' persistence in the soil, anything short

---

[88] *See* Triplett, *supra* note 75, at 1501 (describing how, between 2001 and 2002, beekeepers in Minnesota lodged eighteen complaints about negligent pesticide application, yet only two were found to have sufficient evidence linking the bee deaths to pesticide exposure).
[89] *Supra* Part I.B.4.
[90] Alexandra B. Klass, *Bees, Trees, Preemption, and Nuisance: A New Path to Resolving Pesticide Land Use Disputes*, 32 ECOLOGY L.Q. 763, 792–93 (2005).
[91] *See id.*
[92] CAL CODE REGS. tit. 3 §§ 6650–6656 (2014), *available at* http://www.cdpr.ca.gov/docs/legbills/calcode/030203.htm, *archived at* http://perma.cc/NY7A-T29M.
[93] Ann N. Coenen-Davis, Note, *The Mystery of the Disappearing Honeybee: Will Government Funding and Regulation Save This Important Pollinator?*, 14 DRAKE J. AGRIC. L. 175, 192–93 (2009).

of prohibition may be ineffective.[94] This regulation also assumes that notified beekeepers will have alternative locations to send their bees during pesticide application periods. Even if they do, studies have shown that moving bees creates stress in the colony, leading to lowered immune systems and increased susceptibility to colony collapse disorder.[95]

In New Jersey, the legislature is considering a bill that would prohibit the use or sale of neonicotinoid pesticides.[96] The bill proposes a $500 fine for the first offense, a $1000 fine for each subsequent offense, and the ability to gain injunctive relief to prevent further offenses.[97] However, as of the time of this article's publication, this bill is still in committee and it is unclear if it will pass. Other states have passed less stringent regulations, such as Iowa's law preventing commercial application of pesticides toxic to bees between eight in the morning and six in the evening.[98] Unfortunately, while limiting pesticide application to times when bees are least active may avoid direct application of these chemicals to bees, it does not address the far more prevalent problem of bees' exposure to pesticides through pollinating treated plants.

Although some states like California and possibly New Jersey are taking initiative, many states have done nothing.[99] Even if states did exert more control over neonicotinoid pesticide use, they would probably adopt different regulatory standards, leading to confusion for farmers and pesticide companies. Furthermore, like the collective action problem with individual farmers, states may not want to disadvantage their agricultural businesses by applying stricter standards than other states. The best type of regulation or law would be applied nationwide to provide clarity and fairness to all farmers.

---

[94] Goulson, *supra* note 71, at 979–80.

[95] Alexei Barrionuevo, *Honeybees, Gone With the Wind, Leave Crops and Keepers in Peril*, N.Y. TIMES (Feb. 27, 2007), http://select.nytimes.com/gst/abstract.html?res=F10B1FF8355A0C748EDDAB0894DF404482, *archived at* http://perma.cc/4JGD-SMLT.

[96] H.R. 4349, 215th Gen. Assemb., Reg. Sess. (N.J. 2013) (still in committee as of the time of this article's publication).

[97] *Id.*

[98] IOWA ADMIN. CODE r.21-45.31(206) (2014).

[99] *See, e.g.*, PESTICIDE & FERTILIZER PROGRAM, KAN. DEP'T AGRIC., KANSAS PESTICIDE LAW (2014), *available at* http://agriculture.ks.gov/docs/default-source/statutes-pesticide-fertilizer/pesticide.pdf?sfvrsn=2 (failing to mention bees); BUREAU PESTICIDE CONTROL. MO. DEP'T AGRIC., MISSOURI PESTICIDE USE ACT (2014), *available at* http://mda.mo.gov/plants/pdf/pesticideuseact.pdf (failing to mention bees); CONSUMER PROT. SERVS., OKLA. DEP'T AGRIC., COMBINED PESTICIDE LAW & RULES: UNOFFICIAL COPY (2014), *available at* http://www.ok.gov/~okag/forms/cps/cpl.pdf (failing to mention bees).

D. Congress

Some senators and representatives have introduced bills that would force EPA to confront colony collapse disorder with meaningful, penalty-based regulation.[100] Congress has the ability to ban or limit neonicotinoid use through its commerce clause powers, however, considering all of these bills have died in committee, Congress seems to be unable to use this ability.[101] Thus far, the bills that Congress has been able to pass have only funded USDA studies to monitor and report on the status of colony collapse disorder and, to a lesser extent, the effect of pesticides on colony collapse disorder.[102]

Unfortunately, because of the aforementioned free market issues, Representatives of agricultural states may be reluctant to vote for prohibitions on neonicotinoid pesticide production and use. Representatives and Senators are incentivized to follow their constituents' wishes, so if farmers in agricultural states do not want to stop spraying neonicotinoids, their Representatives do not have the proper incentives to take the paternalistic approach necessary to restrain colony collapse disorder.

With two-year and six-year terms, Congress has an incentive to only focus on short-term issues. Colony collapse disorder, on the other hand, requires thinking in the long-term; although crop producers may initially notice a decrease in production levels by ceasing neonicotinoid pesticide applications, the ramifications if this practice does not stop will be significantly greater than a temporary decrease in production. Because the most dire problems with colony collapse disorder are unlikely to occur in the next two to six years, Congress simply lacks the incentive necessary to face the colony collapse disorder problem.

E. An EPA Emergency Prohibition

If EPA determines that "the continued use of a pesticide during the time required for [a] cancellation proceeding would be likely to result in

---

[100] *See, e.g.*, Saving America's Pollinators Act of 2013, H.R. 2692, 113th Cong. (2013) (died in committee); Farm, Nutrition, and Community Investment Act of 2007, S. 1424, 110th Cong. (2007) (died in committee); Pollinator Protection Act, H.R. 1709, 110th Cong. (2007) (died in committee).

[101] *See, e.g.*, H.R. 2692 (died in committee); S. 1424 (died in committee); H.R. 1709 (died in committee).

[102] *See, e.g.*, 2008 Farm Bill, 122 Stat. 1651, 7204(h) (appropriating $10,000,000 per year from 2008 to 2012 for research grants to study colony collapse disorder, including insecticides).

unreasonable adverse effects on the environment or will involve unreasonable hazard to the survival of a species declared endangered or threatened,"[103] an "imminent hazard" exists and EPA has the authority to immediately suspend the pesticide's registration.[104]

Using the imminent hazard provision to avoid the admittedly laborious process of instituting an entirely new regulation might sound appealing. In 2012, a group of beekeepers attempted to force EPA to use the imminent hazard provision by petitioning the agency to suspend the registration of clothianidin, a type of neonicotinoid.[105] EPA's response suggests that neonicotinoids are unlikely to fall under the strict requirements of the imminent hazard standard.

First, EPA disagreed that clothianidin was causing colony collapse disorder, and listed the other usual suspects—pathogens and parasites—as causes.[106] Again, because of the problems connecting the serious secondary effects of non-lethal exposure, qualifying neonicotinoids as an imminent hazard will prove difficult. Furthermore, an "imminent" hazard requires that the hazard is likely to occur in one to two years; the petitioners were unable to cite any evidence supporting the imminence of colony collapse disorder because current studies solely focus on causes and solutions, not predicting the future.[107]

Consequently, EPA denied the petitioners' request to suspend clothianidin.[108] To succeed with an imminent hazard, the colonies suffering from secondary effects of neonicotinoid exposure must be identifiable, and colony collapse disorder must reach such catastrophic levels to create a hazard within one to two years. In the near future, utilizing EPA's imminent hazard provision will not be a viable solution to colony collapse disorder.

---

[103] 7 U.S.C. § 136(*l*) (2012).
[104] Letter from Stephen P. Bradbury, Dir., Office of Pesticide Programs, U.S. Envtl. Prot. Agency, to Steve Ellis, Sec'y, Nat'l Honey Bee Advisory Bd. et al. (Feb. 18, 2011), *available at* http://www.epa.gov/pesticides/about/intheworks/clothianidin-response-letter.pdf.
[105] CTR. FOR FOOD SAFETY, EMERGENCY CITIZEN PETITION TO THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY SEEKING SUSPENSION OF REGISTRATION FOR CLOTHIANIDIN 31–33 (2012), *available at* http://www.beyondpesticides.org/pollinators/documents/CFS-Clothianidin-Petition-3-20-12.pdf.
[106] Letter from Stephen P. Bradbury, Dir., Office of Pesticide Programs, U.S. Envtl. Prot. Agency, to Peter T. Jenkins, Ctr. for Food Safety & Int'l Ctr. for Tech. Assessment 11 (July 17, 2012), *available at* http://www.epa.gov/pesticides/about/intheworks/epa-respns-to-clothianidin-petition-17july12.pdf.
[107] *Id.*
[108] *Id.* at 10.

F. Limiting Neonicotinoid Use

The most viable alternative to an outright ban on neonicotinoid use would be for EPA to issue a limitation on neonicotinoid use. A limitation would solve many of the same problems as a ban. The collective action and game theory difficulties associated with a free market solution would be corrected by creating greater consequences to defecting and free riding, thus incentivizing cooperative behavior. Additionally, because the limitation would still be issued by EPA, the national reach of an EPA limitation regulation would clarify the law and consequences for pesticide applicators currently only subject to various tort and property laws. Finally, since EPA does not have the same incentives as Congress, EPA can focus on long-term problems like colony collapse disorder, and pass regulations that may have minor negative short-term consequences.

Despite these similarities, a ban on neonicotinoid use is still the best solution to the colony collapse disorder problem. It is tempting to believe that a limitation would be better because simply limiting neonicotinoid use would allow farmers to utilize the pest-controlling powers of the pesticide while simultaneously limiting its harmful effect on bees; however, the choice between neonicotinoid use/pest control and no neonicotinoid use/no pest control is a false dichotomy. There are many alternatives to neonicotinoids that do not harm bees, including hydroponic farming, bee friendly pesticides, and crops that are genetically modified to target only pestilent insects.[109] Consequently, banning neonicotinoids will not put farmers at the mercy of beetles, aphids, and other harmful pests.

Most importantly, limiting neonicotinoid use may also be ineffective at curbing colony collapse disorder. As discussed above, studies have found that even small, sublethal levels of neonicotinoid exposure can lead to colony deaths through decreased navigation skills and immune systems.[110] Because the ancillary effects associated with low neonicotinoid exposure can still be extremely harmful, neonicotinoid limitation is a poor substitute for an outright ban. Additionally, the chemical properties of neonicotinoids would further complicate any proposed limitation. As discussed above, neonicotinoids are water soluble and can have a relatively long half-life.[111] Because the neonicotinoids can build upon a previous year's application, in order to accurately determine whether bees

---

[109] *Infra* Part III.
[110] *Supra* Part I.
[111] *Supra* Part II.

will be exposed to a lethal amount of neonicotinoid pesticides, farmers will have to take soil samples to determine the current level of neonicotinoids in the ground.

Although these measurements are possible, they raise enforcement questions. Would the limitation include an assumed amount of leftover neonicotinoid from the previous year's application? If not, could EPA accurately assume a certain level and limit farmers' applications in consecutive years? If so, would farmers need to report their current soil level of neonicotinoids to EPA before being allowed to apply additional pesticides? A limitation would be far more complex to institute, more cumbersome for EPA to regulate, and overall less effective than a complete ban on neonicotinoid use.

III. EPA REGULATION

A. Why an EPA Regulation is Efficient

An EPA regulation prohibiting the use and sale of neonicotinoid pesticides is the most efficient solution for dealing with colony collapse disorder. Unlike the free market, an EPA regulation can encourage cooperative behavior through purposeful incentives. By creating penalties for using and selling neonicotinoids, the cost of obtaining and applying pesticides increases to the point where the benefits of increased production are no longer worth the cost of the violation.[112] This incentive structure would solve both the collective action free-rider and the game theory defector problems.

Additionally, a bright-line prohibition from EPA would be easy for farmers to follow, serving as a better deterrent than the varied and confusing common law tort and property laws that courts currently apply.[113] Furthermore, as an actor with nationwide jurisdiction, EPA's regulations would force all farmers nationwide to simultaneously stop using this pesticide, avoiding unfairly advantaging or disadvantaging any particular farmer or region.

Finally, an action by an administrative agency does not require further ratification from Congress. Consequently, EPA does not face the same incentives as individual Congress members, and can be more focused on long-term interests.

---

[112] *See* Donald I. Baker, *The Use of Criminal Law Remedies to Deter and Punish Cartels and Bid-Rigging*, 69 GEO. WASH. L. REV. 693, 697 (2001).

[113] *Id.* ("Any system that is based on deterrence—and fairness—must have clear rules.").

B. Alternative Pest Control Methods

Banning neonicotinoid pesticides will not mean the end of pest control for farmers. Many alternative methods of controlling unwanted insects exist. Between novel gene targeting, bee friendly insecticides, and hydroponic farming, crop producers have many options for protecting their plants from harmful creatures without neonicotinoids.

Perhaps the most promising and interesting alternative is RNA[114] interference ("RNAi"). RNAi regulates gene expression, and can work as an incredibly effective pesticide by silencing the genes necessary for an insect's survival.[115] Because this technique targets a specific gene sequence to obstruct, it can kill pestilent insects without affecting desirable ones like bees.[116] This method is so precise that scientists were able to use RNAi to kill one species of fruit fly without affecting the other three.[117] Seed companies can equip seeds with the RNAi technology so that each plant has a built-in pesticide that will not harm the bees it relies on for survival.[118] Monsanto has already successfully developed this technology in corn, and advanced the pest-resistant crop to its final research and development stage.[119]

Additionally, other bee friendly insecticides may be used in lieu of neonicotinoid and other colony collapse disorder–causing chemicals. For example, *bacillus thuringiensis* is a bacteria poisonous to some insects, like beetles, without negatively affecting bees.[120] Flonicamid protects crops from aphids and whiteflies,[121] while remaining relatively harmless

---

[114] Ribonucleic acid ("RNA"), is a copy of DNA (deoxyribonucleic acid) that cells need to survive and multiply. *What is RNA?*, RNA SOCIETY, http://www.rnasociety.org/about/what-is-rna/ (last visited Jan. 15, 2015), *archived at* http://perma.cc/KGX4-9CQC. RNA reads its copy of the organism's genetic code to produce the proteins necessary for the cell to function.

[115] John P. Burand & Wayne B. Hunter, *RNAi: Future in Insect Management*, 112 J. INVERTEBRATE PATHOLOGY S68, S71 (2013). For a less jargon-filled explanation, see Kai Kupferschmidt, *A Lethal Dose of RNA*, 341 SCIENCE 732 (2013).

[116] Kupferschmidt, *supra* note 115, at 733.

[117] *Id.*

[118] *See id.* at 732–33.

[119] *Annual R&D Pipeline Review*, MONSANTO, at 12 (Jan. 8, 2014), http://www.monsanto.com/investors/Documents/2014/2014.01.07_R-D_Update_Presentation.pdf ("CRW III Advances to Phase 4").

[120] ERIC MADER & NANCY LEE ADAMSON, XERCES SOC'Y FOR INVERTEBRATE CONSERVATION ORGANIC-APPROVED PESTICIDES: MINIMIZING RISKS TO BEES 3 (2012), *available at* http://www.xerces.org/wp-content/uploads/2009/12/xerces-organic-approved-pesticides-factsheet.pdf.

[121] Masayuki Morita et al., *Flonicamid, a Novel Insecticide with a Rapid Inhibitory Effect on Aphid Feeding*, 63 PEST MANAGEMENT SCI. 969, 969 (2007).

to bees.[122] There are dozens of other effective, bee friendly pesticides currently on the market.[123] Clearly, crop producers have alternative pesticide options to control insects without killing necessary pollinators.

Hydroponic farming, which involves growing plants in water instead of dirt, can be an incredibly efficient solution to pest problems.[124] This type of soil-free crop production is not new; the Hanging Gardens of Babylon were likely hydroponically grown, and the Aztecs used hydroponic methods when floating rafts of crops in Lake Tenochtitlán.[125] Because hydroponics produce significantly more food per square acre than traditional farming methods,[126] hydroponic farms are smaller and are frequently enclosed in either glass or plastic greenhouses for longer growing seasons and a more controlled environment.[127] These enclosed and highly regulated environments require little to no pesticides to protect their plants from unwanted insects.[128] Hydroponic farmers can incorporate bee colonies inside their enclosed farms, creating a pest-free, sustainable ecosystem.

Although hydroponic farms have a higher start-up cost, they are becoming increasingly popular due to their great efficiency compared to traditional soil farms, and for their environmentally friendly cultivation

---

[122] CHRISTIAN H. KRUPKE ET AL., BEEKEEPING: PURDUE DEP'T ENTOMOLOGY, E-53-W PROTECTING HONEY BEES FROM PESTICIDES 5 (2012), *available at* http://extension.entm.purdue.edu/publications/E-53.pdf.

[123] *See* Mader & Adamson, *supra* note 120.

[124] Callie Seaman & Neil Bricklebank, *Soil-Free Farming*, 6 CHEMISTRY & INDUS. 19, 19–20 (Mar. 21, 2011).

[125] GERHARDUS VENTER, SUCCESSFUL HYDROPONICS: 21ST CENTURY TECHNOLOGY FOR COMMERCIAL AND HOME APPLICATIONS 71–76 (2010).

[126] Seaman & Bricklebank, *supra* note 124, at 20 (explaining how, in 2009, 200 hectares of hydroponic farms in the UK produced 87,000 tons of tomatoes, which would have required 3520 hectares of traditional soil farms).

[127] *See, e.g.*, *Cornell Controlled Environment Agriculture*, CORNELL UNIV. BIOLOGICAL & ENVTL ENGINEERING, http://www.cornellcea.com/ (last visited Jan. 15, 2015), *archived at* http://perma.cc/2R6E-M5E9; Ned Madden, *The Future of Farming, Part 1: Controlling the Environment*, TECHNEWSWORLD (Aug. 6, 2013, 5:00AM), http://www.technewsworld.com/story/78646.html, *archived at* http://perma.cc/EN8J-PE9X.

[128] *See* Judith Blake, *Dirtless Farms—Hydroponics Use Fewer Pesticides to Produce Vegetables and Herbs*, SEATTLE TIMES (Oct. 11, 1995), *available at* http://community.seattletimes.nwsource.com/archive/?date=19951011&slug=2146182, *archived at* http://perma.cc/32PL-4Q5K; *Hydroponics, Know Your Food, and Starting a Farm: Farmer Jeff Barton*, MYFRESHLOCAL (MAR. 22, 2012), http://www.myfreshlocal.com/articles/article_detail/hydroponics-starting-a-farm-and-know-your-food-farmer-jeff-burton, *archived at* http://perma.cc/CRG2-BJ95; *Why Hydroponics?*, EDEN URBAN FARMS, http://www.edenurbanfarms.com/hydroponics/ (last visited Jan. 15, 2015), *archived at* http://perma.cc/F7HG-FPNH.

methods.[129] Although not all farms will be able to convert to a hydroponic system, this efficient technique could offset some of the initial production losses from abstaining or limiting neonicotinoid use.

C. Potential Barriers

Although an EPA prohibition is the most efficient solution to colony collapse disorder, there are some potential complications. A common argument against any pesticide prohibition is that pesticides are not the only cause of colony collapse disorder.[130] Mites, monoculture, fungi, migratory beekeeping, etc. have also been linked to colony collapse disorder.[131] Although these other factors may contribute to colony collapse disorder, because neonicotinoids increase the bees' susceptibility to these other causes by lowering the bees' immune system,[132] prohibiting neonicotinoids should lower the deaths associated with all of these alternative explanations. Additionally, current evidence suggests that pesticides are the greatest cause of colony collapse disorder.[133]

Another potential issue stems from EPA's own procedural requirements when instituting new regulations. Since President Reagan, every president has stipulated by executive order that EPA must complete a cost-benefit analysis before issuing any regulation;[134] however, an accurate cost-benefit analysis should not compare the cost of no pest control to the status quo. First, no existing or upcoming technology can pollinate crops efficiently, meaning that a very real cost of continuing neonicotinoid use should contemplate the endangerment of all of the plants that rely

---

[129] *See* Seaman & Bricklebank, *supra* note 124, at 19–20; James Haggerty, *Hydroponic Businesses Grow After Food-Safety Concerns, Popularity of Locally Grown*, TIMES-TRIB. (May 5, 2013), http://thetimes-tribune.com/news/business/hydroponic -businesses-grow -after-food-safety-concerns-popularity-of-locally-grown-1.1483983, *archived at* http://perma.cc/HZ5Y-G454; Tonya Layman, *Hydroponics, Low-Water Gardens More Popular*, ATLANTA BUS. CHRONICLE (June 29, 2012, 6:00 AM), http://www.bizjournals.com/atlanta/print-edition/2012/06/29/hydroponics-low-water-gardens-more.html?page=all, *archived at* http://perma.cc/M8BP-UL6J.

[130] Alberto Alemanno, *The Science, Law and Policy of Neonicotinoids and Bees: A New Test Case for the Precautionary Principle*, 4 EUR. J. RISK REG. 191 (2013).

[131] *Supra* Part I.

[132] Mason et al., *supra* note 1.

[133] Chensheng Lu et al., *In Situ Replication of Honey Bee Colony Collapse Disorder*, 65 BULL. INSECTOLOGY 99, 99 (2012).

[134] Cass R. Sunstein, *The Stunning Triumph of Cost-Benefit Analysis*, BLOOMBERG VIEW (Sept. 12, 2012 6:30 PM), http://www.bloombergview.com/articles/2012-09-12/the-stunning-triumph-of-cost-benefit-analysis, *archived at* http://perma.cc/6EBD-AZVB.

on honey bee pollination to reproduce, as well as the poor quality of fruits and vegetables that need adequate pollination to yield viable produce.[135]

Furthermore, as discussed above, alternative methods for pest control currently exist.[136] Crop producers currently relying on neonicotinoids to protect their plants will not be defenseless in the event of a ban. Between bee friendly insecticides, RNAi equipped plants, and hydroponic farming methods, the costs associated with abstaining from neonicotinoid use should take these advancements into account. Consequently, the cost of an EPA prohibition on neonicotinoids would not be a lack of pesticides, but rather potentially more effective alternatives.

An understaffed EPA may create an additional enforceability problem. Critics have pointed to EPA's understaffing in its investigation unit as evidence that EPA cannot properly enforce its own regulations.[137] Even assuming this is true, the regulation could allow farmers, municipalities, beekeepers, and other interested parties to privately sue farmers and corporations who violate the regulation with a private right of action in addition to EPA's sanctions.[138] Furthermore, compared to simply limiting neonicotinoid application, an outright ban on the sale and use of this insecticide would be easier to enforce. A ban would force farmers to turn to a black market in order to obtain the prohibited pesticides. A limitation would not only be less effective,[139] but would also require EPA to closely monitor each application, significantly increasing enforcement costs.

By limiting the availability of neonicotinoids, more farmers would stop using this bee-killing toxin outright, lowering bees' exposure to the pesticide and limiting both its direct effects—poisoning—and its lethal secondary effects—decreased health and navigation. Consequently, an EPA prohibition on neonicotinoids should be an effective method to prevent colony collapse disorder.

CONCLUSION

With the potential loss of about one third of our food supply, unchecked colony collapse disorder could lead to catastrophic problems

---

[135] Rosner, *supra* note 9, at 74.
[136] *Supra* Part III.B.
[137] *See* Brandon Keim, *EPA's Pollution-Busting Cops Have Lost Focus, Say Watchdogs*, WIRED (Sept. 15, 2010, 3:53 PM), *available at* http://www.wired.com/wiredscience/2010/09/obama-epa-investigations, *archived at* http://perma.cc/WK9H-PBX5.
[138] By focusing on beekeepers, farmers, and local communities, standing should not be an issue. All of these parties would face harm from continued neonicotinoid pesticide use.
[139] *Supra* Part II.F.

for the United States. Although parasites, fungal diseases, and migratory beekeeping contribute to colony collapse disorder, scientific literature suggests that neonicotinoid pesticides are the worst offender.[140] Furthermore, unlike parasites and fungus, as a human-made and human-applied product, pesticide use can be controlled.

Any free market solution to restrain colony collapse disorder would face collective action and game theory problems. Free riders and defectors currently face no regulation that incentivizes cooperation. Without regulation to incentivize behavioral changes, the status quo is likely to continue. Common law tort and property actions are a poor substitute for nationwide regulation, as they are currently too varied and difficult to provide a clear deterrence to pesticide users. State regulations may help limit colony collapse disorder in certain regions but will be unable to solve the nationwide problem. Furthermore, outside of agreeing to fund research, Congress's attempts to address colony collapse disorder have yet to make it out of committee, probably due to the incentive to focus on short-term goals. An EPA emergency prohibition will also be untenable until beekeepers can properly identify the colonies suffering secondary effects of neonicotinoids and colony collapse disorder is on the verge of causing an environmental hazard. Finally, a limitation on neonicotinoid use would be both inefficient and difficult to enforce.

As a centralized actor, EPA is in the best position to stop colony collapse disorder. Because EPA's jurisdiction is nationwide, its regulations will provide pesticide users with clear rules not subject to the whims of judges. Furthermore, because of the chemical properties of neonicotinoids, an EPA regulation prohibiting the sale and use of neonicotinoid pesticides is the most practical and efficient way to solve colony collapse disorder. With a propensity to stay in the soil for up to years after use,[141] simply limiting the application period to crops' nonblooming season may not be an effective measure against the chemical's harmful effects. Consequently, an outright ban on the sale and use of neonicotinoids is the only viable way to ensure that bees will not be exposed to the water-soluble chemical.

Although an EPA regulation that prohibits neonicotinoid use and sale faces some challenges, it is still the most efficient solution. As an administrative agency, EPA must first complete a cost-benefit analysis before it may issue any new regulations. Scientists, however, have already developed many alternative forms of pest control, like bee friendly pesticides, controlled farming environments, and RNA interference; meanwhile, no

---

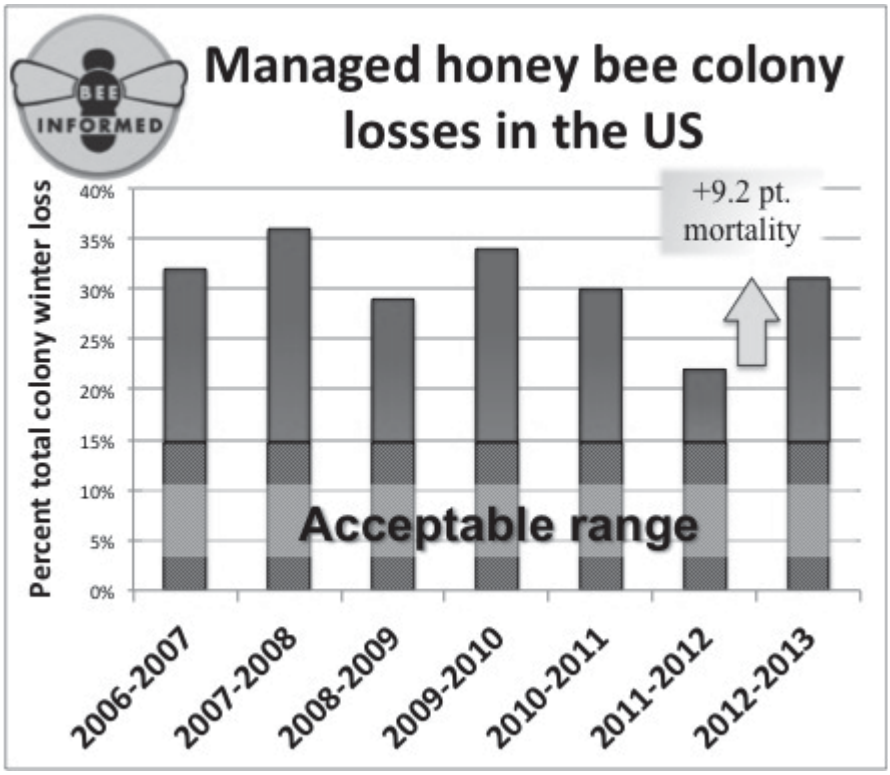
[140] *Supra* Part I discussion.
[141] Goulson, s*upra* note 71, at 979–80.

current technology can pollinate crops at anywhere near the efficiency of the honey bee. Because current scientific progress suggests that it will be easier to develop an alternative pest control system than an alternative pollinator, a cost-benefit analysis comparing continuing neonicotinoid use with a neonicotinoid ban should clearly favor a prohibition.

Finally, although EPA may not have the resources to investigate and enforce every infraction, an outright prohibition would force neonicotinoids into the black market, severely limiting the available supply and incentivizing alternatives. Furthermore, EPA could allow beekeepers and communities to use the prohibition as a basis for a private cause of action against violators, and to collect damages for exposed apairies.

Considering the grave consequences associated with colony collapse disorder and the availability of viable alternatives to neonicotinoid use, an EPA regulation banning neonicotinoids is necessary for America's future as an agricultural giant. In the short term we may face increased prices for crops dependent on bee pollination. In the long term, farmers may switch to crops that do not require bees to survive and produce, driving up the costs of these crops even further. It is easy to forget about such a small cog in the circle of life; however, continuing to place greater value on short-term production than on bee colony fidelity may prove catastrophic to the United States' food supply. EPA must live up to its duty of protecting the United States from this grave future by issuing regulations that save bee health.

APPENDIX A



APPENDIX B