2019-12

PLAN BEE—UNDERSTANDING THREATS TO THE HONEY BEE POPULATION AND EXAMINING STRATEGIES TO PROMOTE AND PROTECT POLLINATORS

Pfrogner, Mildred G.

Monterey, CA; Naval Postgraduate School

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

PLAN BEE—UNDERSTANDING THREATS TO THE HONEY BEE POPULATION AND EXAMINING STRATEGIES TO PROMOTE AND PROTECT POLLINATORS

by

Mildred G. Pfrogner

December 2019

Co-Advisors: Anshu N. Chatterjee
Lynda A. Peters (contractor)

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.			
1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** December 2019	**3. REPORT TYPE AND DATES COVERED** Master's thesis	
4. TITLE AND SUBTITLE PLAN BEE—UNDERSTANDING THREATS TO THE HONEY BEE POPULATION AND EXAMINING STRATEGIES TO PROMOTE AND PROTECT POLLINATORS			**5. FUNDING NUMBERS**
6. AUTHOR(S) Mildred G. Pfrogner			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.			**12b. DISTRIBUTION CODE** A

13. ABSTRACT (maximum 200 words)

In the early 2000s, a series of pollinator colonies, including honey bee colonies, collapsed—an early warning of a serious threat to our nation's environmental, economic, and food security. Two national initiatives (the creation of the White House Pollinator Health Task Force in 2014 and the subsequent implementation of a national strategy to promote pollinator health in 2015) demonstrate that the government is serious about improving pollinator health. This thesis seeks to determine if pollinator health is a homeland security issue, and reviews policies in the United States and the European Union that protect the health of pollinators. These topics are explored through a comparative policy analysis centered on four considerations: a holistic focus on all pollinators, pesticide regulation, the inclusion of regional plans in national policy, and climate change. Research indicates that decisive governance in the quest for pollinator health is essential for national security. This thesis offers a limited scope that must be enhanced to attain a more robust and resilient national pollinator plan and to improve environmental, economic, and food security in the United States.

14. SUBJECT TERMS honey bee, food security, pollinator, colony collapse disorder, pesticides, neonicotinoids, habitat fragmentation, beekeeping, agricultural sustainability, biodiversity, ecosystem, Environmental Protection Agency, monoculture farming, habitat restoration, National Strategy to Promote the Health of Honey Bees and Other Pollinators, Pollinator Health Task Force, Pollinator Research Action Plan			**15. NUMBER OF PAGES** 115
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release. Distribution is unlimited.

PLAN BEE—UNDERSTANDING THREATS TO THE HONEY BEE POPULATION AND EXAMINING STRATEGIES TO PROMOTE AND PROTECT POLLINATORS

Mildred G. Pfrogner
Police Captain, Miami Beach Police Department
BS, Barry University, 1991

Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF ARTS IN SECURITY STUDIES
(HOMELAND SECURITY AND DEFENSE)**

from the

**NAVAL POSTGRADUATE SCHOOL
December 2019**

Approved by: Anshu N. Chatterjee
Co-Advisor

Lynda A. Peters
Co-Advisor

Erik J. Dahl
Associate Professor, Department of National Security Affairs

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

In the early 2000s, a series of pollinator colonies, including honey bee colonies, collapsed—an early warning of a serious threat to our nation's environmental, economic, and food security. Two national initiatives (the creation of the White House Pollinator Health Task Force in 2014 and the subsequent implementation of a national strategy to promote pollinator health in 2015) demonstrate that the government is serious about improving pollinator health. This thesis seeks to determine if pollinator health is a homeland security issue, and reviews policies in the United States and the European Union that protect the health of pollinators. These topics are explored through a comparative policy analysis centered on four considerations: a holistic focus on all pollinators, pesticide regulation, the inclusion of regional plans in national policy, and climate change. Research indicates that decisive governance in the quest for pollinator health is essential for national security. This thesis offers a limited scope that must be enhanced to attain a more robust and resilient national pollinator plan and to improve environmental, economic, and food security in the United States.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

4 Ps	parasites, poor nutrition, pesticides, and pathogens
CAP	common agricultural policy
DHS	Department of Homeland Security
EPA	Environmental Protection Agency
GMO	genetically modified organism
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
MAES	Mapping and Assessment of Ecosystems
National Strategy	*National Strategy to Promote the Health of Honey Bees and Other Pollinator*s
Pollinators Initiative	*EU Pollinators Initiative*
PRAP	*Pollinator Research Action Plan*
STEP	Status and Trends of European Pollinators
USDA	United States Department of Agriculture

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

In the United States, bees and other insects make important contributions through their pollination of wild vegetation, local plant life, and commercial crops. Approximately one-third of food crops, to include apples, strawberries, tomatoes, and almonds, depend on pollination, as do alfalfa and clover, which provide feed for beef and dairy production.[1] By some estimates, pollinators' activities amount to roughly $15 billion per year in economic value.[2] Ecosystem processes such as food webs, biofuel production, carbon sequestration, greenhouse gas absorption, and the creation of habitats for various animal species result from pollination. Since animal pollinators and ecosystems are mutually dependent on one another, both must be protected to prevent the failure of either.

Pollinators are vulnerable to an assortment of threats that affect their health and ability to pollinate, the consequences of which have increased considerably over the past five to ten years.[3] Current widespread risks include colony collapse disorder, climate change, habitat loss, monocultures, plant pesticides, chemical fertilizers, parasites, stress from transportation, poor nutrition, and pesticides used in hives to treat mites.[4] Human intervention in agricultural and natural systems tragically affects pollinator populations.

This thesis looks closely at the contributions made by pollinators and examines the existing research on threats to pollinators' health and performance. The United States' economy, environmental health, and food security depend on pollinators, which lends an

[1] Eric Mader, Marla Spivak and Elaine Evans, *Managing Alternative Pollinators: A Handbook for Beekeepers, Growers, and Conservationists* (College Park, MD: SARE, 2010); "No Bees, No Food," Environment Washington, accessed November 23, 2019, https://environmentwashington.org/feature/wae/no-bees-no-food.

[2] Juliet Ellperin, "How the White House Plans to Help the Humble Bee Maintain its Buzz," *Washington Post*, May 19, 2015, https://www.washingtonpost.com/politics/whats-all-the-obama-buzz-about-bees/2015/05/18/5ebd1580-fd6a-11e4-805c-c3f407e5a9e9_story.html.

[3] Department for Environment, Food and Rural Affairs, *Healthy Bees: Protecting and Improving the Health of Honey Bees in England and Wales* (London: Department for Environment, Food and Rural Affairs, 2009), 5, http://www.nationalbeeunit.com/downloadDocument.cfm?id=92.

[4] Reyes Tirado, Gergely Simon, and Paul Johnston, *Bees in Decline: A Review of Factors That Put Pollinators and Agriculture in Europe at Risk* (Amsterdam: Greenpeace International, 2013), 3, https://www.greenpeace.org/switzerland/Global/international/publications/agriculture/2013/BeesInDecline.pdf.

urgency to understanding pollinator declines, restoring pollinator health, and protecting this high-value asset. Furthermore, this thesis examines whether pollinator health is a homeland security issue. Many nations that rely on pollinators have focused on the numerous present threats and are taking measures to protect and promote pollinators. The United States introduced the *National Strategy to Promote the Health of Honey Bees and Other Pollinator*s (referred to herein as the National Strategy) in 2015. Similarly, in 2018, the European Union unveiled its *EU Pollinators Initiative*. This thesis evaluates the U.S. and EU pollinator policies to derive lessons learned that could contribute to enhanced food security and other environmental benefits.

Key findings of the analysis are as follows:

- Expansion of farming, destruction of natural habitats, and the use of pesticides are the primary culprits of pollinator decline.
- All pollinators are part of a delicately balanced ecosystem.
- The National Strategy emphasizes specific pollinators, like honey bees and monarch butterflies, while the EU policy has a broad focus and includes all pollinators.
- Both the U.S. and EU policies encourage research on pollinators to help inform mitigation efforts, identify gaps in current knowledge, and prioritize research accordingly.
- The National Strategy plans to enrich 7 million acres of federal land for pollinators.[5]
- The European Union protects pollinators from neonicotinoid pesticides; pollinators in the United States lack protection from these pesticides.

[5] Pollinator Task Force, *National Strategy to Promote the Health of Honey Bees and Other Pollinators* (Washington, DC: White House, 2015), 2, https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/Pollinator%20Health%20Strategy%202015.pdf.

- The European Union employs a proactive approach to the effects of climate change on pollinators, whereas the U.S. focus is minimal.

- The EU policy details the pollinator protection policies of its nation-states, whereas the U.S. policy does not incorporate state policies.

The contributions pollinators make to the food security of our nation are vital. Because pollinators face ever-growing threats to their health and stability, they urgently need to be protected. In other words, pollinator health is a homeland security issue. The Department of Homeland Security has a role to play in protecting pollinators by ensuring the nation's critical infrastructure sector partners like the Department of Agriculture and the Environmental Protection Agency are taking specific steps to mitigate dangers to pollinators at the local, regional, and federal levels. Additionally, comparing the strategies of different nations is one tool policymakers can use to safeguard pollinator populations. The recommendations resulting from this research are for the U.S. National Strategy to emphasize the protection of all pollinators, to restrict the use of harmful pesticides such as neonicotinoids, to proactively address climate change, and to incorporate state pollinator plans within the federal policy.

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

First and foremost, I'd like to thank the Center for Homeland Defense and Security for selecting me to attend this challenging program and providing me with all the tools and resources I needed to succeed. To the CHDS instructors and support staff, I sincerely appreciate all of your generous care and encouragement.

To the city of Miami Beach, which invested in me and gave me the time away I needed to complete this master's program, thank you. I hope to repay your contribution by sharing the knowledge and insight I received from my experience in this program with the brave men and women of our outstanding law enforcement agency.

My fellow cohortians, who soldiered on despite countless manic moments and bad hair days, I thank you. It is said that to fully appreciate life's precious moments you must have others to share them with—I'm so glad to have had all of you on this journey with me.

To my advisors, Lynda and Anshu, thank you for your questions and your candor. I am grateful for your invaluable guidance and constructive criticism. It was my honor and pleasure to work with you and learn from you both.

To my sons, Oliver, Jaxon, and TK. Thank you for believing in me. You inspire me every day. To my parents, who taught me always to find ways to be honorable, helpful, and compassionate, I hope I have made you proud.

Last, but never least, to my husband, Colin, whose unwavering support, sacrifice, devotion, and inspiration I will forever be grateful for. You made it all work. You are my rock, my foundation, and my champion. You took on every challenge and kept me motivated when things were the most difficult. You forgave me for leaving you in charge of our life, our kids, our home, and our responsibilities while I worked and researched far from you. With competing priorities getting the best of me, it may have seemed you were last on my list, but you were, and always will be, first in my heart.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A. PROBLEM STATEMENT

Human interaction with the environment is altering natural systems and accelerating the loss of biodiversity. In particular, pollinators are experiencing specific declines, which affect both crop production and the ecosystem services pollinators provide, such as preventing soil erosion and sequestering carbon. Pollinators are known as “keystone species” in many habitats because of the role they play in both food security and biodiversity.[1] Pollinator losses could result in reduced food consumption, threats to the health of the human population, and declines in contributions to ecosystem services. These declines represent an emerging concern for human health because pollinators contribute to an estimated 35 percent of global food production.[2] Although the demise of the honey bee will not spell the immediate end of humanity, the plight of the honey bee has essential implications for our nation’s food and agriculture sector.

The Department of Homeland Security (DHS) has integrated a resiliency focus into its security mission, which means that it is developing and implementing security and resilience programs and initiatives. Currently, supporting restoration activities is an aspect of DHS’s roles and responsibilities.[3] In other words, DHS’s mission encompasses issues that concern risks to people, infrastructure, and the stability of the United States. This mission makes DHS a logical choice to outline pollinator decline reversal measures.

DHS manages the National Security Infrastructure Protection Plan, which is divided into sixteen critical infrastructure sectors, one of which is food and agriculture.[4] Gaps in laws

[1] Anna Traveset, Cristina Tur, and Victor M. Eugiluz, “Plant Survival and Keystone Pollinator Species in Stochastic Coextinction Models: Role of Intrinsic Dependence on Animal Pollination,” *Scientific Reports* 7, no. 1 (July 2017), https://doi.org/10.1038/s41598-017-07037-7.

[2] Elizabeth Black, “Why Protecting the Pollinators Is Essential to Global Food Security,” *Global Food for Thought* (blog), May 19, 2017, https://www.thechicagocouncil.org/blog/global-food-thought/why-protecting-pollinators-essential-global-food-security.

[3] Food and Drug Administration (FDA), U.S. Department of Agriculture (USDA), and Department of Homeland Security (DHS), *Food and Agriculture Sector-Specific Plan* (Washington, DC: DHS, 2015), https://www.dhs.gov/sites/default/files/publications/nipp-ssp-food-ag-2015-508.pdf.

[4] Department of Homeland Security, *Partnering for Critical Infrastructure Security and Resilience*, NIPP 2013 (Washington, DC: Department of Homeland Security, 2013), 9, https://www.dhs.gov/sites/default/files/publications/national-infrastructure-protection-plan-2013-508.pdf.

governing food and agriculture may create vulnerabilities for pollinators, but by closing these gaps and implementing strategies to manage and promote pollinator health, policymakers can mitigate threats to food and ecological security brought on by pollinator declines.

B. RESEARCH QUESTIONS

1. Is protecting pollinator health a homeland security issue?

2. What can be learned by comparing patterns and deviations among pollinator strategies to effectively promote and protect pollinators?

C. LITERATURE REVIEW

The existing literature suggests four interrelated key themes concerning pollinators: food security, pollinator contributions, pollinator threats, and policies protecting pollinators. As is described in the U.S. policy, the *National Strategy to Promote the Health of Honey Bees and Other Pollinators*, each of these themes fits together to tell the following story: Honey bees make substantial nutritional and ecological contributions and, in recent decades, the decline of pollinator populations has begun to threaten food security. This decline has prompted legislation to protect the pollinators.[5] Moreover, within this literature, some people champion the pollinators' cause and favor implementing strategies to protect these species, while others either deny the problem or feel that it can be managed without using too many resources. Either way, both camps have created a context that needs to be understood before DHS can take action. The following sections describe these various positions to explain the threat and its importance to our food system.

1. Food Security

In the period of widespread food scarcity during the 1970s, the idea of food security emerged.[6] Since that time, the term's definition has evolved. In the 1974 *Report of the World Food*

---

[5] Pollinator Task Force, *National Strategy to Promote the Health of Honey Bees and Other Pollinators* (Washington, DC: White House, 2015), 2, https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/Pollinator%20Health%20Strategy%202015.pdf.

[6] Edward Clay, "Food Security: Concepts and Measurement," in *Trade Reforms and Food Security: Conceptualizing the Linkages* (Rome: Food and Agriculture Organization of the United Nations, 2003), 26, http://www.fao.org/3/a-y4671e.pdf.

Conference, the "volume and stability" of "food supplies" defined food security.[7] The Food and Agricultural Organization defines food security in a 2001 document, however, as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life."[8] The changes in the definition reflect how food security has been reshaped from a relative term to a more complex one that includes concepts of food safety and nutrition.[9]

Food insecurity continues to be perceived as an agronomic challenge. The World Bank's 2008 *World Development Report* asked for a more substantial investment in agriculture from emerging countries and stimulated food security conversations around the globe.[10] This report found that despite decades of efforts to eliminate malnourishment and hunger, food insecurity remains an enduring problem.[11] This should not be the case, according to Joshua Muldavin, a professor who focuses on food and agriculture instruction. He states that the world has two to three times the amount of food needed to feed everyone and notes that although brief disaster-related food shortages occur and are managed, long-standing world hunger is disregarded.[12] Emelie Peine, a professor of international politics and economy, backs up this assertion, stating, "We don't have a food shortage problem…. What we have is a distribution and income problem."[13] The World Food Organization names a variety of causes for food insecurity, including economic and political disorder, dwindling water and land resources, climate change, poverty, and warfare.[14] The *National Strategy to Protect Honey Bees and Other Pollinators* maintains that food security is

---

[7] United Nations, *Report of the World Food Conference, Rome 5–16 November 1974* (New York: United Nations, 1975), https://digitallibrary.un.org/record/701143/files/E CONF.65_20-EN.pdf.

[8] Clay, "Food Security," 29.

[9] Clay, 29.

[10] World Bank, *World Development Report 2008: Agriculture for Development* (Washington, DC: World Bank, 2007), http://hdl.handle.net/10986/5990.

[11] World Bank.

[12] Mark Koba, "Millions Hungry Despite World Food Surplus," Public Radio International, July 22, 2013, https://www.pri.org/stories/2013-07-22/millions-hungry-despite-world-food-surplus.

[13] Koba.

[14] Koba.

linked to environmental change and financial markets, and that its policy environs are experiencing globalization and change.[15]

Although no significant research suggests that food insecurity has been eliminated, critics contend that the extent of the problem has been exaggerated in the United States. For example, in 2015, when the Department of Food and Agriculture announced that the number of Americans living in households considered to be food-insecure was 48 million, James Bovard of the Foundation for Economic Education argued that the figures were misleading.[16] He contends that the U.S. Department of Agriculture (USDA) surveys count anyone who fears running out of food, even when it does not happen, as being "food insecure" for the entire year.[17] The USDA also has been criticized by the National Academies of Sciences, Engineering, and Medicine for misrepresenting estimations.[18] These numbers imply that more people are going hungry than actually are.

Although critics do not agree on the number of food-insecure individuals in the United States, they do believe that the USDA should begin measuring hunger separately, since food insecurity and hunger are two different conditions.[19] Inaccuracies in these numbers could be causing the government to place a higher priority on supplemental nutrition assistance for low-income households. Furthermore, the link between food production and current pollinator declines must be recognized as a threat to food security; crops, which are dependent on pollination, are essential to a nutrient-rich human diet.

Scholars also consider crop production factors and environmental influences in the pursuit of food security. Bethany Schroeder explains that, to address food security issues related to crop production, an emphasis on farming is important; the demand for food could increase by as much

---

[15] Pollinator Task Force, *National Strategy*.

[16] James Bovard, "No, 48 Million Americans Are Not Going Hungry," Foundation for Economic Education, September 10, 2015, https://fee.org/articles/no-48-million-americans-are-not-going-hungry/.

[17] Bovard.

[18] Gooloo S. Wunderlich and Janet Lippe Norwood, eds., *Food Insecurity and Hunger in the United States: An Assessment of the Measure* (Washington, DC: National Academies Press, 2006), 53, https://doi.org/10.17226/11578.

[19] Wunderlich and Norwood, 1–12.

as 50 percent by the year 2030.[20] Increasing life expectancy in lesser-developed regions accounts for the anticipated growth in human populations and the necessity of additional food.[21] This growth will likely impinge on current agricultural space. Schroeder suggests that a preventative approach requires improvements in agricultural productivity.[22] She adds that realizing short- and long-term improvements in food security will require stakeholders—such as leaders, planners, farmers, and additional food producers—to develop a systemic understanding of food insecurity.[23] Such improvements are important because access to quality food sources is vital to human survival and necessary for economic progress and job creation and growth.

Concerning environmental influences, the Food and Agricultural Organization outlines a broader view of the underlying causes of food insecurity around the globe. The organization believes that drought, flooding, other climatic extremes, crop-destroying pests, social conflict, population growth, degradation of land and vegetation, and poverty coexist with an already challenging environment of fragile ecosystems.[24] These factors point to the significance of pollinator conservation efforts.[25] Drs. Jeroen P. van der Sluijs and Nora S. Vaage link the decline of pollinators to the vulnerability of the insect species, the resiliency of the ecosystem, and food security on a global scale.[26]

Regardless of where the responsibility for food security lies, sources agree that we need accurate numbers to determine how many people are food insecure in this country—and perhaps

---

[20] Bethany Schroeder, "Health and Food Security," *Resilience*, February 1, 2011, https://www.resilience.org/stories/2011-02-01/health-and-food-security/.

[21] "World Population Projected to Reach 9.7 Billion by 2050," United Nations, July 29, 2015, https://www.un.org/en/development/desa/news/population/2015-report.html.

[22] Schroeder, "Health and Food Security."

[23] Schroeder.

[24] Food and Agriculture Organization, "The Underlying Causes of Food Insecurity," in *The Elimination of Food Insecurity in the Horn of Africa: A Strategy for Concerted Government and UN Agency Action* (New York: United Nations, 2000), http://www.fao.org/docrep/003/x8406e/X8406e01.htm.

[25] "FAO's Global Action on Pollinator Services for Sustainable Agriculture," Food and Agriculture Organization, accessed November 19, 2019, http://www.fao.org/pollination/major-initiatives/en/.

[26] Jeroen P. van der Sluijs and Nora S. Vaage, "Pollinators and Global Food Security: The Need for Holistic Global Stewardship," *Food Ethics* 1, no. 1 (June 2016): 75, https://doi.org/10.1007/s41055-016-0003-z.

the world, since global hunger is an international threat.[27] This gap in the literature appears to strengthen the point made by Bovard, who emphasizes that accurate metrics regarding food security are essential to initiate good policies.[28] Such policies should take into consideration the promotion and protection of pollinator species because of the significant value of their contributions to the world's food supply. This thesis seeks to fill in these gaps.

2. Pollinator Contributions to Food Supply

According to the *National Strategy to Promote the Health of Honey Bees and Other Pollinators*, referred to hereafter as the National Strategy, honey bees are crucial to America's food security, environmental health, and economy.[29] Many scholars echo this view, concurring that pollinators add value to environmental systems by contributing to roughly 35 percent of the global crop production volume, supporting carbon sequestration, and aiding in the prevention of soil erosion.[30]

Some scholars also specifically highlight how the disappearance of pollinators poses a threat to food security systems. According to Michael Schacker, author of *A Spring without Bees*, most of the crops and ornamental plants humans depend on are pollinated by insects, a vast majority of which are bees.[31] According to Elizabeth Black of the Chicago Council on Global Affairs, the decline of the honey bee threatens sustained agricultural productivity, economic stability, public health, and food security.[32] The loss is significant because the essential services provided by honey bees do not cost money or use human labor. Pollination services are a free benefit of nature that meets human agricultural demands efficiently and effectively.

---

[27] Andrew D. Jones et al., "What Are We Assessing When We Measure Food Security? A Compendium and Review of Current Metrics," *Advances in Nutrition* 4, no. 5 (September 2013): 481–505, https://doi.org/10.3945/an.113.004119.

[28] Bovard, "No, 48 Million Americans Are Not Going Hungry."

[29] Pollinator Task Force, *National Strategy*, 5.

[30] Black, "Protecting Pollinators"; Robert Owen, "The Decline of Pollinators," *Bee Culture*, June 27, 2016, https://www.beeculture.com/the-decline-of-pollinators.

[31] Dina Buck, "Disappearing Pollinators Hurt Biodiversity & Threaten Food Security," Pachamama Alliance, January 7, 2018, https://blog.pachamama.org/disappearing-pollinators-hurts-ecosystem-biodiversity-threatens-food-security.

[32] Black, "Protecting Pollinators."

Other researchers present conflicting views regarding the significance of pollinator contributions, including which specific pollinators warrant protection. Some authors argue that the protection of the managed bee species is misguided, is detrimental to the native wild bee populations, and supports an unbalanced dependence on pollination services that humans created.[33] In contrast, politics writer John Haltiwanger dramatically asserts that humans will not survive if bees do not survive.[34] Although A.C. Shilton of Vice agrees that pollinators are vital, she reminds readers that the majority of crops are wind-pollinated; bees are not the world's only pollinators, and other forms of manual pollination, while more expensive and less effective, are possible.[35] According to Dave Goulson, for example, pear and apple farmers in southwest China must pollinate their orchards by hand, as the use of pesticides and the loss of bee habitats have decimated local bee populations.[36] According to Eijiro Miyako of Japan's National Institute of Advanced Industrial Science, researchers are developing self-guided drones to help farmers with crop pollination; he asserts, however, that the industry should not rely entirely on drone pollinators, and stresses that drones should be used together with bees.[37] Even with such steps to mitigate pollinator declines, Shilton also concedes that the total loss of bees would likely be the result of catastrophic environmental challenges that, combined, would pose an infinitely more significant threat to humans than would the loss of bees alone.[38] Ultimately, bees have proven to be one of nature's most effective, efficient, and cost-effective tools. Efforts to combat threats to this natural resource should be examined, understood, and increased.

---

[33] Cara Giamo, "The Case against Honey Bees," *Gastro Obscura* (blog), July14, 2016, https:www.atlasobscura.com/articles/the-case-against-honeybees.

[34] John Haltiwanger, "If All the Bees in the World Die, Humans Will Not Survive," *Elite Daily,* September 15, 2014, https://www.elitedaily.com/news/world/humans-need-bees-to-survive/755737.

[35] A.C. Shilton, "What Would Happen if All the Bees Went Extinct?" Vice, March 1, 2017, https://www.vice.com/en_us/article/d7ezaq/what-would-happen-if-all-the-bees-died-tomorrow.

[36] Dave Goulson, "Decline of Bees Forces China's Apple Farmers to Pollinate by Hand," China Dialogue, February 10, 2012, https://chinadialogue.net/article/show/single/en/5193-Decline-of-bees-forces-China-s-apple-farmers-to-pollinate-by-hand.

[37] Alice Klein, "Robotic Bee Could Help Pollinate Crops as Real Bees Decline," *New Scientist*, February 9, 2017, https://www.newscientist.com/article/2120832-robotic-bee-could-help-pollinate-crops-as-real-bees-decline/.

[38] Shilton, "What Would Happen."

3. Threats to Pollinators

Threats to pollinators continue to emerge and contribute to pollinator declines, as noted by some critical research. According to the White House's Pollinator Task Force, experts concur that multiple factors threaten bee health in a complex set of interacting stressors.[39] According to the varied literature, pesticides, pathogens, poor nutrition, and parasites are the primary stressors to bee health. The most controversial debate revolves around the use of pesticides. Research overwhelmingly supports the theory that pesticides—whose use started as an intended solution to control weeds, limit insect infestations, and reduce plant disease—have caused water and soil contamination and harm to ecosystems because of their unregulated and improper use.[40] Consequently, several countries have banned neonicotinoids, pesticides considered significantly harmful to bees, and cite multiple academic studies on the subject to justify their ban.[41]

Conversely, literature produced by agrochemical companies, including Syngenta AG, Bayer, and DuPont, challenges the findings on the dangers of pesticides.[42] These companies contend that such pesticides, when appropriately used, boost staple crop yields, and attribute bee deaths to other causes.[43] Given the economic stakes, such findings are suspect for defending the use of pesticides and quantifying their harm.

Meanwhile, Dr. Joel Lexchin, along with other scholars, suggest that there is evidence of sponsorship bias in critical research.[44] This bias presents a common concern regarding articles published in the Genetic Literacy Project, for which critics protest that the Monsanto Company, a sponsor of the project, organized academics to write articles supporting genetically modified

---

39 Pollinator Task Force, *National Strategy*, 5.

40 Aaditya Singh, "Pesticides and Safety: Pros and Cons of Pesticides," Tunza Eco Generation, April 10, 2017, https://tunza.eco-generation.org/resourcesView.jsp?boardID=ambassadorReport&viewID=43671&searchType=&searchName=&pageNumber=2.

41 Thomas Hobbs, "EC to Ban Three Neonicotinoids," *Fresh Produce Journal*, April 29, 2013, http:www.fruitnet.com/fpj/article/158173/ec-to-ban-three-neonicotinoid.

42 Carey Gillam, "Bees Crucial to Many Crops Still Dying at Worrisome Rate: USDA," Reuters, May 15, 2014, https://www.reuters.com/article/us-usda-honeybees-report/bees-crucial-to-many-crops-still-dying-at-worrisome-rate-usda-idUSKBN0DV12120140515.

43 Gillam.

44 Joel Lexchin, "Sponsorship Bias in Clinical Research," *International Journal of Risk & Safety in Medicine* 24, no. 4 (January 2012): 233–242, https://doi.org/10.3233/JRS-2012-0574.

organisms (GMOs).[45] As an example, in her book, Carey Gillam accuses Monsanto of indirectly promoting the safety of its chemical products.[46] This allegation is significant because, to have a clear understanding of the effects of GMOs, research on the topic needs to remain unbiased. According to the Library of Congress, the U.S. Department of Agriculture's Animal and Plant Health Inspection Service, which falls under the Plant Protection Act, regulates plant GMOs.[47] Understanding threats to pollinators can inform policy decisions intended to mitigate pollinator population declines and promote honey bee health.

4. Policies Protecting Pollinators

An essential driver of pollinator protection policies is research that equates the decreases in pollinator populations to the proverbial canary in the coal mine. Dina Buck of the Pachamama Alliance believes that colony collapses could signal that agricultural practices are both degrading and poisoning the environment on which our entire ecosystem depends.[48] Today, the convergence of multiple stressors on pollinators, including poor nutrition, pesticides, pathogens, and parasites, has caused significant decreases in their populations. These declines signal the ecological dangers and health consequences of humans' environmentally harmful actions. For example, the Sustainable Development Goals website, sponsored by the United Nations, describes bees "as bellwethers for ecosystem health and biodiversity" and encourages policies and approaches that strengthen the physical wellbeing of pollinators.[49] Countries across the globe have developed plans to support and defend pollinators.

To combat pollinator losses in the United States, President Barack Obama formed the Pollinator Health Task Force in 2014, which was co-chaired by the USDA and the Environmental

---

[45] Jack Kaskey, "How Monsanto Mobilized Academics to Pen Articles Supporting GMOs," *Chicago Tribune*, October 2, 2015, https://www.chicagotribune.com/news/sns-wp-blm-monsanto-0c06199a-692b-11e5-bdb6-6861f4521205-20151002-story.html.

[46] Carey Gillam, Whitewash: The Story of a Weed Killer, Cancer, and the Corruption of Science (Washington, DC: Island Press, 2017).

[47] "Restrictions on Genetically Modified Organisms: United States," Library of Congress, March 2014, https://www.loc.gov/law/help/restrictions-on-gmos/usa.php.

[48] Buck, "Disappearing Pollinators."

[49] "With Busy Bees in the Lead, 'Pollinator Friendly' Approach Vital for Healthy Agriculture Ecosystems–UN," Sustainable Development Goals, May 26, 2016, https://www.un.org/sustainabledevelopment/blog/2016/05/with-busy-bees-in-the-lead-pollinator-friendly-approach-vital-for-healthy-agricultural-ecosystems-un/.

Protection Agency (EPA).[50] The mission of the task force was to create a focused, integrated federal strategy to improve pollinator health and decrease pollinator losses.[51] The task force developed the National Strategy in 2015, which laid out a comprehensive approach to improve pollinator health. Although some literature suggests that the National Strategy does not go far enough to address the key stressors, others argue that its focus on research, outreach, and habitat restoration is a step in the right direction.[52]

Claire Kremen, professor of conservation biology and entomology at Purdue University, though, warns of significant gaps in the National Strategy, which does not question the use of pesticides.[53] Conversely, Kristie Krupke, associate professor of entomology at Purdue University, views the plan as positive momentum; “As recently as a few years ago,” she says, “there was no admission that there was a problem.”[54] Dennis vanEngelsdorp, assistant professor of entomology at the University of Maryland, considers the National Plan “surprisingly balanced” and adds that “[i]t got the main drivers right—Varroa [destructor mites], nutrition, pesticides. And it is honest about the knowledge gaps.”[55] Laurie Adams of the Pollinator Partnership sees the strategy as “the most comprehensive blueprint for conservation in the 21st century,” but cautions that the federal government alone cannot solve this problem; a solution will require the combined efforts of state and local government, nonprofit community groups, farmers, businesses, and homeowners.[56]

Environmental, nutritional, and economic factors all play a role in finding solutions and shaping policies to address the threats facing pollinators. Creating an impactful public policy to

---

[50] Pollinator Task Force, *National Strategy*, 5.

[51] White House, “Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators” (official memorandum, Washington, DC: Office of the Press Secretary, June 20, 2014).

[52] M.E.A. McNeil, “The National Strategy to Promote the Health of Honey Bees and Other Pollinators,” *Bee Culture*, November 20, 2015, https://www.beeculture.com/the-national-strategy-to-promote-the-health-of-honey-bees-and-other-pollinators/.

[53] McNeil.

[54] McNeil.

[55] McNeil.

[56] Jared Green, “A Bold Plan for Saving Pollinators,” *The Dirt* (blog), June 25, 2015, https://dirt.asla.org/2015/06/25/a-bold-plan-for-saving-pollinators/.

address threats to pollinators is an ongoing process in which validation and program assessment are critical for success.

D. RESEARCH DESIGN

This thesis analyzes how the threats to honey bee populations can be mitigated, forming an understanding from which the Department of Homeland Security can act. This research also presents a comparative analysis of the U.S. policy, *National Strategy to Promote the Health of Honey Bees and Other Pollinators*, and the EU policy, *EU Pollinators Initiative*. Like the U.S. National Strategy, the EU model supports participation and coordination from both central and regional governments to develop response plans to pollinator population declines. While the United States has a federal government and individual states, the European Union has a federation and national governments, making it a parallel form of governance. Government documents and academic research inform this thesis.

Chapter II provides a detailed overview of honey bees and their history of interaction with humans. This chapter looks at the context for the economic, environmental, and nutritional contributions made by honey bees and explores the decline of pollinator populations across the globe. It closes by analyzing the threats to honey bee health and identifying similarities and differences in the application of both required and optional strategies to promote and protect honey bees. Chapter III explores the genesis of the National Strategy, its objectives, its four themes for protecting pollinators, and the strategy's gaps and limitations. Next, it explores the genesis of the *EU Pollinators Initiative*, its objectives, and its gaps and limitations. Chapter IV provides a comparative analysis between the two governmental policies, examining similarities and deviations in content, motivation, and implementation. Chapter V synthesizes the national security considerations of pollinator declines and the pollinator policies of the United States and the European Union to answer the research questions. The chapter concludes by offering policy recommendations for improved pollinator health.

This thesis provides an overview of the contributions made by honey bees and other pollinators, a summary of the threats they face, and awareness and insight into policy effectiveness through the lens of a comparative study. This thesis does not explore every nation's pollinator policies—only those of the United States and the European Union.

Investigating how national policies protect or impede pollinator health will help us determine the successes and failures of current and future protection and promotional efforts. This thesis offers recommendations that policymakers in the United States can implement to resolve the threats facing pollinators. Ultimately, outcomes developed or identified by this research may be used to inform and support U.S. policy. Accordingly, an analysis of the effects of pollinator policies may lead to a greater understanding and definition of the DHS's role in protecting pollinator health.

II. HONEY BEES AND HUMANS: BACKGROUND

Approximately 4,000 species of native bees and a variety of birds and other insects are vital to pollination.[57] Although many pollinators contribute to managed and wild ecosystems, this thesis focuses primarily on the honey bee. Bred as a portable, commercial crop pollinator, the honey bee is the most recognized symbol of pollination and has been the subject of the most research regarding pollinator decline.[58]

The decline of the honey bee population has seized the attention of entomologists and beekeepers worldwide since the late 1990s.[59] Because of pollinators' role in food security, these downtrends are distressing. Pollinator-dependent crops account for over 35 percent of global crop production volume; thus the decline of the honey bee threatens sustained agricultural productivity, economic stability, public health, and food security.[60] Monocultures, parasites, climate change, pesticides, and loss of habitat are all contributing to the decline of the honey bee. Many concerned stakeholders agree that this decline should be addressed and reversed, but the most effective strategy to protect and promote honey bees is still emerging.[61]

Scientists and researchers today consistently focus on the significance of the past, present, and future of the honey bee. They regularly analyze and evaluate environmental, commercial, and global concerns, and share recommendations for research, advocacy, education, health, and promotion surrounding the honey bee. Their recommendations will address challenges faced by pollinator populations to better protect and support the health of our environment, help to curtail economic impacts to the agricultural sector, and provide methods that safeguard the sustainability of our food production systems.

---

57 Giamo, "The Case against Honey Bees," 4.

58 Giamo, 5.

59 Reyes Tirado, Gergely Simon, and Paul Johnston, *Bees in Decline: A Review of Factors That Put Pollinators and Agriculture in Europe at Risk* (Amsterdam: Greenpeace International, 2013), 3, https://www.greenpeace.org/switzerland/Global/international/publications/agriculture/2013/BeesInDecline.pdf.

60 Black, "Protecting Pollinators."

61 White House Pollinator Task Force, *National Strategy*, 53.

A. EVOLUTION OF THE HONEY BEE

When considering the evolution of pollinators, it is essential to recognize the unique ecological and agricultural significance of the honey bee. Evolving from the wasp species, "honey bees first appeared during the Cretaceous period, about 130 million years ago" on the landmass of Gondwanan.[62] Insects more dependably transfer pollen than wind does, and this caused flowering plants known as angiosperms to evolve distinct color patterns to attract them.[63] Eventually, plants produced nectar as well as pollen, which provides carbohydrates to their symbiotic visitors.[64] In turn, the honey bee developed specific morphologies such as extra fuzz, longer tongues, pollen baskets, and colonies where they can collect and store volumes of pollen and nectar.[65]

Author Tove Danovich, in an article published by *Food52*, speculates that the first humans discovered honey over ten thousand years ago inside of a wild bee's nest and, deciding to taste it, were pleasantly rewarded with its sweet flavor.[66] Early civilizations in the seventeenth century quickly developed honey hunting abilities; they migrated to North America over the following two centuries, bringing comprehensive beekeeping skills with them.[67] At the same time, settlers travelling from England transported bees to the nations of New Zealand, Australia, and Tasmania, thus carrying out the managed distribution of bees across the world.[68]

In time, people discovered other benefits of bee byproducts, such as wax production and medicinal products. These continue to be valuable commodities. Nonetheless, honey bees' most significant contribution is their ability to pollinate agricultural crops. Increasingly, honey bees have been tasked with more and more pollination responsibilities. The agriculture industry's reliance on pollinators between 1961 and 2006, for example, grew by 50 percent in developed

---

[62] Dave Goulson, "The Beguiling History of Bees," *Scientific American*, April 25, 2014, https://www.scientificamerican.com/article/the-beguiling-history-of-bees-excerpt/.

[63] Tammy Horn, "Honey Bees: A History," *Times Topics* (blog), April 11, 2008, https://topics.blogs.nytimes.com/2008/04/11/honey-bees-a-history/.

[64] Horn.

[65] Horn.

[66] Tove K. Danovich, "The History of Honey," *Food52* (blog), December 13, 2013, https://food52.com/blog/9010-the-history-of-honey.

[67] Horn, "Honey Bees."

[68] Horn.

countries.[69] Because of the relative ease with which bees can be managed, their contribution to pollination makes them a highly valued asset around the world.

B. POLLINATION PROCESS

Pollination is a bee's most essential action. Many plants rely on birds and insects, including bees, to perform the pollination necessary for them to reproduce. The male reproductive organ of a flower is the stamen. The stigma, or tip of the pistil, is the female reproductive organ. Pollen from the stamen sticks to the fur on a bee's body as it gathers nectar from a flower. As the bee travels from flower to flower, it transfers and deposits pollen. This results in fertilization and allows for fruit, containing seeds, to form.[70] Since plant reproduction depends on pollinators, over time, plants have adapted features that make them more appealing to bees and other pollinators, such as bright colors and sweet scents. These enticing features help to ensure pollination occurs.

Effective and efficient pollination ensures the survival of many plant species. A variety of crops and foods are essential to maintain the health of humans and animals. Many fruits and vegetables depend on or at least benefit from bee pollination. The more routinely a plant is visited by a pollinator, the larger and more proportioned the fruit will appear.[71] Additionally, honey bees are exceptionally valuable pollinators because they exhibit flower fidelity, meaning they visit only one type of flower on an individual trip.[72] This is beneficial to plants because plant reproduction will only occur when a pollinator transfers pollen from one plant to another of the same species. Transferring pollen to different species of flowers results in much less effective pollination.[73]

Wind, water, insects, and animals each share in the task of pollination. Each plant, in turn, has adapted to best support its predominant pollinators. Plants pollinated by wind are usually less

---

[69] Dennis vanEngelsdorp and Marina Doris Meixner, "A Historical Review of Managed Honeybee Populations in Europe and the United States and the Factors That May Affect Them," *Journal of Invertebrate Pathology*, 103, supplement (January 2010): S80–S95, https://doi.org/10.1016/j.jip.2009.06.011.

[70] "Bees: A Honey of an Idea," Canada Agriculture and Food Museum, accessed November 21, 2019, https://bees.techno-science.ca/english/bees/pollination/default.php.

[71] Canada Agriculture and Food Museum.

[72] Carol Clark, "Bees 'Betray' Their Flowers When Pollinator Species Decline," *Science Daily*, July 22, 2013, https://www.sciencedaily.com/releases/2013/07/130722152733.htm.

[73] Clark.

colorful and do not produce a scent or nectar. Their pollen is typically lighter, making it easier to travel through the air. Similarly, plants that grow in rivers and streams are pollinated by that water that flows around them. Bats, which pollinate at night, gravitate to strongly scented flowers that open at night as opposed to colored flowers. Tiny insects, lacking large mouthparts to extract the nectar from the depths of large or tubular flowers, seek out small flowers with shallow, exposed nectar basins. Additionally, some small birds, including hummingbirds, pollinate brightly colored flowers. It stands to reason that the scent of such flowers is not as important, as birds have a poor sense of smell. Each of these examples demonstrates how plant evolution and adaption sustain the success of the pollination process.[74]

C. POLLINATOR CONTRIBUTIONS

As a result of pollination, food consumed by humans, commercial livestock, and animals that contribute to the ecological welfare of the world is available. The honey bee aids the production of approximately ninety commercially grown crops in North America alone, and humans depend on pollinator-mediated crops for diverse and nutrient-rich diets.[75] Many essential food crops, like rice, wheat, corn, and soybeans, that are wind- or self-pollinated are not dependent on bees or other living pollinators. But for many fruits and vegetables, crop yields rely completely or significantly on bee pollination. Table 1 in the Appendix provides further information regarding the types of crop plants that are pollinated by honey bees.[76] In addition to pollination, bees provide a variety of other services that make them invaluable to the natural world and ecosystem.

Pollinators contribute significantly to a number of important ecological and industrial processes, including food webs, cotton fibers, medicines, biofuels, and plant-based construction materials.[77] In the United States alone, over $15 billion in crop value is attributed to honey bees

[74] Canada Agriculture and Food Museum, "Bees A Honey of an Idea."

[75] "Fact Sheet: The Economic Challenge Posed by Declining Pollinator Populations," White House, June 20, 2014, https://obamawhitehouse.archives.gov/the-press-office/2014/06/20/fact-sheet-economic-challenge-posed-declining-pollinator-populations.

[76] Amber Pariona, "Which Crops and Plants Are Pollinated By Honey Bees?" World Atlas, March 5, 2019, https://www.worldatlas.com/articles/which-crops-plants-are-pollinated-by-honey-bees.html.

[77] Black, "Protecting Pollinators."

due to their pollination of fruits, nuts, and vegetables.[78] Honey bees also pollinate plants such as protein-rich clover and alfalfa, which are eaten by herbivores and, as a result, indirectly supply humans with meat, milk, and other animal products.[79]

Honey bees provide consumers and farmers billions of dollars' worth of free labor for the service they deliver, and agriculture as we know it would not exist without them.[80] Yet, in the United States, the honey bee population has decreased by more than 50 percent since WWII.[81] Over the past sixty years, the number of managed honey bee colonies (beehives) has dropped steadily, from 6 million in 1947 to 4 million in 1970, to 3 million in 1990, and to only 2.5 million in 2014.[82] The reduction in the number of pollinators presents a genuine risk to domestic agriculture because certain crops rely significant on commercial pollination, including almonds, blueberries, and pumpkins[83]

The significant declines in honey bee populations are a concern for commercial beekeepers, who in the United States alone have lost approximately 10 million beehives; at approximately $200 dollars apiece, this amounts to $2 billion.[84] The cost of rebuilding these colonies is substantial, which places commercial beekeeping in jeopardy: many beekeepers cannot afford the cost of replacing lost bees. Additionally, colony losses considerably increase the price of commercial pollination.[85] For example, in 2003 it cost roughly $50 dollars to rent a honey bee hive for almond pollination; by 2009, the cost had increased to between $150 and175 per hive.[86] According to an article in the *American Journal of Agricultural Economics*, "Almond prices rose from $1.10 per

---

78 White House, "Fact Sheet."

79 Allan Stomfeldt Christiansen, "Bee Collapse Is the Result of Their Enslavement in Industrial Monocultures," *Ecologist*, May 2, 2015, https://theecologist.org/2015/may/02/bee-collapse-result-their-enslavement-industrial-monocultures.

80 Christiansen.

81 Haltwinger, "If All the Bees in the World Die."

82 White House, "Fact Sheet."

83 White House.

84 White House.

85 White House.

86 White House.

pound in 2001 to $3.74 per pound in 2014 (in constant 2010 dollars)."[87] The latter seven years showed a price increase each year.[88] Continuous pollinator decline could result in a worldwide loss of crop production and supply, which could negatively affect incomes for many individuals and their communities and cause an increase in prices for consumers.[89] Thus, continuous losses of commercial bees are threatening the health of the beekeeping industry.

Pollinators provide a host of benefits besides commercial pollination. For example, carbon sequestration, greenhouse gas absorption, and nesting grounds for various animal species result from pollination. As pollinators and ecosystems are mutually dependent on one another, they both must be protected to prevent the failure of either. The significant loss of pollinators is a serious problem that needs to be understood so it can be addressed. One area of research focuses on colony collapse disorder.

D. COLONY COLLAPSE DISORDER

For approximately 130 million years bees have existed on Earth and only in the past few decades have their numbers been observed to be in record decline. Colony collapse disorder is "the phenomenon that occurs when the majority of worker bees in a colony disappear and leave behind a queen, plenty of food and a few nurse bees to care for the remaining immature bees and the queen."[90] As one example, in 2006, while taking care of his bees, commercial beekeeper David Hackenberg discovered 400 of his 3,000 hives were nearly empty. He contacted his friend and fellow beekeeper David Mendes and shared this worrying news. Within a few months, Mendes noticed a decline in his hives. Soon thereafter, news accounts were reporting more claims of devastating bee declines from beekeepers all across the country. The majority of these claims came

---

[87] Hyunok Lee, Daniel A. Sumner, and Antoine Champetier, "Pollination Markets and the Coupled Futures of Almonds and Honey Bees: Simulating Impacts of Shifts in Demands and Costs," *American Journal of Agricultural Economics* 101, no. 1 (January 2019): 240, https://doi.org/10.1093/ajae/aay063.

[88] Lee, Sumner, and Champetier, 240.

[89] Black, "Protecting Pollinators."

[90] "Colony Collapse Disorder," Environmental Protection Agency, April 26, 2018, https://www.epa.gov/pollinator-protection/colony-collapse-disorder.

from commercial beekeepers and not the researchers who reported on wild bees.[91] Research to determine what causes colony collapse disorder has revealed a combination of factors.

E. THREATS TO HONEY BEES

While no one can be exactly sure what is causing colony collapse disorder or causing honey bee population declines across the globe, researchers investigating the causes are focused on several intermingling factors. These include monocultures, chemical fertilizers, inadequate forage, pesticides, poor nutrition, disease-carrying parasites, and stress from transportation. These issues are not separate from one another. Individually, they constitute the reasons bees are dying at an increased rate; collectively, however, they explain how modern agriculture operates and how its practices are unsustainable for a pollinator like the honey bee. Parasites, poor nutrition, pesticides, and pathogens are the four distinctly separate categories that have emerged to describe the threats to pollinators. They are known as the "4 Ps."[92]

1. Parasites

The first of the 4 Ps is the parasite. One parasite that is a major problem and is nearly exclusive to honey bees is the Varroa destructor mite—a reddish-brown parasite that thrives by attaching its eight clutching legs to the backs of honey bees and draining their bodily fluids through a straw-shaped mouth.[93] Figure 1 shows a honey bee with its back covered in harmful parasitic mites.

---

[91] Bryanne McNamarra, "The Disappearance of the Bees" (final project essay, Evergreen State College, 2016), 4–5, https://sites.evergreen.edu/environmentalhealth/wp-content/uploads/sites/174/2016/03/EnvironmentalHealthProjectFinal.pdf.

[92] Steve Davies, "No Easy Answers: Bee Health Threatened by 'Four P's,'" *AgriPulse*, June 21, 2017, https://www.agri-pulse.com/articles/9427-no-easy-answers-bee-health-threatened-by-four-ps.

[93] Thor Hanson, *Buzz: The Nature and Necessity of Bees* (New York: Basic Books, 2018), 189.

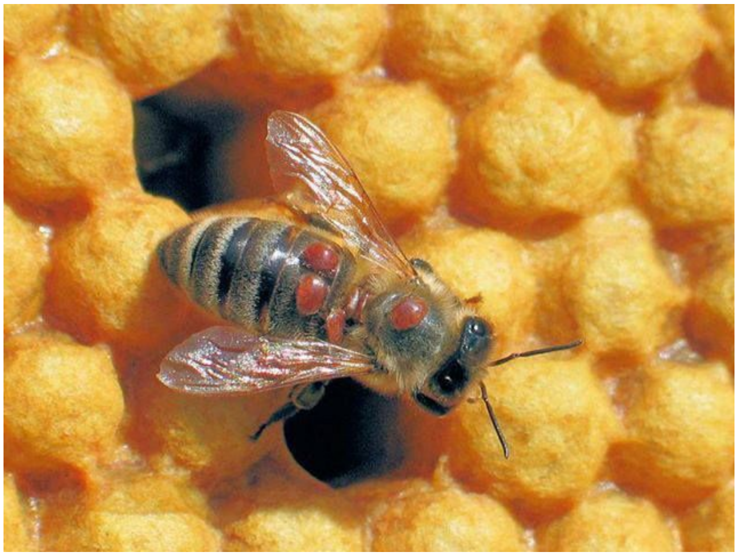

Figure 1. Parasitic mites on a bee[94]

Transported to the hive by their host bee, Varroa mites are also known to cause irreparable damage by attacking brood cells, gorging on larvae, and then breeding inside the sealed comb chamber, which provides the Varroa young with an abundance of nourishment, as depicted in Figure 2. Over the years, they have spread from the forests of Southeast Asia to every corner of the world as hives and equipment have become more mobile. Without management, a Varroa mite incursion can stifle brood development and annihilate entire beehives. Additionally, Varroa mites transmit a variety of lethal viruses that lead to the deterioration of bee health in general, much like the second P in the design: poor nutrition.

94 Source: Shearer Turton, "Comparing Mite Treatments," Bee Culture, August 23, 2016, https://www.beeculture.com/comparing-mite-treatments/.

Figure 2. Varroa destructor mites on a larva[95]

2. Poor Nutrition

Poor nutrition continues to put increased pressure on the health of pollinators. An article titled "Diet Effects on Honeybee Immunocompetence," published in *Biology Letters,* emphasizes that diversity in a bee's diet allows it to more aptly guard its colony from diseases and bacteria.[96] Specific nutrient deficiencies can result from having only one food source.[97]

Monocropping is an agricultural development that contributes to the erosion of honey bee health by stripping out biodiversity. Monocropping, or monolculturing, is a popular industrial farming technique that some farmers use to grow one crop in a field or farming system at a time; while buying the equipment necessary to harvest only one type of plant is more economical for farmers, the practice results in a loss of biodiversity.[98] Figure 3 illustrates an expansive monocropped landscape.

---

[95] Source: image file, Vatorex, accessed October 6, 2019, https://www.vatorex.ch/wp-content/uploads/2019/06/Varroa-mite-1024x683.jpeg.

[96] Cédric Alaux et al., "Diet Effects on Honeybee Immunocompetence," *Biology Letters* 6, no. 4 (2010): 562–65, https://doi.org/10.1098/rsbl.2009.0986.

[97] Robert Brodschneider and Karl Crailsheim, "Nutrition and Health in Honey Bees," *Apiodologie* 41, no. 3 (May–June 2010): 278–94, https://doi.org/10.1051/apido/2010012.

[98] Hanson, *Buzz*, 190.

Figure 3. Monoculture landscape[99]

The monoculture growing technique has several drawbacks and the associated factors are harmful to bees. While monocropping creates increased efficiency in planting and harvest, growing the same species of plant year after year can lead to soil degradation and a quicker buildup of pests and diseases that spread rapidly, making the single crop vulnerable to pathogens.[100] In nature, monocultures do not exist. As author Michael Pollan describes it in *Vanishing of the Bees*: "Mother Nature does not put all her eggs in one basket."[101] For some farmers, planting crops "mother nature's" way is too slow or expensive. Provided with only one food source, however, bees are likely to leave the area. Essentially, monocropping creates thousands of acres of farmland that cannot suitably provide the type of ecosystem necessary to maintain honey bee colonies. Consequences of monoculture farming can be avoided by planting diverse plant species that produce nutrient-packed soil.[102]

---

99 Source: "Difference between the Monoculture and Polyculture Farming Techniques," Gardenerdy, accessed October 17, 2019, https://gardenerdy.com/difference-between-monoculture-polyculture-farming-techniques.

100 Susan Patterson, "What Is Monocropping: Disadvantages of Monocultures in Gardening," Gardening Know How, last modified April 5, 2018, https://www.gardeningknowhow.com/plant-problems/environmental/monoculture-gardening.htm.

101 *Vanishing of the Bees,* directed by Maryam Henein and George Langworthy (Hive Mentality Films and Hipfuel Films, 2009).

102 Patterson, "What Is Monocropping,"

The monoculture system presents an additional problem: the short time frame during which the plants are in bloom and available to be pollinated and harvested by bees for nutrients. Short bloom phases that limit the availability of nectar and pollen result in flowerless landscapes.[103] To grow a single crop—which saves time and money—farmers remove all plant life in the field with the exception of their intended crop. They eliminate cover crops that cultivate the soil, nourish the pollinators, and provide a natural predator habitat. This results in what is sometimes referred to as "agricultural deserts" for large portions of the year in the pollinators' home environment.[104] Combined with other stressors, the absence of a diversified diet creates poor nutrition for pollinators and compromises their immune systems.[105] The monoculture system reduces the pollinators' ability to thrive year-round among a number of blooms that provide them with a variety of essential nutrients. Reversing the impact of these practices by creating agricultural borders where native species and weeds can grow provides honey bees with nourishment all year while allowing them to perform essential crop pollination.[106] Figure 4 shows a polyculture garden where land is dedicated to more than one crop at a time and the emphasis is on leveraging energy, space, and land.

103 Axel Decourte, Eric Mader, and Nicholas Desneux, "Landscape Enhancement of Floral Resources for Honey Bees in Agro-Ecosystems," *Apilodogie,* 41, no. 3 (2010): 264–67, https://doi.org/10.1051/apido/2010024.

104 "Say 'No!' to Agricultural Deserts," Bee America, August 15, 2013, https://www.bee-america.com/content/say-%E2%80%9Cno%E2%80%9D-agricultural-deserts.

105 David Smitley, "How to Protect and Increase Pollinators in Your Landscape," Michigan State University, May 1, 2019, https://www.canr.msu.edu/publications/how_to_protect_and_increase_pollinators_in_your_landscape.

106 Bee America, "Say 'No!' to Agricultural Deserts."

Figure 4. Polyculture garden[107]

Another significant threat to many pollinator populations, including the honey bee, is habitat fragmentation and loss of natural habitats.[108] Roads, highways, malls, sporting arenas, office parks, and apartment complexes have replaced the natural habitats where bees used to live. Urbanization has also fragmented the land bees try to travel across.[109] Bees suffer from poor nutrition because it has become increasingly difficult for them to locate flowers for sustenance. The once vast landscape rich with an abundance of blooms has become fragmented by non-floral spaces that are too vast for the pollinator to traverse. Fragmentation and loss of natural habitats will continue to affect pollinator populations until it becomes a priority to restore and enhance pollinator habitats.

New, innovative designs, however, may help reverse the impact of habitat fragmentation. Sarah Bergmann, founder of The Pollinator Pathway, designed a concept to help others think about landscapes and pollinators differently and challenge them to create their own pollinator pathways. She has spent several years designing a mile-long pathway through the middle of Seattle that connects existing isolated green spaces, to encourage biodiversity. Figure 5 depicts the Pollinator

---

[107] Source: Josh Noland, “Mono vs Poly,” Beyond Sustainable, May 28, 2017, https://beyondsustainable.org/sustainability/monoculture-vs-polyculture/.

[108] “Habitat Fragmentation,” *Bee Informed!* (blog), accessed August 6, 2018, https://beependent.wordpress.com/habitat/.

[109] Bee Informed.

Pathway, a twelve-foot-wide strip of vegetation, which creates a distinct change in the habitat, visible from above. The pathway permits insects of all types to pass through the city instead of being cordoned off in patches.[110]

Figure 5. Pollinator pathway[111]

Bees' natural habitats have been limited by space, bloom time, and nutritional value, which has resulted in their vulnerability to further threats in their environment, which includes the third "P"—pesticides.

3. Pesticides

Pesticides are an outcome of monocropping. This method of farming, which stems from the need for large cash crops, eliminates biodiversity and makes it easy for pests and pathogens to grow accustomed to the soil.[112] When a pest discovers a monoculture environment, it takes up residence there. With no natural enemies and all the food it needs, pest populations grow and

[110] Giamo, "The Case against Honey Bees."

[111] Source: "Pollinator Pathways," Healthy Yards, accessed October 17, 2019, https://www.healthyyards.org/activities/pollinator-pathways/.

[112] Patterson, "What Is Monocropping."

become a threat to pollinators.[113] A lack of diversity makes plants vulnerable because they all have the same natural defenses and cannot help each other fight off any challengers they are exposed to.[114] Companion planting, in contrast, contributes to the holistic health of the plants and their environment because such planting allows different types of plants to thrive in the same space. By providing each other different protection and an exchange of nutrients in the soil, plants are better equipped to collectively fight off pests.[115] In addition, companion planting can boost growth, improve the flavor of plants, replenish the soil through rotation, keep the soil moist, help prevent erosion, and prevent keep weeds.[116]

Monoculture farmers treat their crops with pesticides to eliminate pest infestations that are characteristic of and overpower monoculture environs. Farmers administer pesticides in various ways, including spraying the plants. With spraying, the pesticide covers all parts of the plant that the pests attack so that the pest feeding on the plant ingests poison and dies.[117] Pollinators, however, are also at risk from the harmful effects of the pesticides.

Due to the effects of these pesticides on humans, manufacturers created a new type of insecticide called neonicotinoids. However, neonicotinoids also have a harmful effect on pollinators. Neonicotinoids are applied to the seed, and then travel through the plant's vascular system, spreading internally to the plant's stem, leaves, and flowers.[118] Neonicotinoids were originally considered an optimal choice as a pesticide due to their low toxicity to humans and animals; "they are 10 thousand times more toxic to insects than mammals."[119] In February 2018,

---

[113] Patterson.

[114] Patterson.

[115] George Kuepper and Marti Dodson, *Companion Planting & Botanical Pesticides: Basic Concept and Resources* (Butte, MT: ATTRA Sustainable Agriculture, 2009), https://attra.ncat.org/product/companion-planting-botanical-pesticides-concepts-resources/.

[116] Nan Fischer, "How to Start Companion Planting," *Home Gardening* (blog), June 5, 2017, https://www.naturespath.com/en-us/blog/the-benefits-of-companion-planting/.

[117] Marla Spivak et al., *Why Does Bee Health Matter? The Science Surrounding Honey Bee Health Concerns and What We Can Do About It* (Ames, IA: Council for Agricultural Science and Technology, 2017), 13, https://www.cast-science.org/wp-content/uploads/2018/12/QTA20171_Bee_Health_565CB839D149E.pdf.

[118] Spivak et al., 13.

[119] Spivak et al.

> a major report from the European Union's scientific risk assessors (Efsa) concluded that the high risk to both honeybees and wild bees resulted from any outdoor use, because the pesticides contaminate soil and water. This leads to pesticides appearing in wildflowers or succeeding crops. A recent study of honey samples revealed global contamination by neonicotinoids.[120]

Additionally, the dust from the seeds spread by the wind during planting lands on neighboring farms' flowers. Neonicotinoid dust is very harmful to bees because it adheres, like pollen, to their hairs.[121] When the same type of treated seeds are repeatedly planted over time, a high concentration of pesticide filtrate ends up in the soil.[122] Ultimately, treating seeds does not avoid negative effects; it still causes the harmful toxins to be transferred to the bees.

Agrochemical companies and scientists disagree about the dangers of pesticides, specifically neonicotinoids, for pollinators. Scientists, referring to a study issued in May 2014 by the Harvard School of Public Health, say that two widely used neonicotinoids were responsible for causing serious wintertime losses to colonies of honey bees, specifically during very cold winters.[123] The study replicated a 2012 study conducted by Chensheng (Alex) Lu, associate professor of environmental exposure biology at Harvard, that suggested that colony collapse disorder was related specifically to neonicotinoids.[124] Lu, who participated in both studies, said, "We demonstrated again in this study that neonicotinoids are highly likely to be responsible for triggering colony collapse disorder in honey bee hives that were healthy prior to the arrival of winter."[125] The agrochemical companies that produce and sell the neonicotinoids that are used to

---

[120] Damian Carrington, "EU Agrees to Total Ban on Bee-Harming Pesticides," *Guardian*, April 27, 2018, https://www.theguardian.com/environment/2018/apr/27/eu-agrees-total-ban-on-bee-harming-pesticides.

[121] Debra Smith, "Could Weed and Feed be Killing Bees?" *HeraldNet*, April 22, 2008, https://www.heraldnet.com/news/could-weed-and-feed-be-killing-bees/.

[122] Spivak et al., Why Does Bee Health Matter.

[123] Gillam, "Bees Crucial to Many Crops Still Dying."

[124] Marge Dwyer, "Study Strengthens Link between Neonicotinoids and Collapse of Honey Bee Colonies," Harvard School of Public Health, May 9, 2014, https://www.hsph.harvard.edu/news/press-releases/study-strengthens-link-between-neonicotinoids-and-collapse-of-honey-bee-colonies/.

[125] Dwyer.

boost yields of staple crops——Monsanto, Syngenta AG, Bayer, and DuPont—say that the bees are being killed off by other factors, like mites.[126]

In 2013, the European Union placed a limited restriction on neonicotinoids, banning their use on flowering crops that attract bees.[127] In April 2018, the European Commission announced that it would ban neonicotinoids from all fields by the end of the year due to the danger they pose to bees and food security.[128] The restriction was carried out by the EU member states in May 2018 for three neonicotinoid pesticides.[129] The previous year, the authorization for the insecticide Fipronil, considered harmful to bees, expired and this product could no longer be used.[130] Although some farming groups and manufacturers of the pesticide have called the ban overly cautious and warn that crop harvests could decline, Nicolas Munier-Jolain from France's National Institute for Agriculture research disagrees. His team conducted a recent study published in the peer-reviewed journal *Nature Plants* that showed that 78 percent of farmers would be equally or more profitable when using fewer pesticides of all kinds. The study analyzed over 1,000 farms in France (although the similarity between them was not specified) that used high or low levels of pesticides.[131]

According to environmental editor Damian Carrington, scientists believe farmers want to limit pesticide use, in part, out of concern for their own health—but farmers may not have access to data about other options. Instead, farmers get guidance and recommendations from the representatives that manufacture and sell pesticides and the businesses that buy their crops.[132] The

---

126 Bayer and Syngenta make the pesticides in question; Monsanto and DuPont use them for coatings on the seeds they sell. Gillam, "Bees Crucial to Many Crops Still Dying."

127 "EU Moves to Full Ban on Pesticides That Harm Bees," *News Tribune*, April 28, 2018, https://www.newstribune.com/news/national/story/2018/apr/28/eu-moves-to-full-ban-on-pesticides-that-harm-bees/723912/.

128 News Tribune.

129 Rochelle Toplensky, "EU Court Upholds Ban on Insecticides Found to Harm Bees," *Financial Times*, May 17, 2018, https://www.ft.com/content/4c4abfb0-59ba-11e8-bdb7-f6677d2e1ce8.

130 Toplensky.

131 Martin Lechenet et al., "Reducing Pesticide Use While Preserving Crop Productivity and Profitability on Arable Farms," *Nature Plants* 3 (2017), https://www.nature.com/articles/nplants20178.

132 Damian Carrington, "Farms Could Slash Pesticide Use without Losses, Research Reveals," *Guardian*, April 6, 2018, https://www.theguardian.com/environment/2017/apr/06/farms-could-slash-pesticide-use-without-losses-research-reveals.

scientists submit that this does not mean that pesticides are useless or inefficient; it just indicates that farmers who use low-level chemicals could employ other methods, such as rotating crops, mechanical weeding, and careful sowing management, if they knew how to effectively do so.[133]

Bayer, a pesticide manufacturer, continues to present itself as a bee-friendly company while fighting to keep its pesticide on the shelf.[134] In 2013, the journal *Current Opinion in Environmental Sustainability* published an analysis of the effect neonicotinoids have on honey bees and presented a variety of ways bees can be exposed to them.[135] It found honey bees were exposed to the toxins through the ingestion, contact, and inhalation of contaminated air, water, nectar, pollen, and sowing dust as a result of treated seeds, plants, and ground soil.[136] Different honey bees could be exposed to varying extents, in different ways. For example, bees have different jobs (some are nurse bees while others are foragers; some forage nectar while others forage pollen), and a bee's job may impact its exposure levels. Lethal doses of neonicotinoids kill bees outright, while sub-lethal doses result in behavior or physiological modifications such as immune deficiency, memory impairment, or failure to forage. The study establishes that neonicotinoids, the most widely used class of insecticides, are highly neurotoxic to honey bees and exposure over time amplifies the toxicity.[137] The study concludes that the "worldwide production of neonicotinoids is still increasing. Therefore, a transition to pollinator-friendly alternatives to neonicotinoids is urgently needed for the sake of the sustainability of pollinator ecosystem services."[138]

Although pesticides, miticides, fungicides, insecticides, herbicides, and rodenticides were created as solutions to particular crop problems, all have resulted in unintended pollinator

---

[133] Carrington.

[134] "Bayer, Bees & the Hall of Shame," *GroundTruth* (blog), January 5, 2015,-http://www.panna.org/blog/bayer-bees-hall-shame.

[135] Jeroen P van der Sluijs et al., "Neonicotinoids, Bee Disorders and the Sustainability of Pollinator Services," *Current Opinion in Environmental Sustainability* 5, no. 3 (September 2013): 293–305, https://doi.org/10.1016/j.cosust.2013.05.007.

[136] van der Sluijs et al., 295.

[137] van der Sluijs et al., 299.

[138] van der Sluijs et al., 2.

problems due to unregulated and injudicious use.[139] Likewise, even though the negative impacts are well known, pesticides continue to play a significant role in food production because they promote and protect harvests, and increase the number of times per year a particular crop can be grown on the same land. In underdeveloped or developing countries, pesticides are considered essential to supporting the increased yield requirement in the face of food scarcities.[140]

Like pesticides, chemical fertilizers are also dangerous for bee health. As mentioned previously, the practice of not rotating crops means that one type of plant absorbs all of the nutrients it requires from the soil, thereby depleting the soil of nutrients.[141] Replenishing the soil requires chemical fertilizers. Such fertilizers provide immediate nutritional access and control, which means farmers do not have to wait until microbes in compost or other organic fertilizers have broken down into usable parts.[142] Moreover, chemical fertilizers do not contain the undesirable elements found in compost such as the seeds of unwanted plants or weeds, and insect eggs.[143] That said, chemical fertilizers create a host of problems. For instance, they release nutrients too quickly, which results in fragile and disease-prone plants.[144] Furthermore, chemical fertilizers move to waterways through runoff, where they can potentially harm wildlife or people.[145]

Dave Pehling of the Washington State University Extension Team of Snohomish County, Oregon, considered the question: Could weed and feed be killing bees? In his answer, Pehling refers to the USDA Agricultural Handbook #335 (*Beekeeping in the United States*), which says that while herbicides and fungicides are decidedly less lethal to honey bees, there is little information to address the effect of chemical fertilizers in the honey bee's environment, or their

---

139 Singh, "Pesticides and Safety."

140 Singh.

141 Patterson, "What Is Monocropping."

142 Michelle Miley, "The Advantages & Disadvantages of Chemical Fertilizer," Hunker, March 13, 2018, https://www.hunker.com/13404813/the-advantages-disadvantages-of-chemical-fertilyzers.

143 Miley.

144 Miley.

145 Miley.

effect in combination with other chemicals to which honey bees are exposed.[146] He adds that fertilizers, even when used with good intentions, can be improperly used, overused, or used in combination with other chemicals which, could result in harm.[147] Testing the soil for nutrient content prior to fertilizing provides a guide for the amount of fertilizer that should be used.[148] A recommended approach to controlling pests is the integrated pest management system. Integrated pest management is used in agricultural settings to protect people, pets, and the environment against harmful exposures through more suitable techniques that reduce the number of pests. These techniques include the use of chemicals, cultures, fertilization, irrigation, resistant plant varieties, and data.[149]

Scientific studies have revealed that while neonicotinoids and chemical fertilizers are clearly a troubling issue for bees, they are not the only problem caused by plant chemicals. When a variety of chemicals are used in combination, they synergize. For example, while fungicides do not always harm bees, when mixed together they can make certain insecticides up to 1,100 times more powerful; these unpredictable blends can be very bad for bees because, even when they are labeled as safe for bees on their own, certain ingredients can become unsafe when joined with other ingredients.[150]

Unmistakably, chemicals in many forms present a wide assortment of threats to pollinators. To find solutions, we must go beyond simply understanding that toxic chemicals pose a risk to pollinators. To create tangible solutions for protecting unwanted and unintended exposures, we must follow best management practices, which include education, targeted research, surveillance, and funding.

---

146 William T. Wilson, Philip E. Sonnet, and Adair Stoner, "Pesticides and Honey Bee Mortality," in *Beekeeping in the United States*, ed. E.C. Martin, Everett Oertel, and William P. Nye, *Agriculture Handbook No. 335* (Washington, DC: Government Printing Office, 1980), 129–40, https://thebeeyard.org/wp-content/uploads/2014/02/Beekeeping.in_.the_.United.States.pdf.

147 Smith, "Could Weed and Feed be Killing Bees."

148 Miley, "Chemical Fertilizer."

149 "Integrated Pest Management (IPM) Principles," Environmental Protection Agency, April 11, 2019, https://www.epa.gov/safepestcontrol/integrated-pest-management-ipm-principles.

150 Hanson, *Buzz*, 194–95.

4. Pathogens

The final of the 4 Ps, and possibly the most threatening, is honey bees' vulnerability to pathogens. No shortage of viruses, deformities, diseases, and harmful bacteria infects bees today. Unlike the immune systems of humans and mammals, the immune system of the honey bee does not have antibodies; there is therefore no method to vaccinate bees against viruses. Consequently, pathogens can weaken bees, sicken their colonies, and decrease their populations.[151]

Evidence suggests pathogens are capable of being transmitted from one bee species to another.[152] This is problematic because the honey bee has become an ecosystem service: so many hives and queens are being shipped and transported all over the world. Their population decline has created a new industry with its own set of shortcomings.[153] Beekeepers used to make the majority of their income from honey, wax, and other bee products. Now, honey bees are raised, placed in crates, and transported throughout the country and abroad to provide pollination services to a variety of monocultures.[154] They are shipped, flown, and trucked thousands of miles in a matter of months. For example, during three weeks in February each year, more than one million hives travel from as far as New England to pollinate the roughly 600,000 acres of almond farms in the central valley of California.[155] Additionally, hives are flown in from Australia to supplement the dwindling number of hives in the United States. While millions of bee colonies are in close proximity during transit, all kinds of microbes and parasites—from not just around the country, but around the world—circulate.[156] Furthermore, bees may pollinate cantaloupes in Texas in May and then travel to Illinois to pollinate pumpkins during the summer, increasing their exposure.

The already compromised immune systems of managed bees are consistently subject to a homogenous diet of one nectar for weeks on end. Although the result may be healthy foods for humans, a one-food-source diet weakens the already compromised honey bee, stresses its digestive

---

151 Spivak et al., "Why Does Bee Health Matter."

152 Hanson, *Buzz*, 195.

153 Christiansen, "Bee Collapse."

154 Christiansen.

155 Christiansen.

156 Christiansen.

system and leaves it susceptible to disease.[157] Therefore, industrial honey bees regularly receive antibiotics to fight bacterial infections—to the point that many colonies' bees now carry antibiotic-resistant bacteria.[158] Because of managed bees' poor health, partly caused by the conditions of captivity, strips of insecticide are placed inside their hives to kill off the Varroa mites and other pestilences that the honey bee is too sickly to combat. Reducing the human-created conditions that have caused malnourishment to honey bees may, instead, allow their immune system to better fight pests and parasites.[159]

Dr. Diana Cox-Foster, professor of entomology at Pennsylvania State University, anticipates that, over time, the following letters will be added to the 4 Ps: an "N" for the nesting habitats now dominated by industrial farming and development; an "I" for invasive species, referring to both plants and bees; and a double "C" for climate change.[160] The 4 Ps, in combination with the N, I, and double C, suggest a challenging future for pollinators. Dave Goulson, professor of life sciences at the University of Sussex, provides a common-sense approach to the problem. He insists that while research continues regarding challenges facing pollinators, action to reduce pressure from any of the combined stressors also is helpful.[161] He adds that a full understanding of the problem is not necessary, as we know enough now to take immediate and specific positive action. Steps include enhancing pollinator habitats, reducing pesticide use, and limiting the spread of pathogens that results from the long-distance transportation of bees.[162] Researchers, farmers, conservationists, and the general public are just beginning to see the beneficial impact these strategies can have.[163]

---

157 Christiansen.

158 Christiansen.

159 Christiansen.

160 Hanson, *Buzz*, 196.

161 Hanson, 199.

162 Hanson, 198–99.

163 Hanson, 199.

F. A FUTURE FOR HONEY BEES

In 2005, a steep decline in pollinators in the United States raised concerns among environmentalists about bee health; by 2007, several potential causes were being debated. Beekeepers in Europe were also losing bees at an increasing rate. Although pesticides were targeted from the beginning, other proposed sources of the harm included viruses, mites, fungi, cell towers, and climate change. A 2014 paper published in *Science* magazine attributed the honey bee declines to "chronic exposure to multiple interacting stressors."[164] Bee colonies might survive stress from parasites, pesticides, or disease individually, but the cumulative exposure to several simultaneous threats is too much for the bees' already compromised systems.[165] As Cara Giamo explains, "When we turned the honeybee's industriousness into industry, we failed to build in a sufficient health care plan."[166]

The honey bee is vital to the environment as well as to societies' financial stability and nutritional sustainability. Blossoming vegetation is the sole nutritional source for honey bees; humans rely tremendously on pollinators for their nutrient sources, both directly and indirectly. And, for a variety of reasons, honey bees are disappearing. Research and measures to strengthen and protect the bees have led to debates between government, business, and environmental groups across the globe. Because of competing interests, commercial enterprise, and disagreements about what is causing the complex issue of pollinator decline, there is no clear solution.

Steady colony losses, the increasing number of studies, and the mounting research all give rise to serious concerns on a national level. John P. Holdren, assistant to the president for science and technology, "said in an interview that the president is concerned about the issue not just because of bees' economic impact, but also because of the 'canary in the coal mine' phenomenon."[167] Holdren further commented: "If honey bee colonies are collapsing for a reason

---

[164] Dave Goulson et al., "Bee Declines Driven by Combined Stress from Parasites Pesticides, and Lack of Flowers," *Science* 347, no. 6229 (March 2015), https://doi.org/10.1126/science.1255957.

[165] Giamo, "The Case against Honey Bees," 5.

[166] Giamo, 5.

[167] Juliet Ellperin, "How the White House Plans to Help the Humble Bee Maintain its Buzz," *Washington Post*, May 19,2015, https://www.washingtonpost.com/politics/whats-all-the-obama-buzz-about-bees/2015/05/18/5ebd1580-fd6a-11e4-805c-c3f407e5a9e9_story.html.

we don't understand, what is that telling us about our overall impacts and understanding of the ecosystems on which we depend?"[168] Those discussions led to the launch of the White House's Pollinator Health Task Force, which is co-chaired by the secretary of agriculture and the administrator of the EPA.[169] After determining that previous efforts to reverse the decline in honey bees were insufficient, the task force announced the first *National Strategy to Promote the Health of Honey Bees and Other Pollinators*. This strategy is explored in Chapter III.

168 Ellperin.

169 Ellperin.

THIS PAGE INTENTIONALLY LEFT BLANK

III. POLLINATOR POLICY FRAMEWORKS: THE UNITED STATES AND THE EUROPEAN UNION

In both the United States and the European Union, policymakers have decided that pollinator protections are important to their region's environment, economy, and food security. Consequently, they have created national policies to address these issues. The United States and the European Union are both stable regions with considerable economies that are capable of addressing the conditions affecting pollinators. Yet they are facing challenges due to the approaches they have adopted. These challenges are related to gaps in scientific knowledge, protection of corporate interests, and a failure to enact substantial regulations to safeguard pollinator health. This chapter compares the development and objectives of pollinator protection strategies in the U.S. and EU. First, it examines America's *National Strategy to Protect Honey Bees and Other Pollinators* (referred to herein as the National Strategy) and then it examines the *EU Pollinators Initiative* (referred to as the Pollinators Initiative). Lastly, the chapter addresses the policy gaps and greatest concerns identified by experts in the field of pollinator studies.

The Pollinators Initiative shares similarities with the National Strategy but also differs in ways that might contribute to enhanced food security and other environmental benefits. While the United States has a federal government and individual states, the European Union has a federation and national governments, making it a roughly parallel system of governance. Furthermore, the European Union is geographically, economically, and politically similar to the United States. By comparing and contrasting the U.S. and EU strategies to address the pollinator health crisis, it may be possible to identify solutions and best practices regarding America's pollinator concerns. This thesis thus outlines the most salient points drawn from the policies to answer the research questions.

A. *NATIONAL STRATEGY TO PROMOTE HONEY BEES AND OTHER POLLINATORS*

The National Strategy details important actions required to understand pollinator declines and promote pollinator health. This section explores the genesis and objectives of the document, the four themes it presents for protecting pollinators, and the gaps and limitations of the document.

1. The Genesis of the U.S. National Strategy

U.S. efforts to create a national pollinator strategy arose from beliefs among academics, government officials, conservationists, and industry stakeholders that pollinator decline is a threat to environmental, economic, nutritional, and food security. In 2014, President Barack Obama named a task force composed of federal administrative bureaus to address pollinator declines and to rebuild pollinator populations; he chose the secretary of agriculture and the administrator of the EPA to co-chair the Pollinator Health Task Force.[170] This task force developed the *National Strategy to Promote the Health of Honey Bees and Other Pollinators* and also created the *Pollinator Research Action Plan* (PRAP). The PRAP is a standalone document that accompanies the National Strategy to coordinate the following:

- Studies of the health of honey bees, other managed bees, and wild bees that assess stressors leading to species decline and Colony Collapse Disorder, as well as strategies for mitigation.
- Plans for expanding and automating data collection and data sharing related to pollinator losses, in partnership with the private sector.
- Assessments of wild bee and monarch butterfly population patterns, and modeling of the relationship of those population patterns to habitat variables.
- Development of pollinator-friendly seed mixes and guidelines for evaluating their effectiveness in restoration and reclamation.
- Identification of best practices for minimizing pollinator exposure to pesticides, and new cost-effective ways to manage pests and diseases.
- Creation of strategies for targeting restoration efforts at areas that will yield the greatest expected net benefits for pollinator health.[171]

[170] Pollinator Task Force, *National Strategy*, 9.

[171] Pollinator Task Force, 9.

The National Strategy was created to guide desired outcomes toward improved pollinator health and implement fundamental recommendations to help direct decision-makers. The National Strategy does not significantly address pesticides, parasites, or pathogens other than to encourage additional research. With regard to poor nutrition, the National Strategy promotes awareness, incentivizes public-private partnerships, and makes a significant commitment to increasing and enhancing habitats to provide space and nutrition for pollinators. Overall, critics of the U.S. policy contend that the plan does not go far enough.[172] Its proponents, however, argue that this policy is the first serious action the United States has taken to protect pollinators and is a step in the right direction.[173] A comparative analysis with other policies may help determine its effectiveness and future direction.

2. Objectives of the National Strategy

The National Strategy has three guiding objectives: decreasing honey bee losses, increasing monarch butterfly populations, and enhancing land for pollinators.[174] Like the honey bee, monarch butterflies are pollinators and, as such, need a similar habitat. Additionally, monarch butterflies have a distinctive migration pattern that arouses curiosity about science and nature throughout the world.[175] This curiosity leads to an interest in environmental sustainability, revitalization, and conservation. Essentially, protecting the monarch butterfly species is significant from an ecological, educational, and motivational standpoint.[176] In some respects, achieving stable and healthy populations of honey bees and butterflies will require the success of the policy's third objective, the restoration and enhancement of 7 million acres of land: expanding and protecting land for pollinators is essential to conserving both the honey bee and the monarch butterfly. Without sufficient space for them to feed and breed, pollinator populations will continue to decline.

---

[172] McNeil, "National Strategy."

[173] McNeil.

[174] Pollinator Task Force, *National Strategy*, i.

[175] "Why Is the Monarch Population Decline Important?" Monarch Joint Venture, accessed August 2, 2019, https://monarchjointventure.org/resources/faq/why-is-the-monarch-population-decline-important.

[176] Monarch Joint Venture.

3. Four Themes for Protecting Pollinators

The four fundamental themes of the National Strategy are "conducting research to understand, prevent, and recover from pollinator losses; expanding public education programs and outreach; increasing and improving pollinator habitat; and developing public-private partnerships across all these activities."[177] These themes and their importance are laid out in this section.

a. Research

According to the National Strategy, one method of conducting research and determining whether honey bee losses are being reduced is by evaluating data from the quarterly and annual Bee Informed Partnership surveys, directed by the USDA National Agricultural Statistical Service.[178] Target outcomes can be assessed by "develop [ing] baseline data and additional goal metrics for winter, summer, and total annual colony loss."[179] Currently, records exist for the years 2006 to 2019, as depicted in Figure 6. In July 2019, CNN reported that the USDA suspended data collection for the annual report due to budget cuts.[180] This is concerning considering that 2018 honey bee hive loses were the highest on record.[181] It is significantly easier to determine if pollinator population numbers are improving if there are records available for comparison.

---

[177] Pollinator Task Force, *National Strategy*, i.

[178] Pollinator Task Force, 10.

[179] Pollinator Task Force, 10.

[180] Sam Fossum, "Honeybees Hit by Trump Budget Cuts," CNN, July 6, 2019, https://www.cnn.com/2019/07/06/politics/honeybees-study-usda-donald-trump-budget-cuts/index.html.

[181] Fossum.

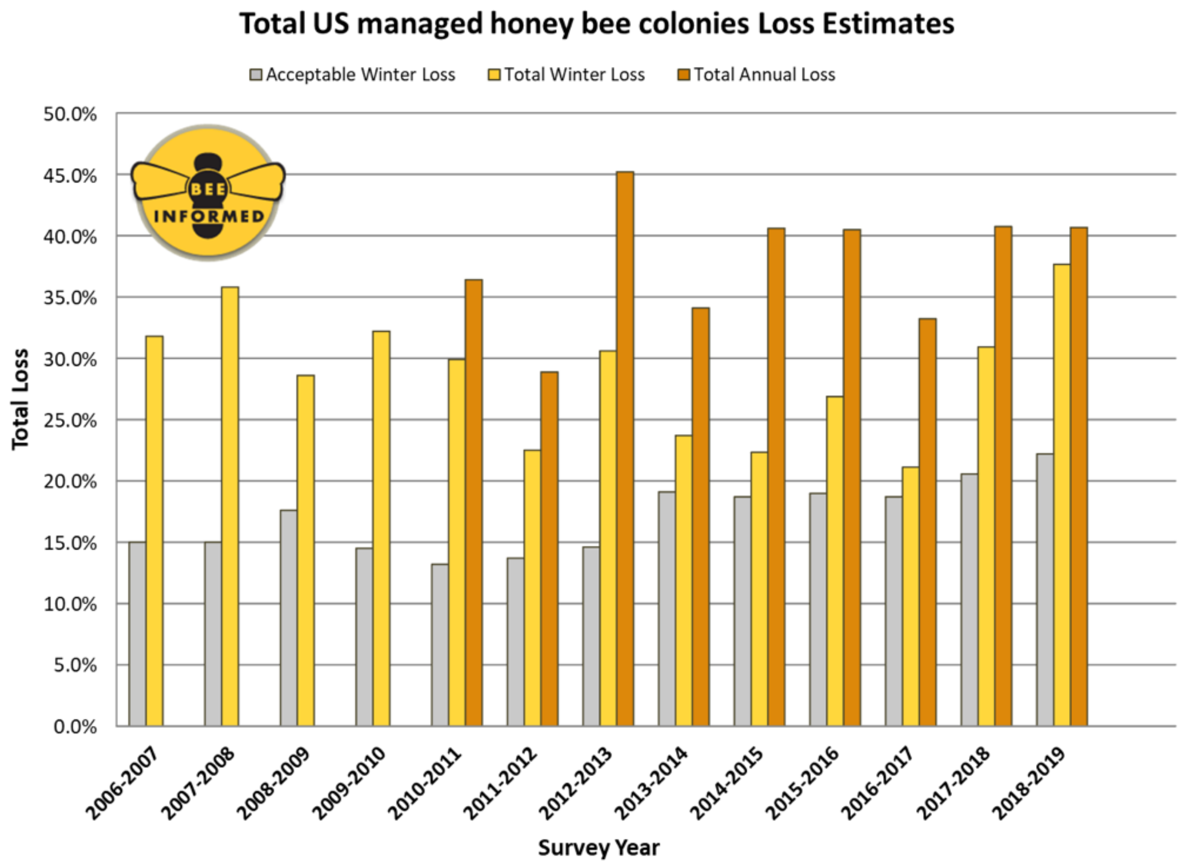

Figure 6. U.S. honey bee colony loss estimates[182]

Figure 6 demonstrates that, for each year surveys were conducted, the actual winter loss exceeded the acceptable winter loss numbers. Sometimes, as in the years 2006 to 2007, 2007 to 2008, 2009 to 2010, 2010 to 2011, and 2012 to 2013, the actual winter loss exceeded the acceptable loss by 100 percent or more. Through this assessment, evaluators can examine, in part, whether the other themes of education, habitat enhancements, and public-private partnerships are having an impact.

182 Source: "Honey Bee Colony Losses 2018–2019: Preliminary Results," *Bee Informed!* (blog), June 19, 2019, https://beeinformed.org/results/2018-2019/.

b. Education

The National Strategy emphasizes education as an essential tool for protection of pollinators. According to the strategy, "[a] variety of education and outreach materials, programs, and media already exist to enlist the participation of … different audiences in actions that benefit pollinators."[183] Outreach is available for private citizens, small businesses, educational centers, and administrative and cultural centers, to include libraries and museums, as well as government land management staff.[184] Helping the community understand that pollinator conservation is a shared national responsibility is imperative because even one individual who engages meaningfully in conservation efforts can make a difference.

c. Habitat

Increasing and improving pollinator habitats is anticipated to be one of the largest change agents associated with the third theme of the National Strategy.[185] It includes the following goals:

- Improving the quality and quantity of overall acreage for pollinators;
- Expanding pollinator habitats on rights-of-way;
- Strengthening Federal guidance documents to increase pollinator habitat;
- Increasing habitat quantity and quality on Federally-managed facilities; and,
- Creating a native seed strategy and reserve.[186]

This section of the policy addresses several efforts. One course of action includes expanding the Conservation Reserve Program, which offers farmers incentives to devote a portion of their land to planting pollinator-friendly habitats.[187] The federal government manages the largest amounts of land and largest number of facilities in the country, so it offers an ideal starting place to create pollinator-friendly environments and influence private-sector habitat activities.[188] Additionally, the policy provisions for federal lands and buildings act as a model to encourage pollinator habitat

[183] Pollinator Task Force, *National Strategy*, 19.

[184] Pollinator Task Force, 19.

[185] Pollinator Task Force, 28.

[186] Pollinator Task Force, 28.

[187] Pollinator Task Force, 29.

[188] Pollinator Task Force, 29.

creation by private landowners and operators.[189] This section of the National Strategy also discusses development of a reserve of native seed mixes to help safeguard an established supply of "genetically appropriate" plants.[190] Honey bees, and the environs that rely on pollinators, require a sufficient and quality habitat to thrive.

d. Public-Private Partnerships

Finally, the National Strategy makes pollinator health a national priority by encouraging members of the private and public sectors to work together to promote and protect pollinators.[191] Within this realm, partnerships are encouraged and coordinated within the federal government and through non-federal organizations. In 2014, the Conservation Reserve Program, an $8 million honey bee incentive, began offering farmers and landowners in five Midwestern states (Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin) incentives to grow effective sources of pollen and nectar for honey bees on their land as a mid-contract management activity.[192] Cumulatively, these five states host 65 percent of the U.S. summer honey bee hives.[193]

Additionally, a limited number of public-private conservation efforts are being funded through the Pollinator Partnership—which is coordinated by the North American Pollinator Protection Campaign—and with the Honey Bee Health Coalition, to encourage the promotion of pollinator health throughout the farming community.[194] These initiatives include activities such as "planting pollinator gardens with seed provided by companies, enlisting farm and forestry organizations, or encouraging the expansion of pollinator habitat on working lands."[195]

Stakeholders, including beekeepers, farmers, environmental groups, industry, researchers, conservationists, and philanthropic organizations, can plant pollinator-friendly gardens, conduct

---

[189] Pollinator Task Force, 33.

[190] Pollinator Task Force, 44.

[191] Pollinator Task Force, 25.

[192] Pollinator Task Force, 29.

[193] Pollinator Task Force, 29.

[193] Pollinator Task Force, 29.

[194] Pollinator Task Force, 26.

[195] Pollinator Task Force, 25–26.

greener cleanups, and engage in other ecosystem-protection initiatives.[196] According to the National Strategy, "The value of leveraging Federal investments through public-private partnerships has been a basic tenet of the Obama Administration."[197] The goal of public-private partnerships is a progressive focus on identifying new pathways that will promote honey bee health.

4. Gaps and Limitations

The National Strategy is a groundbreaking attempt to understand the pollinator decline problem, encourage research, enhance and restore habitats, improve public land, and promote public-private partnerships. However, the policy does have limitations. Claire Kremen, professor of conservation biology and entomology at Purdue University, argues that the National Strategy does not question the use of pesticides enough.[198] The director of the environmental health program at the Center for Biological Diversity, Lori Ann Burd, similarly criticizes the policy, claiming that "countless studies have found that pesticides, and particularly neonicotinoid insecticides, are a leading cause of pollinator declines."[199] Also in agreement is entomologist May Berenbaum, who claims a drawback of the policy is its failure to issue a total ban on neonicotinoid pesticides.[200]

While the National Strategy does encourage the "assessment of other pesticides for their potential impacts on pollinators," it emphasizes the critical role pesticides play in promoting agricultural health, controlling invasive species, and combatting of harmful insects.[201] It blames adverse environmental and human health consequences on the misuse and overuse of these chemicals and imposes no immediate bans. According to Kaitlin Stack Whitney, who wrote an

---

196 Pollinator Task Force, 27.

197 Pollinator Task Force, 25.

198 McNeil, "National Strategy."

199 "Pollinator Task Force Releases National Strategy," Farm Progress, May 21, 2015, https://www.farmprogress.com/government/pollinator-task-force-releases-national-strategy.

200 Kaitlin Stack Whitney, "Pros and Cons of the U.S. Federal Strategy to Protect Pollinators," *Macroscope* (blog), September 17, 2015, https://www.americanscientist.org/blog/macroscope/pros-and-cons-of-the-u.s.-federal-strategy-to-protect-pollinators.

201 Pollinator Task Force, *National Strategy*, 47.

article for *Macroscope* entitled "Pros and Cons of U.S. Federal Strategy," understanding why a ban is difficult to achieve involves understanding the process of restricting pesticides in the United States (discussed further in the next chapter).[202]

The policy also does not fully address climate change or monoculture farming. The National Strategy references climate change twice; while climate change is making its way into national policy regulations in other countries, this has not been the case in the United States.[203] Additionally, the National Strategy does not make any overture to reduce or alter conventional uses of monoculture farming, with the exception of discussion about improving landscapes alongside federal roadways and other substantial acreage containing natural vegetation.[204] Monoculture farming, as described previously, is a gateway threat to pollinators, meaning it opens the door to an excess of other threats, to include pesticides, fertilizers, poor nutrition, and agricultural deserts.

In the United States, the scientific community has identified a myriad of threats to pollinators. Determining the extent to which each threat is represented in the National Strategy is a challenge and worthy of additional research. Setting policy linked to regulations becomes a sticking point when it threatens to affect the profit margins of major corporations and/or potential crop losses due to the regulation of pesticide use. In response to these complex challenges, it makes sense to explore how other nations are dealing with a similar issue. One such model that can be evaluated is the *EU Pollinators Initiative*, which has been responsible for the implementation of a broader and more comprehensive pollinator protection plan.

B. *EU POLLINATORS INITIATIVE*

The goal of the *EU Pollinators Initiative* is to bring together interested stakeholders to manage conservation and promote research and education for pollinators. This section explores the genesis and objectives of the plan, along with its gaps and limitations.

---

[202] Whitney, "Pros and Cons of the U.S. Federal Strategy."

[203] Richard Youngs, *Climate Change and European Security* (London: Routledge, 2015), 81; Jos Delbeke and Peter Vis, eds., *EU Climate Policy Explained* (New York: Routledge, 2015), https://op.europa.eu:443/en/publication-detail/-/publication/65ff050c-b8f8-11e5-8d3c-01aa75ed71a1.

[204] Pollinator Task Force, *National Strategy*, 36.

1. The Genesis of the Pollinators Initiative

Like the United States, European nations have also experienced sharp pollinator declines. However, their policy responses appear to be more comprehensively and proactively addressing pesticides, climate change, member state inclusion, and a variety of pollinators. Their actions to prevent further decline outline a map for possible future actions by other nations, such as the United States.

As early as 2012, member states of the European Union were given a directive to adopt national pollinator action plans. In October of 2017, however, a commission report showed insufficient progress.[205] In response, the *EU Pollinators Initiative* was unveiled in 2018. Prior to drafting the policy, the European Union Commission's Directorate-General for the Environment offered an environmental consultation to the public to collect views on the decline of pollinators for the purposes of informing the government policy.[206] The civic response from over 66,579 respondents is believed to be the fourth-highest public response ever to an environmental consultation in Europe.[207] The resulting *EU Pollinators Initiative*, similar to the U.S. National Strategy, is also the first of its kind in the European Union.

The Pollinators Initiative includes protections for pollinators against certain pesticides and encourages more research on the harmful effects of pesticides on pollinators. It encourages research to address threatening parasites and pathogens. With regard to poor nutrition, the Pollinators Initiative incentivizes public and agricultural sectors to take conservation action, it promotes urban and rural habitat improvement, and it supports the monitoring and assessment of declining pollinator populations. The European Union proactively combats climate change by planting a variety of crops and conserving pollinator habitats. The Pollinators Initiative is the

---

205 European Commission, *EU Pollinators Initiative* (Brussels: European Commission, June 1, 2018), 20, https://ec.europa.eu/environment/nature/conservation/species/pollinators/documents/EU_pollinators_initiative.pdf.

206 "Factsheet: Public Consultation on EU Pollinators Initiative," European Commission, accessed November 22, 2019, 1, http://ec.europa.eu/environment/nature/conservation/species/pollinators/documents/EU_pollinators_initiative_factsheet.pdf.

207 Matthew Appleby, "EU Pollinator Consultation Draws Huge Response," *Horticulture Week*, April 11, 2018, https://www.hortweek.com/eu-pollinator-consultation-draws-huge-response/plant-health/article/1461739; European Union, *EU Pollinators Initiative: Summary of the Results of the Public Consultation* (Luxembourg: European Union Publications Office, 2018), 3, https://ec.europa.eu/environment/nature/conservation/species/pollinators/documents/EU_pollinators_summary_public_consultation.pdf.

European Union's first policy addressing pollinator declines and, determined by its impacts, will likely inform future EU strategies that protect pollinators.

2. Objectives of the Pollinators Initiative

The Pollinators Initiative outlines its three priorities as "improving knowledge on pollinator decline, its causes and consequences; tackling the causes of pollinator decline; and raising awareness, engaging wider society and promoting collaboration."[208] The thirty-four-page policy directs prudent and expedient action regarding the health of pollinators and their relationship to the environment. Additionally, the policy provides a framework for existing measures and challenges related to pollinator conservation.[209] A concern facing the European Union is the fear that pollinator losses and a collapse of the EU ecosystems will hinder the European Union's road to continued and sustainable development and will threaten human health.[210]

a. Knowledge on Pollinators

The policy details the value of the contributions made by pollinators. For instance, it discusses how pollinators influence both the quality and quantity of crop yield, noting that strawberries pollinated by insects are of higher quality and enjoy a longer shelf life than those that have been wind- or self-pollinated.[211] This is significant because pollinators account for over half of strawberries' market value (over 1 billion Euros). Another example is a list of the range of yields produced by honey bees, to include propolis, pollen, royal jelly, beeswax, and honey.[212]

In the European Union, some nations—such as Spain, Italy, and Greece—are more dependent on pollinators for their economic sustainability than others because their agricultural commodities are almost entirely reliant on bees and other pollinators.[213] Greater demand for select produce in the face of colony losses has elevated concerns about reliance on only one pollinator

---

[208] European Commission, EU Pollinators Initiative.

[209] European Commission, 3.

[210] European Commission, 3.

[211] European Commission, 12.

[212] European Commission, 12.

[213] European Commission, 12.

species. Spain is a leading producer of mandarins and oranges. Italy produces apples and oranges, and Greece produces melons and peaches. Each of these crops is heavily reliant on pollinators and therefore more susceptible to the consequences associated with pollinator losses.

The EU policy documents examples of additional ecological revitalization and the recreational benefits of pollinators. These benefits include enabling the diversity of crops and supplementary ecosystem services like natural pest control, landscape aesthetics, biodiversity conservation, and the protection of water and soil quality by mitigating runoff and minimizing soil erosion.[214] The policy details how pollinators have inspired art, music, literature, religion, and technology, and how they create social, educational, and recreational explorations, such as the *Flight of the Bumblebee* orchestral by Rimsky-Korsakov.[215] It is evident that crop yields, ecosystem health, and pollinator-inspired art and recreation in the European Union are dependent on good pollinator health.

The Pollinators Initiative is founded on larger intergovernmental research bases. One such source is a global report containing a section on pollinators that was published in 2016 and is known as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) thematic assessment. IPBES is an intergovernmental body established by member states in 2012, and it aims "to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being, and sustainable development."[216] The IPBES global report on pollinators and food production helps officials make informed decisions at local, regional, national, and international levels by providing governments, the private sector, and the public with independent and scientifically reliable current assessments of available knowledge.[217]

---

214 European Commission, 12.

215 European Commission, EU Pollinators Initiative, 12.

216 "About IPBES," Intergovernmental Platform for Biodiversity and Ecosystem Services, accessed August 2, 2019, https://www.ipbes.net/about.

217 European Commission, *EU Pollinators Initiative*, 4.

b. Actions to Tackle Pollinator Decline

An important first step in protecting pollinators is accurately identifying declines in biodiversity. The European Red List (known simply as the Red List), compiled and published by the International Union for the Conservation of Nature (IUCN), does this by categorizing species that are threatened with extinction in the European Union.[218] The list was created so that applicable and appropriate conservation measures could be employed to improve the status of endangered species. Accordingly, many countries in the European Union have issued lists of species that are under threat based on the evaluation criteria developed by the IUCN.

The Red List's data demonstrates that approximately 9 percent of the bee species and 7 percent of the butterfly species evaluated in the EU environment are threatened with extinction.[219] Even so, the Red List has insufficient data to evaluate the status of more than half of the bee species, indicating that the actual percentage of threatened pollinator species could be between 4 and 60 percent.[220] Directing mitigation actions requires immediate, comprehensive, and accurate data from all nations on all pollinator species. Without ample understanding, governments cannot properly prevent declines or promote pollinator health. The *EU Pollinators Initiative* acknowledges knowledge gaps in the scientific community when it comes to data on pollinators; nonetheless, the Red List is a key tool that helps researchers evaluate the status and trend of pollinators in the European Union.[221]

Its focus on chemicals that are harmful to pollinators is an important aspect of the Pollinators Initiative—and something that is lacking from the U.S. strategy. The Pollinators Initiative explains that herbicides affect bees indirectly because they reduce the amount of nutrition provided by flowering plants, whereas insecticides affect pollinators directly based on their toxicity and the concentration at the time of exposure.[222] Although some chemicals may be sub-lethal, such chemicals still can weaken foraging performance and make bees more susceptible to

[218] European Commission, 5–7.

[219] European Commission, 3.

[220] European Commission, 6.

[221] European Commission, 6.

[222] European Commission, 6.

other stressors. Some pollinators can exhibit symptoms referred to as a "cocktail effect" after being exposed to a combination of chemicals.[223] The EU policy contains provisions that initially limited, then ultimately banned, several varieties of pesticides. Nonetheless, its critics contend that the policy fails to implement sufficiently concrete measures to address intensive agriculture and land-use change.[224]

c. Promote Understanding, Attract Public Attention, and Encourage Partnerships

The policies created by the EU member states show unique responses based on the region's most pressing pollinator issues. According to the *EU Pollinators Initiative*, there are at least six national or regional strategies, and several others are being planned.[225] For example, a Belgium plan called the "Federal Bee Plan 2017–2019," which concentrates on honey bees, has created a Federal Pesticide Reduction Programme, which monitors the effects of pesticides on bees and has raised awareness for the wild bee population. In France, multiple national plans are aimed at reducing pesticide use, supporting research, promoting public awareness and action, and stimulating pollinator habitats.[226] The "All Ireland Pollinator Plan" identifies eighty-one activities aimed at developing public, private, and farm land to be pollinator-friendly and has been used as a model for other countries' policies. The Netherlands has also adopted a national plan to address the effects of pesticide on the food supply and on biodiversity. The Netherlands has successfully promoted hundreds of local and regional pollinator initiatives, public-private partnerships, and public awareness campaigns.[227] Slovenia has no explicit pollinator policy, but public concern is high and pollinators are protected through environmental conservation efforts. Slovenia has designated more than 50 percent of its land as naturally protected.[228] In a coordinated initiative to improve information about wild bee pollinators in Spain, the atlas of bee fauna is being updated by the Spanish National Council for Research and, since 1994, the butterfly populations have been

---

223 European Commission, 14.

224 "Save Our Bees? EU Pollinator Initiative Lacks Teeth to Address Unsustainable Practices!" World Wide Fund for Nature, June 1, 2018, http://www.wwf.eu/?uNewsID=328674.

225 European Commission, *EU Pollinators Initiative*, 16–17.

226 European Commission, 17.

227 European Commission, 17.

228 European Commission, 18.

counted.[229] England, Wales, and Scotland have also developed regional pollinator strategies. Pollinators are not restricted by borders, therefore the *EU Pollinators Initiative* encourages each country to develop its own policies that are both compliant with and complementary to their sister nations' policies, as well as to the policies of the greater European Union.[230]

Although Germany does not have a national pollinator policy, it does have a national biodiversity strategy that covers pollinator initiatives.[231] Moreover, Germany also prepared a national plan of action to respond to the disappearance of insects as a whole, which is directed at both pollinating and non-pollinating insects. Scott Black, executive director of the Xerces Society, echoes these concerns by stating, "The vast majority of studies that have come out in the last decade are showing a decline in populations [or] insect species or biomass, and we're seeing that consistently whether in Germany or equatorial areas or the United States."[232]

Just as pollinators know no borders, neither does climate change. Climate change is barely mentioned in the National Strategy but is a frequent theme in the *EU Pollinators Initiative*. For instance, when listing the causes of pollinator decline, the policy notes: "Climatic conditions are the main factor determining the European-wide distribution of pollinators."[233] It attributes both gradual shifts and extreme weather conditions to pollinator losses.[234] The EU policy connects decisions related to land use modifications and management to the quantity and makeup of pollinator populations and relates this to ecosystem operation and resilience.[235] Additionally, the policy acknowledges studies that have concluded that pollinators enhance plant yield recovery following extreme weather events.[236] In one study, crop yield production of a faba plant turned out to be significantly more reliant on insect pollination after it was exposed to a 30-degree heat

---

[229] European Commission, 18.

[230] European Commission, 19.

[231] European Commission, 19.

[232] Mary Hoff, "As Insect Populations Decline, Scientists Are Trying to Understand Why," *Scientific American*, November 1, 2018, https://www.scientificamerican.com/article/as-insect-populations-decline-scientists-are-trying-to-understand-why/.

[233] European Commission, *EU Pollinators Initiative*, 15.

[234] European Commission, 15.

[235] European Commission, 15.

[236] European Commission, 15.

stress treatment.[237] This study suggests that, with growing heat stress, insect pollination may become progressively more important. Climate changes are anticipated to impact food security; therefore, this study may provide valuable insight to help the European Union implement effective resilience strategies related to its agricultural infrastructure.

3. Gaps and Limitations

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IBPES) report, mentioned previously, cautions that major data gaps exist regarding pollinator populations, specifically among the recordings of population declines at regional levels.[238] The report encourages long-term observation of pollinators in order to gather further information on their global status.[239] These gaps become evident when reviewing other systems of measurement that the European Union has incorporated into its policy, such as the Red List. When it comes to the Red List, the *EU Pollinators Initiative* emphasizes that accurate trend data are key to assessing a population's trend, but are sorely lacking among multiple countries and pollinator species. In countries lacking accurate data, trends are usually reported as stable by the Red List assessors; where trend data is more comprehensive, however, more threatened species are reported.

While both the National Strategy and the Pollinators Initiative are too new to have generated statistics to support their success, a comprehensive review of the two pollinator policies may help us identify and address the root causes of pollinator declines and specific actions that are, or are not, being taken to reverse population declines and promote pollinator health. Furthermore, an examination of pollinator policies may help us develop principal recommendations to incorporate pollinator protections and enhancements into existing agricultural policies. The next chapter contrasts the processes among the U.S. and the EU pollinator policies to explain why one policy works better than the other. By doing this, U.S. policymakers can benefit from the experiences of the EU policymakers who appear to be managing this crisis more competently.

---

[237] Jacob Bishop et al., "Insect Pollination Reduces Yield Loss Following Heat Stress in Faba Bean (Vicia Faba L.)," *Agriculture, Ecosystems & Environment* 220 (2016): 89–96, https://doi.org/10.1016/j.agee.2015.12.007.

[238] European Commission, EU Pollinators Initiative.

[239] European Commission, 5.

IV. COMPARING AND CONTRASTING THE U.S. AND EU POLLINATOR POLICIES

How does the United States evaluate the European Union's responses to pollinator population declines—a transnational challenge—and can the United States learn from these responses? Protection and preservation of pollinator health in the United States involves cooperation and collaboration with other countries as well as an understanding of how other nations are managing these issues inside their borders.[240] Furthermore, such an assessment may also reveal concepts and strategies that would be beneficial to U.S. pollinator initiatives, and that may not otherwise be recognized.[241] This chapter presents a comparative analysis of the pollinator policies of the United States and the European Union and provides evidence that, given the challenges facing pollinators, the European Union is addressing the threats with a more systematic and holistic approach.

A. THE COMMONALITIES

As the United States and the European Union are both industrialized and developed regions that engage on the global stage and are active members of the United Nations, it is unsurprising that their pollinator polices share commonalities. Additionally, both regions encourage environmental protection. This section covers three distinct commonalities among the policies; the commonalities indicate that U.S. and EU policymakers believe the threat to pollinators is substantial, requires further research, and is worthy of attention.

1. Increasing Knowledge and Research

The National Strategy and the Pollinators Initiative both seek to increase knowledge and research about pollinator declines. Policymakers in both regions acknowledge that understanding the full extent of the decline of pollinators is limited by the amount of current research.[242] Both

---

240 Nadav Morag, *Comparative Homeland Security: Global Lessons*, 2nd ed. (Hoboken, NJ: John Wiley and Sons, 2018), 10–11.

241 Morag, 11.

242 "EU Pollinator Initiative," EU Business, June 2, 2018, https://www.eubusiness.com/topics/environ/pollinators; Pollinator Task Force, *National Strategy*, 17.

policies recommend similar steps to develop pollinator inquiries, and depend on programs to produce additional research to help fill in identified gaps. For example, the United States aims to increase knowledge through the creation of the *Pollinator Research Action Plan* (PRAP), the previously mentioned standalone document that is part of the National Strategy. The goal of the PRAP is to develop a better understanding of specific stressors and the collective effects of those stressors on the overall health of pollinators.[243] The United States plans to use federal agencies and academic studies to build on existing data and to inform specific actions of the National Strategy.[244]

Similarly, the European Union published the *EU Biodiversity Strategy to 2020*, an effort that is working to curtail the harm to biodiversity and the collapse of ecosystem services in the European Union.[245] Several ongoing activities, including Mapping and Assessment of Ecosystems and their Services (MAES), inform this action. The MAES report defines ecosystem conditions and describes the link between pressures, ecosystem conditions, and ecosystem services.[246] In essence, this report helps determine which conditions should be evaluated based on measured impacts and declines of pollinators.[247]

Both the United States and the European Union inform their policies using the Intergovernmental Platform on Biodiversity and Ecosystem Services. (IPBES).[248] IPBES is an intergovernmental entity open to all member countries of the United Nations that responds to policymakers by making assessments of the "conditions of biodiversity" and of the ecosystem services delivered to the world.[249] Both U.S. and EU policymakers agree that long-term monitoring will provide the best possible avenue to collect data, which will offer insight about the threats to pollinators and determine how effective mitigation efforts have been.[250]

---

243 Pollinator Task Force, *National Strategy*, 17.

244 Pollinator Task Force, 18.

245 European Commission, *EU Pollinators Initiative*, 19.

246 European Commission, 19.

247 European Commission, 19.

248 Pollinator Task Force, *National Strategy*, 7; European Commission, *EU Pollinators Initiative*, 4.

249 European Commission, *EU Pollinators Initiative*, 4.

250 EU Business, "EU Pollinator Initiative"; Pollinator Task Force, *National Strategy*, 1–3.

2. Developing Strategies to Protect and Improve Pollinator Health

Both policies also stress the need to develop strategies to protect and improve pollinator health. The National Strategy has set a goal of reducing colony losses for honey bees during winter months to less than 15 percent within ten years.[251] By implementing quarterly and annual surveys of beekeepers taken by the USDA National Agriculture Statistics Service, the Pollinator Taskforce is compiling baseline information and metrics to measure progress for losses incurred annually, as well as during the winter and summer months. Then, by implementing strategies such as expanding and improving pollinator habitats, creating opportunities for public-private partnerships, conducting education and research, and initiating steps found in the PRAP, the United States hopes to see a marked improvement in pollinator health. However, stakeholders worry that their efforts to track the progress of pollinator populations will be considerably hindered by the suspension of USDA data collection, which was announced in July 2019.[252]

Likewise, the Pollinators Initiative includes strategies for protecting and promoting pollinator health, to include the 2014–2020 common agricultural policy (CAP).[253] The CAP offers opportunities to maintain and support pollinators' prospects in agronomic and rural areas, and consists of two pillars. The first pillar supports direct annual payments to farmers who engage in specific greening practices that create favorable habitats for pollinators.[254] One section of the first pillar's greening practices relates to Ecological Focus Areas, which include a permanent grassland measure relevant to pollinators.[255] The second pillar is funding for rural development programs aimed at protecting the sustainable management of natural assets in healthy-living countrysides, and at decreasing the impacts of pesticides.[256]

---

[251] Pollinator Task Force, *National Strategy,* 2.

[252] Fossum, "Honeybees Hit by Trump Budget Cuts."

[253] European Commission, *EU Pollinators Initiative*, 19.

[254] European Commission, 20.

[255] European Commission, 20.

[256] European Commission, 20.

3. Stimulating Education, Engaging Society, and Promoting Collaboration

The final significant commonality between the two pollinator policies is three shared goals: stimulating education, engaging society, and promoting collaboration. For the United States, the National Strategy details numerous ways to accomplish these tasks through federal, state, local, and private entities. The Pollinator Task Force has requested that communities and government entities across the country create and participate in efforts to protect and promote pollinator health.[257] According to Dave Fischer, writing for the Wildlife Society, at least twelve research projects related to bee health are underway at the federal level.[258] Additionally, forty distinct agencies and groups have collaborated to create the Honey Bee Health Coalition, whose goal is to form partnerships that develop solutions to the challenges facing bees.[259] One further example is the Pollinator Partnership, an association that has partnered with federal organizations on eleven conservation agreements that support pollinator health. These actions have resulted in the restoration of 1.5 billion acres of natural habitat intended for pollinator conservation.[260] The U.S. policy encourages robust forms of conservation with public and private sponsors through education, awareness, and promotion of pollinators.

Likewise, the Pollinators Initiative emphasizes knowledge-sharing and collaborative action among stakeholders in creating cost-conscious measures and effective pollinator protection processes. The EU's policy recognizes that successful pollinator conservation efforts require cooperation between policymakers, researchers, scientists, and the public, and need to be strengthened.[261] Some examples include the European Innovation Partnership for Agricultural Productivity and Sustainability, which encourages innovation and information exchange on features associated with biodiversity, including natural assets.[262] An example of information

---

257 Pollinator Task Force, *National Strategy*, 2.

258 Dave Fischer, "Improving Pollinator Health Requires Collaboration, Public-Private Partnerships," The Wildlife Society, November 3, 2016, https://wildlife.org/improving-pollinator-health-requires-collaboration-public-private-partnerships/.

259 Fischer.

260 Fischer.

261 European Commission, *EU Pollinators Initiative*, 23.

262 European Commission, 22.

exchange is the sharing of pollinator knowledge developed through the Red List.[263] Another European Union program, LIFE, which supports environmental and climate action, provides funding for groups or individuals who can create and demonstrate best practices and solutions for the preservation of pollinators.[264] One project funded by LIFE is Urban Bees, which promotes the improvement of habitats and flora for pollinators and educates people about the importance of sustainable and responsible beekeeping.[265] Both the European Union and the United States believe that the benefits of education, collaboration, and public-private partnerships are not only worthwhile but also a necessity in the struggle to protect and promote pollinator health. Along with the similarities between the U.S. and EU models, however, significant differences also exist.

B. THE DIFFERENCES

Although the differences between the policies are easy to identify, the reasoning behind those differences is less clear. A review of these differences may help identify strategies that can lead to improved health for pollinator populations in the United States; the United States appears to have a narrow view shaped by corporate interests, while the European Union appears to view the challenges more holistically and as a public interest. This section details the five major differences between the two policies.

1. Stressing Protection of a Few Species of Pollinators versus Protection of Many

The titles of the policies alone reveal some differences between the National Strategy and the Pollinators Initiative. The Unites States' *National Strategy to Promote the Health of Honey Bees and Other Pollinators* stresses the protection of honey bees while the *EU Pollinators Initiative* addresses the protection of pollinators in general. The overarching goals listed at the outset of the National Strategy and the Pollinators Initiative are also indicative of markedly different priorities. While the emphasis for the United States is honey bees, monarch butterflies,

[263] European Commission, 22.

[264] European Commission, 22.

[265] Brian McCallum and Alison Benjamin, "Who We Are: Urban Bees Helping Bees in the City," Urban Bees, accessed October 18, 2019, https://www.urbanbees.co.uk/who/who.htm.

and acreage, the emphasis for the European Union is knowledge and consequences, causes of decline, and raising awareness—a discernably wider scope.

While the National Strategy attributes the majority of crop pollination services to honey bees, research under programs like the Status and Trends of European Pollinators (STEP) project mentioned in the EU document shows that honey bees supplement rather than substitute wild pollinators.[266] The STEP project documents the nature and extent of pollinator declines by examining the drivers of the declines and measuring the impacts of the pollinator falloffs.[267] This difference in priorities between the two policies is an important one because it demonstrates that the United States tends to focus its conservation efforts primarily on the honey bee instead of working toward conserving pollinators of all kinds. Native wild pollinators are essential to the conservation of a wide variety of plant diversity and to ecosystem resilience. The Pollinators Initiative embraces diverse conservation, which is favorable to the myopic view taken by the National Strategy. Honey bees are managed by humans; therefore, their populations are not at risk of extinction. In the United States, native bees and other pollinators do not enjoy the same level of advocacy. While the United States focuses predominantly on two species—honey bees and monarch butterflies—the European Union focuses on all pollinators. The EU's research may help address wider biodiversity crisis issues.

Beyond policy initiatives, certain individuals advocate for protecting a wider variety of pollinators. For example, activist and designer Sarah Bergmann, based in Seattle, highlights the larger problem of the decline of pollinators in general, not just the problems associated with the managed honey bee.[268] In her estimation, the honey bee dominates the conservation discourse and distracts from the larger picture of a biodiversity crisis.[269] Therefore, she has been working on the Pollinator Pathway for the better part of a decade.[270] As described previously, the Pollinator Pathway is a stretch of green space, approximately one mile long, through the heart of Seattle that

---

266 Pollinator Task Force, *National Strategy*, 1; European Commission, *EU Pollinators Initiative*, 11.

267 European Commission, *EU Pollinators Initiative*, 11.

268 Giamo, "The Case Against Honey Bees," 4.

268 Giamo, 4.

269 Giamo, 4.

270 Giamo, 4.

connects isolated green spaces to allow all pollinators to pass through the city instead of being cordoned off in patches, thus encouraging biodiversity.[271] Science and health journalist Troy Farah makes a similar argument that the singular focus in the United States on honey bees ignores significant pollinators that are crucial to a healthy ecosystem.[272]

2. Collaborating with Member States

Just as more than one species of pollinators is significant, concentrating conservation efforts in more than one region where pollinators exist is also important. Unlike the U.S. model, the EU policy describes the strategies of individual European Union member nations, demonstrating the importance of creating a collaborative model. In the European Union, each member nation provides data regarding its national and regional strategies, which inform the report for the European Commission. Because pollinators cross borders, the EU shares knowledge, data, and strategies within and between its member states to realize a positive impact. Furthermore, with data from a variety of member states who are working collaboratively, the EU can replicate successful strategies and minimize duplication of collected information.

In contrast, the National Strategy does not emphasize individual state strategies. Some states and regions have initiated individual pollinator plans, but the lack of coordination and shared knowledge at the federal level does raise concern over whether the strategies of one state conflict at the borders of another. Are efforts being duplicated? Are measurements being calculated similarly from state to state? Does the failure to incorporate state strategies into the National Strategy sacrifice accuracy and efficiency? When states implement different policies that affect pollinators, there may be conflict. For example, if one state requests a voluntary suspension of pesticides when flowers are in bloom but a neighboring state does not recognize this request, cross-contamination could still occur and harm pollinators. The inclusion of member state action in the Pollinators Initiative demonstrates a collaborative commitment to tackling the threat to pollinators at the regional, state, and national levels—a system that the U.S. can learn from.

---

[271] Giamo, 4.

[272] Troy Farah, "While We Worry about Honeybees Other Pollinators Are Disappearing," *The Crux* (blog), August 3, 2018, http://blogs.discovermagazine.com/crux/2018/08/03/honeybees-pollinator-really-going-extinct/#.XaqUC2Z7nIU.

3. Regulating Pesticides

Pesticide regulations are another major difference between the policies. The European Union has embraced strict regulations on the use of agricultural pesticides and this has limited the chemicals' harmful effects to humans, pollinators, and the environment. It is critical for the United States to similarly explore pesticide regulations in order to protect the pollinators and the health of the country. As previously discussed, several authorities claim that the U.S. National Strategy should have included restrictions that would protect pollinators from chemical harm. The laws that govern chemicals, their uses, and related restrictions in the United States differ from those in Europe, however.[273] To ban a pesticide in the United States, the EPA must demonstrate that it has an "unreasonable adverse effect."[274] Under current U.S. laws, the shortage of applicable research to support a ban makes "adverse effect" a high bar to meet.[275] "In the EU," on the other hand, "active substances used in plant protection products can only be approved following a risk assessment to make sure there are no undesired effects on honeybees and other non-target organisms."[276] When harmful effects are detected, legal proceedings will ensure the substance's use is restricted or prohibited.[277] On April 27, 2018, the EU member states endorsed restricting three neonicotinoid pesticides and fipronil (an insecticide that disrupts an insect's central nervous system).[278]

Because additional research must determine more precisely what is causing the pollinator population to decline, the U.S. government is likely hesitant to take serious regulatory action on pesticides. As expected when a policy is the first of its kind, the National Strategy has many gaps in this area. Researchers, environmentalists, and the public have criticized the lack of protection against harmful chemicals in the National Strategy. In the United States, the EPA depends almost solely on industry-funded studies when evaluating the health and environmental impacts of

---

273 Whitney, "Pros and Cons of the U.S. Federal Strategy."

274 Whitney.

275 Whitney.

276 European Commission, *EU Pollinators Initiative*, 21.

277 EU Business, "EU Pollinator Initiative."

278 European Commission, *EU Pollinators Initiative*.

pesticide products.[279] Findings from these studies are frequently the driving forces behind regulatory decisions—or indecision. Lobbying is a full-time endeavor for corporate agribusinesses, which have invested over $90 million a year to lobby Congress for control of the public conversation on food and agriculture.[280]

However, the European Union's concern for environmental health has shifted the priority from agrochemical companies to the public good. When a chemical is identified as concerning in the European Union, it is removed from the market. This illustrates that the EU has put more of an emphasis on independent scientific evidence. In contrast, when a chemical is identified as concerning in the United States, a pesticide manufacturer will fund its own scientific research to prove that the product is safe.[281] A strategic focus on pollinators and their interactions with pesticides must continue; a more complete understanding of the active, passive, and collective effects of pesticides on pollinators and the biosphere requires it.

4. Addressing Climate Change

The European Union and the United States' perspectives also differ on climate change. As if pathogens, parasites, pesticides, and poor nutrition were not enough, extensive research shows that climate change is negatively affecting pollinator populations. Climate change is causing flowers to bloom earlier than they did in the past century; if plants bloom before pollinators emerge in the spring, the plants will not get pollinated and bees will be left without a food source.[282] Moreover, as climate change results in loss or migration of pollinators, human populations may suffer from diminished food sources and diversity due to the socioeconomic cost and implications

---

279 "Corporate Science & Spin," Pesticide Action Network, accessed October 6, 2019, http://www.panna.org/gmos-pesticides-profit/corporate-science-spin.

280 Pesticide Action Network "Corporate Science and Spin."

281 Kristin Schafer, "EU Bans Neonics: U.S. Bees Not so Lucky," Pesticide Action Network, May 3, 2018, http://www.panna.org/blog/eu-bans-neonics-us-bees-not-so-lucky.

282 Mariken Kjohl, Anders Nielson, and Nils Christian Stenseth, Potential Effects of Climate Change on Crop Pollination: Extension of Knowledge Base, Adaptive Management, Capacity Building, Mainstreaming (Rome: Food and Agriculture Organization of the United Nations, 2011), http://www.fao.org/fileadmin/templates/agphome/documents/Biodiversity-pollination/Climate_Pollination_17_web__2_.pdf.

of the relocation of agricultural production.[283] The EU policy focuses more directly on climate change as a contributing factor to pollinator conservation.

Increasingly, debates about the effects of climate change on various human, animal, and plant populations are showing up in governments' policy decisions around the world.[284] However, the U.S. and EU national policies reflect wide differences. The European Union has embraced, supported, and promoted the Kyoto Protocol: "the first step to globally reduce human influence on the climate system."[285] Meanwhile, the United States, whose climate change policy is based on fossil fuels, has been much slower to incorporate policy measures to reduce human impact on the climate.[286] As an example, the U.S. National Strategy is fifty-three pages long (not including the reference section), and the word "climate" is mentioned twice; while the *EU Pollinators Initiative* is twenty-three pages long and the word "climate" appears eleven times.[287] According to the Pollinators Initiative, climatic conditions are the main factor affecting the European-wide distribution of pollinators. The National Strategy tends to be more reactive and less proactive in dealing with issues related to climate change. The Pollinators Initiative provides a sound foundational perspective regarding climate change that proposes a direction the United States could follow.

5. Improving Pollinator Habitat through Federal Lands

The United States is seeking to increase and improve pollinator habitats on federal lands—a topic that is largely absent from the EU strategy. This increase in habitats could be the largest change agent associated with the U.S. National Strategy.[288] The policy aims to do this by designing and increasing pollinator-friendly landscapes at federally managed facilities across the

---

[283] Kjohl, Nielson, and Stenseth.

[284] Irene Lorenzoni and Nick F. Pidgeon, "Public Views on Climate Change: European and USA Perspectives," *Climatic Change* 77, no. 1–2 (2006): 73, https://doi.org/10.1007/s10584-006-9072-z.

[285] Lorenzoni and Pidgeon, 73.

[286] Lorenzoni and Pidgeon, 73–74.

[287] European Commission, *EU Pollinators Initiative*,10, 12, 17, 18, 19, 21; Pollinator Task Force, *National Strategy*, 5, 32.

[288] Pollinator Task Force, *National Strategy*, 28.

country.[289] Pollinator-friendly landscaping already exists at a variety of federal facilities, such as the Smithsonian Institution, the National Zoo, and USDA facilities.[290] A variety of other landscaping projects are in the works at the Departments of Transportation, Energy, Housing and Urban Development, Interior, Defense, and State.[291] These projects signify the conversion of thousands of acres of federally controlled land into pollinator-friendly habitats.

The federal government manages the largest amount of land and largest number of facilities in the country, which makes it an ideal leader for creating pollinator-friendly environments; the government's actions can influence private-sector habitat activities.[292] Additionally, the policy provisions for federal lands and buildings act as a model to encourage pollinator habitat creation by private landowners and operators.[293] Plentiful and healthy pollinator habitats are essential to the honey bees and ecosystem health, as well as the health of populations reliant on the resources that pollinators provide. The United States could share this strategy with the European Union and other governments that are looking to safeguard the health and security of their pollinator populations.

The similarities between the EU and U.S. policies take the basic needs of pollinators into account. But the differences are more thought-provoking. While some differences are less profound, others are distinct and need to be explored because they involve proactive and reactive strategies to pollinator resilience. National culture, corporate influence, education, governance, and economics all play a role in perception and subsequent action by policymakers.

---

[289] Pollinator Task Force, 28.

[290] Pollinator Task Force, 2.

[291] Pollinator Task Force, 37–42.

[292] Pollinator Task Force, 29.

[293] Pollinator Task Force, 33.

THIS PAGE INTENTIONALLY LEFT BLANK

V. CONCLUSION AND RECOMMENDATIONS

Pollinators face a serious global challenge that requires the balancing of human priorities and pollinator needs in efficient and effective ways. The research presented in this thesis demonstrates an understanding of the critical components that shape the current drivers impacting pollinators. It discusses the vital contributions pollinators make and the multiple interacting stressors they face, which render their decline a threat to food and other ecological securities in the United States. This thesis evaluates the U.S. and EU policies that have been developed to promote and protect pollinator health and resilience. The synthesis of information—and the answers to the research questions provided in this chapter—offer a foundation for understanding the complexities of pollinator declines and the paths being taken to protect them.

A. RESEARCH QUESTION 1: HOMELAND SECURITY

Is protecting pollinator health a homeland security issue?

This thesis demonstrates that protecting pollinator health is a U.S. homeland security issue. Presidential Policy Directive 21 states that DHS is responsible for making sure the United States' critical infrastructure is "secure and able to withstand and rapidly recover from all hazards."[294] DHS further states that critical infrastructure includes "assets, systems, and networks, whether physical or virtual, [that] are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety or any combination thereof."[295] This thesis firmly establishes that pollinators are an integral part of the nation's critical infrastructure system due to their impact on the economy, environment, and food security.

This viewpoint is echoed by Jason Nairn, director of Concordia University's Homeland Security Simulation Lab, in a piece he wrote for the *Homeland Security Roundtable* on May 19,

---

[294] Brian Blodgett, "A Critical Component of Our Agriculture System: Honey Bees," In Homeland Security, August 7, 2019, https://inhomelandsecurity.com/component-agriculture-system-honey-bees/.

[295] White House, *Critical Infrastructure Security and Resilience*, PPD-21 (Washington, DC: White House, February 12, 2013), https://obamawhitehouse.archives.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil.

2015, the date the *National Strategy to Protect the Health of Honey Bees and Other Pollinators* was released. Nairn reflects on the policy's significance and how homeland security encompasses risks to people, stability, and infrastructure.[296] He notes that DHS official Caitlin Durkovich was quoted by Reuters as saying: "Increasingly we've moved from a security to a resiliency focus."[297] Nairn believes that honey bee losses are worrisome, and stresses the need to focus on "resilience" in the face of declining pollinator populations. He concludes by saying, "If this [Durkovich's statement] is true, honey bees are a homeland security issue."[298]

The United States is critically dependent on pollinators. A significant loss of domestic pollinators can be costly, increasing the cost of honey bee hives for farmers and food for citizens, and deteriorating the ecosystem services honey bees provide. In the *Food and Agriculture Sector-Specific Plan—2015*, DHS states that facilities primarily engaged in raising insects, like bees, fall within the confines of DHS in the animal production category.[299] In doing so, DHS recognizes the primary role bees play in sustaining U.S. crops. This recognition has led the USDA and the EPA to promote resilience in the face of declining pollinator populations and to develop policies that will safeguard pollinators' continued contribution to the nation's ecosystems and food security. Although the United States has demonstrated a commitment to protecting pollinator health, pollinators are still at risk, still experiencing declines, and still being exposed to hazards created by civilization. The European Union has taken decisive steps toward protecting pollinators that the United States can learn from to advance its own policy.

B. RESEARCH QUESTION 2: SHARING PROBLEMS, SHARING SOLUTIONS

What can be learned by comparing patterns and deviations among pollinator strategies to effectively promote and protect pollinators?

---

[296] Jason Nairn, "Homeland Security and the Honey Bee," *Homeland Security Roundtable* (blog), May 19, 2015, http://homelandsecurityroundtable.com/2015/05/19/homeland-security-and-the-honey-bee/.

[297] Lisa Anderson, "US Homeland Security Moves to Tackle Climate Change Risks," Reuters, September 25, 2014, https://www.reuters.com/article/us-foundation-climate-security/us-homeland-security-moves-to-tackle-climate-change-risks-idUSKCN0HK2PW20140925.

[298] Nairn, "Homeland Security and the Honey Bee."

[299] Blodgett, "Critical Component of Our Agriculture System."

The European Union shares political, economic, and geographical traits with the United States. Like the United States, the European Union recognizes the threat that declining pollinator populations poses to its national security, and has developed a policy to address the impacts. The *EU Pollinators Initiative*, though, contains a myriad of distinctions from the U.S. National Strategy. To combat the challenges presented by pollinator decline, the European Union has developed a holistic response to the threat; the EU policy considers the larger picture, focusing on the decline of all insects, not just pollinators. In addition to writing policy, the European Union has engaged its citizens individually, and its member states collectively, in the process. Furthermore, the European Union has acknowledged the influence of climate changes in established policy and has evaluated the threat it poses to pollinators. Finally, the European Union has implemented regulations to protect pollinators from harmful chemical pesticides. Through a deeper understanding of these key distinctions, the United States can enhance and improve its own policy.

C. COMPARATIVE STUDY CONSIDERATIONS

One key lesson that American policymakers can learn from the European Union is that a fluid system of coregulation may provide the most responsive method to address competing concerns of economic and environmental undertakings. While the unregulated approach applied by the United States creates an opportunity for public-private partnerships to develop, there is still a necessity for regulation. Regulation will help the country avoid duplication of data collection efforts and poor communication, and will help ensure that accurate and parallel measurements and assessments occur. As previously mentioned, pollinators recognize no borders; uniform regulation may be necessary to lessen the threats from pesticides, habitat fragmentation, parasites, and other harmful agricultural practices that negatively affect pollinator populations in the United States.

Both the U.S. and EU policies detail a similar and comprehensive understanding of the challenges facing pollinator populations, as well as the economic, environmental, and food security consequences that may result if pollinator population declines continue. It is vital that continued and varied actions are taken to address pollinator declines. Best practices, successes, failures, information, and the identification of new threats from every nation (not just the United States and the European Union) should be shared and capitalized on. Policies should reflect an understanding of, but independence from, political interference and influence from stakeholders, to include agrochemical companies that may be concerned more with profit margins than food safety or the environmental consequences of their actions. There is no substitute for investment in non-biased, competently conducted research that identifies solutions to the challenges facing pollinators. The development of environmentally conscious professions should increase. Any global regions that are not currently enacting policies to protect pollinators should be educated by the regions experiencing the most success in stimulating pollinator health. Environmental factors that affect pollinator declines, directly or indirectly, must continue to be addressed in policies to protect pollinators, to include pollution, erosion, habitat fragmentation, deforestation, monocultural farming, chemical use, invasive species, poor nutrition, disease, parasites, and climate change. If correctly implemented on local and global scales, preservation and promotional actions can result in a coordinated and operational policy framework that will form a comprehensive foundation of conservation efforts.

The European Union's laws, policies, and strategies differ from those of the United States.[300] As the world grows more globally connected, it becomes increasingly necessary to understand the differences in legal, institutional, and cultural frameworks affecting different geopolitical regions. It may be challenging to modify laws and policies to implement foreign strategies, but it is not impossible.[301] According to Nadav Morag, chair of the Department of Security Studies at Sam Houston State University and a faculty member at the Center for Homeland Defense and Security, it is unlikely that homeland security tactics that begin and end at a single nation's borders will be successful.[302] Successful protection for pollinators will likely require a united resolve between multiple countries that are sharing actionable data and best practices.

D. RECOMMENDATIONS

This conclusion lays down five specific recommendations that the United States might adopt, or adapt into, its pollinator protection approach to improve results.

---

300 Morag, Comparative Homeland Security, 448.

301 Morag, 449.

302 Morag, 450.

(1) Broaden the focus from honey bees to all pollinators

The European Union recognizes that all pollinators, not just honey bees, are increasingly vulnerable to environmental threats. This thesis recommends that the United States increase and broaden its research efforts similarly to include long-term studies of all insects in order to identify causes and remedies for the large-scale decline of a variety of pollinating insect species. The barriers to this approach would likely be limited to funding and interest. Opening the aperture to include other insects would lead to a robust amount of research that can connect the decline of all pollinators and help bring about a more globally sustainable future. Bees are not the only important pollinators on Earth. When public opinion and outcry shape science funding and policy, the result is gaps in the scientific knowledge.[303] All pollinators are important and are part of the larger homeland security picture.[304]

(2) Determine how pesticides harm pollinators.

The European Union policy ensures that chemicals used on plants can only be applied after they have passed a risk assessment confirming they will not harm honey bees and other unintended targets.[305] The United States differs from the European Union because the U.S. economy is a significant driver of many of its political and policy decisions. For an EU-style policy regarding pesticide bans to be used in the United States, the United States will need to conduct more research to clearly identify the impact, both individually and collectively, of pesticides and to identify a path forward for adopting a measured pesticide ban that would better protect pollinators.

(3) Involve scientists, not corporate interests, in policy review.

This thesis also recommends that the United States should have qualified scientists serve on the EPA Scientific Advisory Panel and participate in the process of policy formation and review. This participation would include selecting the study criteria for use in data evaluations. The research they provide would thus become more than just interesting and newsworthy

---

303 Kaitlin Stack Whitney, "6 Misconceptions about Saving the Bees," *Macroscope* (blog), June 15, 2015, https://www.americanscientist.org/blog/macroscope/6-misconceptions-about-saving-the-bees.

304 Whitney.

305 European Union, *EU Pollinators Initiative*.

information; it would become applicable to policy decisions.[306] In order to write and pass effective policies to protect pollinators, U.S. policymakers need research that provides clear and convincing evidence about the adverse effects of pesticides on these insects. This recommendation, however, will be limited by a conflict of interest: chemical corporations contribute financially to political candidates and for advertisements in their favor. The United States should therefore create regulations designed to prevent parties that have a conflict of interest from participating in scientific studies regarding the impact of pesticides on pollinators. Scientific risk assessments should also be conducted that address cumulative harmful exposure to pesticides.

(4) Have states in the United States to work individually and collaboratively to identify best pollinator protection practices.

The *EU Pollinators Initiative* specifically includes the EU member states' national and regional strategies, and uses them to inform the overall strategy. This integration of policy allows the European Union to identify best practices and avoid duplication of efforts. This measure has resulted in continuous and updated bans on specific harmful chemicals, to include neonicotinoids, to protect pollinators.[307] The shared membership of the European Union signatories encourages collaboration and nations are mutually aligned against common threats. Just as the EU member states share knowledge, data, and strategies with each other, the United States can strengthen its policy by ensuring that each state is working collaboratively with one another, sharing successful strategies, and minimizing the duplication of efforts. There should be no real barriers to this effort in the United States, as it is a common-sense approach and states already work collaboratively under a variety of other circumstances.

(5) Address the climate change issues that most threaten pollinators.

Finally, in reference to the important consideration the European Union places on climate change and its impact on pollinators, this thesis recommends that the United States acknowledge—through an established policy—that climate change is exerting additional stress on pollinator populations. A barrier to this recommendation will be conflict caused by those who deny that

[306] Whitney, "Pros and Cons of the U.S. Federal Strategy."

[307] European Union, EU Pollinators Initiative.

climate change is a factor. The United States nonetheless should work in concert with other nations that are identifying strategies to combat the adverse effects of climatic conditions on pollinator health.

E. CONCLUSION

Plants supply the oxygen living creatures need to breathe. Plants help control the world's water supply. Plants provide shelter for a variety of animals and distribute nutrients throughout the soil. Plants are also the source of our country's food supply. Most significantly, approximately 80 percent of plants require pollination to propagate.[308] Pollinator health is threatened and pollinator populations are declining. Humans are responsible for this decline. Ultimately, achieving pollinator health will be the result of a compromise between environmentalists, scientists, private enterprise, and government about regulations, societal preferences, and food security needs. Meeting these needs calls for policies that balance the country's societal, economic, and environmental needs with its homeland security objectives.

[308] Erica Cirino, "What Do the Birds and the Bees Have to Do with Global Food Supply?" Audubon, March 10, 2016, https://www.audubon.org/news/what-do-birds-and-bees-have-do-global-food-supply.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX. CROPS AND PLANTS POLLINATED BY HONEY BEES

Table 1. Crops and plants pollinated by honey bees[309]

Rank	Common name	Latin name	Pollinator	Commercial product of pollination
1	Okra	Abelmoschus esculentus	Honey bees (incl. Apis cerana), Solitary bees (Halictus spp.)	Fruit
2	Kiwifruit	Actinidia deliciosa	Honey bees, Bumblebees, Solitary bees	Fruit
3	Onion	Allium cepa	Honey bees, Solitary bees, Blow flies	Seed
4	Cashew	Anacardium occidentale	Honey bees, Stingless bees, Bumblebees, Solitary bees (Centris tarsata), Butterflies, Flies, hummingbirds	Nut
5	Celery	Apium graveolens	Honey bees, Solitary bees, Flies	Seed
6	Strawberry tree	Arbutus unedo	Honey bees, Bumblebees	Fruit
7	Carambola, Starfruit	Averrhoa carambola	Honey bees, Stingless bees	Fruit
8	Beet	Beta vulgaris	Hover Flies, Honey bees, Solitary bees	Seed
9	Mustard	Brassica alba, Brassica hirta, Brassica nigra	Honey bees, Solitary bees (Osmia	Seed

309 Adapted from Ameber Pariona, "Which Crops and Plants Are Pollinated By Honey Bees?," last modified March 5, 2019, https://www.worldatlas.com/articles/which-crops-plants-are-pollinated-by-honey-bees.html.

Rank	Common name	Latin name	Pollinator	Commercial product of pollination
			cornifrons, Osmia lignaria)	
10	Rapeseed	Brassica napus	Honey bees, Solitary bees	Seed
11	Broccoli	Brassica oleracea cultivar	Honey bees, Solitary bees	Seed
12	Cauliflower	Brassica oleracea Botrytis Group	Honey bees, Solitary bees	Seed
13	Cabbage	Brassica oleracea Capitata Group	Honey bees, Solitary bees	Seed
14	Brussels sprouts	Brassica oleracea Gemmifera Group	Honey bees, Solitary bees	Seed
15	Chinese cabbage	Brassica rapa	Honey bees, Solitary bees	Seed
16	Turnip, Canola	Brassica rapa	Honey bees, Solitary bees (Andrena ilerda, Osmia cornifrons, Osmia lignaria, Halictus spp.), Flies	Seed
17	Pigeon pea, Cajan pea, Congo vean	Cajanus cajan	Honey bees, Solitary bees (Megachile spp.), Carpenter bees	Seed
18	Chilli pepper, Red pepper, Bell pepper, Green pepper	Capsicum annuum, Capsicum frutescens	Honey bees, Stingless bees (Melipona spp.), Bumblebees, Solitary bees, Hover flies	Fruit
19	Papaya	Carica papaya	Honey bees, thrips, large sphinx moths, Moths, Butterflies	Fruit

Rank	Common name	Latin name	Pollinator	Commercial product of pollination
20	Safflower	Carthamus tinctorius	Honey bees, Solitary bees	Seed
21	Caraway	Carum carvi	Honey bees, Solitary bees, Flies	Seed
22	Chestnut	Castanea sativa	Honey bees, Solitary bees	Nut
23	Watermelon	Citrullus lanatus	Honey bees, Bumblebees, Solitary bees	Fruit
24	Tangerine	Citrus tangerina	Honey bees, Bumblebees	Fruit
25	Orange, Grapefruit, Tangelo	Citrus spp.	Honey bees, Bumblebees	Fruit
26	Coconut	Cocos nucifera	Honey bees, Stingless bees	Nut
27	Coffea spp. Coffea arabica, Coffea canephora	Coffea spp.	Honey bees, Stingless bees, Solitary bees	Fruit
28	Coriander	Coriandrum sativum	Honey bees, Solitary bees	Seed
29	Crownvetch	Coronilla varia L.	Honey bees, Bumblebees, Solitary bees	seed (increased yield from pollinators)
30	Azarole	Crataegus azarolus	Honey bees, Solitary bees	Fruit
31	Cantaloupe, Melon	Cucumis melo L.	Honey bees, Squash bees, Bumblebees,	Fruit

Rank	Common name	Latin name	Pollinator	Commercial product of pollination
			Solitary bees (Ceratina spp.)	
32	Cucumber	Cucumis sativus	Honey bees, Squash bees, Bumblebees, Leafcutter bee (in greenhouse pollination), Solitary bees (for some parthenocarpic gynoecious green house varieties pollination is detrimental to fruit quality)	Fruit
33	Squash (plant), Pumpkin, Gourd, Marrow, Zucchini	Cucurbita spp.	Honey bees, Squash bees, Bumblebees, Solitary bees	Fruit
34	Guar bean, Goa bean	Cyamopsis tetragonoloba	Honey bees	Seed
35	Quince	Cydonia oblonga Mill.	Honey bees	Fruit
36	Lemon		Honey bees	Fruit
37	Lime		Honey bees	Fruit
38	Carrot	Daucus carota	Flies, Solitary bees, Honey bees	Seed
39	Hyacinth bean	Dolichos spp.	Honey bees, Solitary bees	Seed
40	Longan	Dimocarpus longan	Honey bees, Stingless bees	

Rank	Common name	Latin name	Pollinator	Commercial product of pollination
41	Persimmon	Diospyros kaki, Diospyros virginiana	Honey bees, Bumblebees, Solitary bees	Fruit
42	Cardamom	Elettaria cardamomum	Honey bees, Solitary bees	
43	Loquat	Eriobotrya japonica	Honey bees, Bumblebees	Fruit
44	Buckwheat	Fagopyrum esculentum	Honey bees, Solitary bees	Seed
45	Feijoa	Feijoa sellowiana	Honey bees, Solitary bees	Fruit
46	Fennel	Foeniculum vulgare	Honey bees, Solitary bees, Flies	Seed
47	Strawberry	Fragaria spp.	Honey bees, Stingless bees, Bumblebees, Solitary bees (Halictus spp.), Hover flies	Fruit
48	Cotton	Gossypium spp.	Honey bees, Bumblebees, Solitary bees	seed, fiber
49	Sunflower	Helianthus annuus	Bumblebees, Solitary bees, Honey bees	Seed
50	Flax	Linum usitatissimum	Honey bees, Bumblebees, Solitary bees	Seed
51	Lychee	Litchi chinensis	Honey bees, Flies	Fruit

Rank	Common name	Latin name	Pollinator	Commercial product of pollination
52	Lupine	Lupinus angustifolius L.	Honey bees, Bumblebees, Solitary bees	Seed
53	Macadamia	Macadamia ternifolia	Honey bees, Stingless bees (Trigona carbonaria), Solitary bees (Homalictus spp.), Wasps, Butterflies	Nut
54	Acerola	Malpighia glabra	Honey bees, Solitary bees	fruit (minor commercial value)
55	Apple	Malus domestica, or Malus sylvestris	Honey bees, orchard mason bee, Bumblebees, Solitary bees (Andrena spp., Halictus spp., Osmia spp., Anthophora spp.), Hover flies (Eristalis cerealis, Eristalis tenax)	Fruit
56	Mango	Mangifera indica	Honey bees, Stingless bees, Flies, Ants, Wasps	Fruit
57	Alfalfa	Medicago sativa	Alfalfa leafcutter bee, Alkali bee, Honey bees	Seed
58	Rambutan	Nephelium lappaceum	Honey bees, Stingless bees, Flies	Fruit
59	Sainfoin	Onobrychis spp.	Honey bees, Solitary bees	Seed
60	Avocado	Persea americana	Stingless bees, Solitary bees, Honey bees	Fruit

Rank	Common name	Latin name	Pollinator	Commercial product of pollination
61	Lima bean, Kidney bean, Haricot bean, Adzuki bean, Mungo bean, String bean, Green bean	Phaseolus spp.	Honey bees, Solitary bees	fruit, seed
62	Scarlet runner bean	Phaseolus coccineus L.	Bumblebees, Honey bees, Solitary bees, Thrips	Seed
63	Allspice	Pimenta dioica	Honey bees, Solitary bees (Halictus spp., Exomalopsis spp., Ceratina spp.)	
64	Apricot	Prunus armeniaca	Honey bees, Bumblebees, Solitary bees, Flies	Fruit
65	Sweet Cherry	Prunus avium spp.	Honey bees, Bumblebees, Solitary bees, Flies	Fruit
66	Sour cherry	Prunus cerasus	Honey bees, Bumblebees, Solitary bees, Flies	Fruit
67	Plum, Greengage, Mirabelle, Sloe	Prunus domestica, Prunus spinosa	Honey bees, Bumblebees, Solitary bees, Flies	Fruit
68	Almond	Prunus dulcis, Prunus amygdalus, or Amygdalus communis	Honey bees, Bumblebees, Solitary bees (Osmia cornuta), Flies	Nut
69	Peach, Nectarine	Prunus persica	Honey bees, Bumblebees, Solitary bees, Flies	Fruit

Rank	Common name	Latin name	Pollinator	Commercial product of pollination
70	Guava	Psidium guajava	Honey bees, Stingless bees, Bumblebees, Solitary bees (Lasioglossum spp.)	Fruit
71	Pomegranate	Punica granatum	Honey bees, Solitary bees, Beetles	Fruit
72	Pear	Pyrus communis	Honey bees, Bumblebees, Solitary bees, Hover flies (Eristalis spp.)	Fruit
73	Black currant, Red currant	Ribes nigrum, Ribes rubrum	Honey bees, Bumblebees, Solitary bees	Fruit
74	Rose hips, Dogroses	Rosa spp.	Honey bees, Bumblebees, Carpenter bees, Solitary bees, Hover flies	
75	Boysenberry	Rubus spp.	Honey bees, Bumblebees, Solitary bees	Fruit
76	Raspberry	Rubus idaeus	Honey bees, Bumblebees, Solitary bees, Hover flies (Eristalis spp.)	Fruit
77	Blackberry	Rubus fruticosus	Honey bees, Bumblebees, Solitary bees, Hover flies (Eristalis spp.)	Fruit
78	Elderberry	Sambucus nigra	Honey bees, Solitary bees, Flies, Longhorn beetles	Fruit

Rank	Common name	Latin name	Pollinator	Commercial product of pollination
79	Sesame	Sesamum indicum	Honey bees, Solitary bees, Wasps, Flies	Seed
80	Rowanberry	Sorbus aucuparia	Honey bees, Solitary bees, Bumblebees, Hover flies	Fruit
81	Hog plum	Spondias spp.	Honey bees, Stingless bees (Melipona spp.)	Fruit
82	Tamarind	Tamarindus indica	Honey bees (incl. Apis dorsata)	Fruit
83	Clover (not all species)	Trifolium spp.	Honey bees, Bumblebees, Solitary bees	Seed
84	White clover	Trifolium alba	Honey bees, Bumblebees, Solitary bees	Seed
85	Alsike clover	Trifolium hybridum L.	Honey bees, Bumblebees, Solitary bees	Seed
86	Crimson clover	Trifolium incarnatum	Honey bees, Bumblebees, Solitary bees	Seed
87	Red clover	Trifolium pratense	Honey bees, Bumblebees, Solitary bees	Seed
88	Arrowleaf clover	Trifolium vesiculosum Savi	Honey bees, Bumblebees, Solitary bees	Seed
89	Cranberry	Vaccinium oxycoccus, Vaccinium macrocarpon	Bumblebees (Bombus affinis), Solitary bees (Megachile addenda,	Fruit

Rank	Common name	Latin name	Pollinator	Commercial product of pollination
			Alfalfa leafcutter bees), Honey bees	
90	Broad bean	Vicia faba	Honey bees, Bumblebees, Solitary bees	Seed
91	Vetch	Vicia spp.	Honey bees, Bumblebees, Solitary bees	Seed
92	Cowpea, Black-eyed pea, Blackeye bean	Vigna unguiculata	Honey bees, Bumblebees, Solitary bees	Seed
93	Karite	Vitellaria paradoxa	Honey bees	Nut
94	Grape	Vitis spp.	Honey bees, Solitary bees, Flies	Fruit
95	Jujube	Zizyphus jujube	Honey bees, Solitary bees, Flies, Beetles, Wasps	Fruit

LIST OF REFERENCES

Alaux, Cédric, François Ducloz, Didier Crauser, and Yves Le Conte. "Diet Effects on Honeybee Immunocompetence." *Biology Letters* 6, no. 4 (2010): 562–65. https://doi.org/10.1098/rsbl.2009.0986.

Anderson, Lisa. "US Homeland Security Moves to Tackle Climate Change Risks." Reuters, September 25, 2014. https://www.reuters.com/article/us-foundation-climate-security/us-homeland-security-moves-to-tackle-climate-change-risks-idUSKCN0HK2PW20140925.

Appleby, Matthew. "EU Pollinator Consultation Draws Huge Response." *Horticulture Week*, April 11, 2018. https://www.hortweek.com/eu-pollinator-consultation-draws-huge-response/plant-health/article/1461739.

Bee America. "Say 'No!' to Agricultural Deserts." August 15, 2013. https://www.bee-america.com/content/say-%E2%80%9Cno%E2%80%9D-agricultural-deserts.

Bee Informed! (blog). "Habitat Fragmentation." Accessed August 6, 2018. https://beependent.wordpress.com/habitat/.

———. "Honey Bee Colony Losses 2018–2019: Preliminary Results." June 19, 2019. https://beeinformed.org/results/2018-2019/.

Bishop, Jacob, Hannah Elizabeth Jones, Martin Lukac, and Simon Geoffrey Potts. "Insect Pollination Reduces Yield Loss Following Heat Stress in Faba Bean (Vicia Faba L.)." *Agriculture, Ecosystems & Environment* 220 (2016): 89–96. https://doi.org/10.1016/j.agee.2015.12.007.

Black, Elizabeth. "Why Protecting the Pollinators Is Essential to Global Food Security." *Global Food for Thought* (blog), May 19, 2017. https://www.thechicagocouncil.org/blog/global-food-thought/why-protecting-pollinators-essential-global-food-security.

Blodgett, Brian. "A Critical Component of Our Agriculture System: Honey Bees." In Homeland Security, August 7, 2019. https://inhomelandsecurity.com/component-agriculture-system-honey-bees/.

Bovard, James. "No, 48 Million Americans Are Not Going Hungry." Foundation for Economic Education, September 10, 2015. https://fee.org/articles/no-48-million-americans-are-not-going-hungry/.

Brodschneider, Robert, and Karl Crailsheim. "Nutrition and Health in Honey Bees." *Apiodologie* 41, no. 3 (May–June 2010): 278–94. https://doi.org/10.1051/apido/2010012.

Buck, Dina. “Disappearing Pollinators Hurt Biodiversity & Threaten Food Security.” Pachamama Alliance, January 7, 2018. https://blog.pachamama.org/disappearing-pollinators-hurts-ecosystem-biodiversity-threatens-food-security.

Canada Agriculture and Food Museum. “Bees: A Honey of an Idea.” Accessed November 21, 2019. https://bees.techno-science.ca/english/bees/pollination/default.php.

Carrington, Damian. “EU Agrees to Total Ban on Bee-Harming Pesticides.” *Guardian*, April 27, 2018. https://www.theguardian.com/environment/2018/apr/27/eu-agrees-total-ban-on-bee-harming-pesticides.

———. “Farms Could Slash Pesticide Use without Losses, Research Reveals.” *Guardian*, April 6, 2018. https://www.theguardian.com/environment/2017/apr/06/farms-could-slash-pesticide-use-without-losses-research-reveals.

Christiansen, Allan Stomfeldt. “Bee Collapse Is the Result of Their Enslavement in Industrial Monocultures.” *Ecologist*, May 2, 2015. https://theecologist.org/2015/may/02/bee-collapse-result-their-enslavement-industrial-monocultures.

Cirino, Erica. “What Do the Birds and the Bees Have to Do with Global Food Supply?” Audubon, March 10, 2016. https://www.audubon.org/news/what-do-birds-and-bees-have-do-global-food-supply.

Clark, Carol. “Bees ‘Betray’ Their Flowers When Pollinator Species Decline.” *Science Daily*, July 22, 2013. https://www.sciencedaily.com/releases/2013/07/130722152733.htm.

Clay, Edward. “Food Security: Concepts and Measurement.” In *Trade Reforms and Food Security: Conceptualizing the Linkages*, 25–34. Rome: Food and Agriculture Organization of the United Nations, 2003. http://www.fao.org/3/a-y4671e.pdf.

Danovich, Tove K. “The History of Honey.” *Food52* (blog), December 13, 2013. https://food52.com/blog/9010-the-history-of-honey.

Davies, Steve. “No Easy Answers: Bee Health Threatened by ‘Four P’s.’” *AgriPulse*, June 21, 2017. https://www.agri-pulse.com/articles/9427-no-easy-answers-bee-health-threatened-by-four-ps.

Decourte, Axel, Eric Mader, and Nicholas Desneux. “Landscape Enhancement of Floral Resources for Honey Bees in Agro-Ecosystems.” *Apilodogie*, 41, no. 3 (2010): 264–67. https://doi.org/10.1051/apido/2010024.

Delbeke, Jos, and Peter Vis, eds. *EU Climate Policy Explained*. New York: Routledge, 2015. https://op.europa.eu:443/en/publication-detail/-/publication/65ff050c-b8f8-11e5-8d3c-01aa75ed71a1.

Department for Environment, Food and Rural Affairs. *Healthy Bees: Protecting and Improving the Health of Honey Bees in England and Wales*. London: Department for Environment, Food and Rural Affairs, 2009. http://www.nationalbeeunit.com/downloadDocument.cfm?id=92.

Department of Homeland Security (DHS). *Partnering for Critical Infrastructure Security and Resilience*. NIPP 2013. Washington, DC: Department of Homeland Security, 2013. https://www.dhs.gov/sites/default/files/publications/national-infrastructure-protection-plan-2013-508.pdf.

Delbeke, Jos, and Peter Vis, eds. *EU Climate Policy Explained*. New York: Routledge, 2015. https://op.europa.eu:443/en/publication-detail/-/publication/65ff050c-b8f8-11e5-8d3c-01aa75ed71a1.

Dwyer, Marge. "Study Strengthens Link between Neonicotinoids and Collapse of Honey Bee Colonies." Harvard School of Public Health, May 9, 2014. https://www.hsph.harvard.edu/news/press-releases/study-strengthens-link-between-neonicotinoids-and-collapse-of-honey-bee-colonies/.

Ellperin, Juliet. "How the White House Plans to Help the Humble Bee Maintain its Buzz." *Washington Post*, May 19, 2015. https://www.washingtonpost.com/politics/whats-all-the-obama-buzz-about-bees/2015/05/18/5ebd1580-fd6a-11e4-805c-c3f407e5a9e9_story.html.

Environmental Protection Agency. "Colony Collapse Disorder." April 26, 2018. https://www.epa.gov/pollinator-protection/colony-collapse-disorder.

———. "Integrated Pest Management (IPM) Principles." April 11, 2019. https://www.epa.gov/safepestcontrol/integrated-pest-management-ipm-principles.

Environment Washington. "No Bees, No Food." Accessed November 23, 2019. https://environmentwashington.org/feature/wae/no-bees-no-food.

EU Business. "EU Pollinator Initiative." June 2, 2018. https://www.eubusiness.com/topics/environ/pollinators.

European Commission. *EU Pollinators Initiative*. Brussels: European Commission, June 1, 2018. https://ec.europa.eu/environment/nature/conservation/species/pollinators/documents/EU_pollinators_initiative.pdf.

———. "Factsheet: Public Consultation on EU Pollinators Initiative." Accessed November 22, 2019. http://ec.europa.eu/environment/nature/conservation/species/pollinators/documents/EU_pollinators_initiative_factsheet.pdf.

European Union. *EU Pollinators Initiative: Summary of the Results of the Public Consultation*. Luxembourg: European Union Publications Office, 2018. https://ec.europa.eu/environment/nature/conservation/species/pollinators/documents/EU_pollinators_summary_public_consultation.pdf.

Farah, Troy. "While We Worry about Honeybees Other Pollinators Are Disappearing." *The Crux* (blog), August 3, 2018. http://blogs.discovermagazine.com/crux/2018/08/03/honeybees-pollinator-really-going-extinct/#.XaqUC2Z7nIU.

Farm Progress. "Pollinator Task Force Releases National Strategy." May 21, 2015. https://www.farmprogress.com/government/pollinator-task-force-releases-national-strategy.

Fischer, Dave. "Improving Pollinator Health Requires Collaboration, Public-Private Partnerships." The Wildlife Society, November 3, 2016. https://wildlife.org/improving-pollinator-health-requires-collaboration-public-private-partnerships/.

Fischer, Nan. "How to Start Companion Planting." *Home Gardening* (blog), June 5, 2017. https://www.naturespath.com/en-us/blog/the-benefits-of-companion-planting/.

Food and Agriculture Organization. "FAO's Global Action on Pollinator Services for Sustainable Agriculture." Accessed November 19, 2019. http://www.fao.org/pollination/major-initiatives/en/.

———. "The Underlying Causes of Food Insecurity." In *The Elimination of Food Insecurity in the Horn of Africa: A Strategy for Concerted Government and UN Agency Action*. New York: United Nations, 2000. http://www.fao.org/docrep/003/x8406e/X8406e01.htm.

Food and Drug Administration, U.S. Department of Agriculture, and Department of Homeland Security. *Food and Agriculture Sector-Specific Plan*. Washington, DC: Department of Homeland Security, 2015. https://www.dhs.gov/sites/default/files/publications/nipp-ssp-food-ag-2015-508.pdf.

Fossum, Sam. "Honeybees Hit by Trump Budget Cuts." CNN, July 6, 2019. https://www.cnn.com/2019/07/06/politics/honeybees-study-usda-donald-trump-budget-cuts/index.html.

Gardenerdy. "Difference between the Monoculture and Polyculture Farming Techniques." Accessed October 17, 2019. https://gardenerdy.com/difference-between-monoculture-polyculture-farming-techniques.

Giamo, Cara. "The Case against Honey Bees." *Gastro Obscura* (blog), July14, 2016. https:www.atlasobscura.com/articles/the-case-against-honeybees.

Gillam, Carey. "Bees Crucial to Many Crops Still Dying at Worrisome Rate: USDA." Reuters, May 15, 2014. https://www.reuters.com/article/us-usda-honeybees-report/bees-crucial-to-many-crops-still-dying-at-worrisome-rate-usda-idUSKBN0DV12120140515.

———. *Whitewash: The Story of a Weed Killer, Cancer, and the Corruption of Science*. Washington, DC: Island Press, 2017.

Goulson, Dave. "The Beguiling History of Bees." *Scientific American*, April 25, 2014. https://www.scientificamerican.com/article/the-beguiling-history-of-bees-excerpt/.

———. "Decline of Bees Forces China's Apple Farmers to Pollinate by Hand." China Dialogue, February 10, 2012. https://chinadialogue.net/article/show/single/en/5193-Decline-of-bees-forces-China-s-apple-farmers-to-pollinate-by-hand.

Goulson, Dave, Elizabeth Nicholls, Cristina Botías, and Ellen L. Rotheray. "Bee Declines Driven by Combined Stress from Parasites, Pesticides, and Lack of Flowers." *Science* 347, no. 6229 (March 2015). https://doi.org/10.1126/science.1255957.

Green, Jared. "A Bold Plan for Saving Pollinators." *The Dirt* (blog), June 25, 2015. https://dirt.asla.org/2015/06/25/a-bold-plan-for-saving-pollinators/.

GroundTruth (blog). "Bayer, Bees & the Hall of Shame." January 5, 2015. http://www.panna.org/blog/bayer-bees-hall-shame.

Haltiwanger, John. "If All the Bees in the World Die, Humans Will Not Survive." *Elite Daily,* September 15, 2014. https://www.elitedaily.com/news/world/humans-need-bees-to-survive/755737.

Hanson, Thor. *Buzz: The Nature and Necessity of Bees*. New York: Basic Books, 2018.

Healthy Yards. "Pollinator Pathways." Accessed October 17, 2019. https://www.healthyyards.org/activities/pollinator-pathways/.

Hobbs, Thomas. "EC to Ban Three Neonicotinoids." *Fresh Produce Journal*, April 29, 2013. http:www.fruitnet.com/fpj/article/158173/ec-to-ban-three-neonicotinoid.

Hoff, Mary. "As Insect Populations Decline, Scientists Are Trying to Understand Why." *Scientific American*, November 1, 2018. https://www.scientificamerican.com/article/as-insect-populations-decline-scientists-are-trying-to-understand-why/.

Horn, Tammy. "Honey Bees: A History." *Times Topics* (blog), April 11, 2008. https://topics.blogs.nytimes.com/2008/04/11/honey-bees-a-history/.

Intergovernmental Platform for Biodiversity and Ecosystem Services. "About IPBES." Accessed August 2, 2019. https://www.ipbes.net/about.

Jones, Andrew D., Francis M. Ngure, Gretel Pelto, and Sera L. Young. “What Are We Assessing When We Measure Food Security? A Compendium and Review of Current Metrics.” *Advances in Nutrition* 4, no. 5 (September 2013): 481–505. https://doi.org/10.3945/an.113.004119.

Kaskey, Jack. “How Monsanto Mobilized Academics to Pen Articles Supporting GMOs.” *Chicago Tribune,* October 2, 2015. https://www.chicagotribune.com/news/sns-wp-blm-monsanto-0c06199a-692b-11e5-bdb6-6861f4521205-20151002-story.html.

Kjohl, Mariken, Anders Nielson, and Nils Christian Stenseth. *Potential Effects of Climate Change on Crop Pollination: Extension of Knowledge Base, Adaptive Management, Capacity Building, Mainstreaming*. Rome: Food and Agriculture Organization of the United Nations, 2011. http://www.fao.org/fileadmin/templates/agphome/documents/Biodiversity-pollination/Climate_Pollination_17_web__2_.pdf.

Klein, Alice. “Robotic Bee Could Help Pollinate Crops as Real Bees Decline.” *New Scientist*, February 9, 2017. https://www.newscientist.com/article/2120832-robotic-bee-could-help-pollinate-crops-as-real-bees-decline/.

Koba, Mark. “Millions Hungry Despite World Food Surplus.” Public Radio International, July 22, 2013. https://www.pri.org/stories/2013-07-22/millions-hungry-despite-world-food-surplus.

Kuepper, George, and Marti Dodson. *Companion Planting & Botanical Pesticides: Basic Concept and Resources*. Butte, MT: ATTRA Sustainable Agriculture, 2009. https://attra.ncat.org/product/companion-planting-botanical-pesticides-concepts-resources/.

Lechenet, Martin, Fabrice Dessaint, Guillaume Py, David Makowski, and Nicolas Munier-Jolain. “Reducing Pesticide Use While Preserving Crop Productivity and Profitability on Arable Farms.” *Nature Plants* 3 (2017). https://www.nature.com/articles/nplants20178.

Lee, Hyunok, Daniel A. Sumner, and Antoine Champetier. “Pollination Markets and the Coupled Futures of Almonds and Honey Bees: Simulating Impacts of Shifts in Demands and Costs.” *American Journal of Agricultural Economics* 101, no. 1 (January 2019): 230–49. https://doi.org/10.1093/ajae/aay063.

Lexchin, Joel. “Sponsorship Bias in Clinical Research.” *International Journal of Risk & Safety in Medicine* 24, no. 4 (January 2012): 233–242. https://doi.org/10.3233/JRS-2012-0574.

Library of Congress. “Restrictions on Genetically Modified Organisms: United States.” March 2014. https://www.loc.gov/law/help/restrictions-on-gmos/usa.php.

Lorenzoni, Irene, and Nick F. Pidgeon. "Public Views on Climate Change: European and USA Perspectives." *Climatic Change* 77, no. 1–2 (2006): 73–95. https://doi.org/10.1007/s10584-006-9072-z.

Mader, Eric, Marla Spivak, and Elaine Evans. *Managing Alternative Pollinators: A Handbook for Beekeepers, Growers, and Conservationists*. College Park, MD: SARE, 2010.

McCallum, Brian, and Alison Benjamin. "Who We Are: Urban Bees Helping Bees in the City." Urban Bees, accessed October 18, 2019. https://www.urbanbees.co.uk/who/who.htm.

McNamarra, Bryanne. "The Disappearance of the Bees." Final project essay, Evergreen State College, 2016. https://sites.evergreen.edu/environmentalhealth/wp-content/uploads/sites/174/2016/03/EnvironmentalHealthProjectFinal.pdf.

McNeil, M.E.A. "The National Strategy to Promote the Health of Honey Bees and Other Pollinators." *Bee Culture*, November 20, 2015. https://www.beeculture.com/the-national-strategy-to-promote-the-health-of-honey-bees-and-other-pollinators/.

Miley, Michelle. "The Advantages & Disadvantages of Chemical Fertilizer." Hunker, March 13, 2018. https://www.hunker.com/13404813/the-advantages-disadvantages-of-chemical-fertilyzers.

Monarch Joint Venture. "Why Is the Monarch Population Decline Important?" Accessed August 2, 2019. https://monarchjointventure.org/resources/faq/why-is-the-monarch-population-decline-important.

Morag, Nadav. *Comparative Homeland Security: Global Lessons*, 2nd ed. Hoboken, NJ: John Wiley and Sons, 2018.

Nairn, Jason. "Homeland Security and the Honey Bee." *Homeland Security Roundtable* (blog). May 19, 2015. http://homelandsecurityroundtable.com/2015/05/19/homeland-security-and-the-honey-bee/.

News Tribune. "EU Moves to Full Ban on Pesticides That Harm Bees." April 28, 2018. https://www.newstribune.com/news/national/story/2018/apr/28/eu-moves-to-full-ban-on-pesticides-that-harm-bees/723912/.

Noland, Josh. "Mono vs Poly." Beyond Sustainable, May 28, 2017. https://beyondsustainable.org/sustainability/monoculture-vs-polyculture/.

Owen, Robert. "The Decline of Pollinators." *Bee Culture*, June 27, 2016. https://www.beeculture.com/the-decline-of-pollinators.

Pariona, Amber. “Which Crops and Plants Are Pollinated By Honey Bees?” World Atlas, March 5, 2019. https://www.worldatlas.com/articles/which-crops-plants-are-pollinated-by-honey-bees.html.

Patterson, Susan. “What Is Monocropping: Disadvantages of Monocultures in Gardening.” Gardening Know How, last modified April 5, 2018. https://www.gardeningknowhow.com/plant-problems/environmental/monoculture-gardening.htm.

Pesticide Action Network. “Corporate Science & Spin.” Accessed October 6, 2019. http://www.panna.org/gmos-pesticides-profit/corporate-science-spin.

Pollinator Task Force. *National Strategy to Promote the Health of Honey Bees and Other Pollinators*. Washington, DC: White House, 2015. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/Pollinator%20Health%20Strategy%202015.pdf.

Schafer, Kristin. “EU Bans Neonics: U.S. Bees Not so Lucky.” Pesticide Action Network, May 3, 2018. http://www.panna.org/blog/eu-bans-neonics-us-bees-not-so-lucky.

Schroeder, Bethany. “Health and Food Security.” *Resilience*, February 1, 2011. https://www.resilience.org/stories/2011-02-01/health-and-food-security/.

Shilton, A.C. “What Would Happen if All the Bees Went Extinct?” Vice, March 1, 2017. https://www.vice.com/en_us/article/d7ezaq/what-would-happen-if-all-the-bees-died-tomorrow.

Singh, Aaditya. “Pesticides and Safety: Pros and Cons of Pesticides.” Tunza Eco Generation, April 10, 2017. https://tunza.eco-generation.org/resourcesView.jsp?boardID=ambassadorReport&viewID=43671&searchType=&searchName=&pageNumber=2.

Smith, Debra. “Could Weed and Feed be Killing Bees?” *HeraldNet*, April 22, 2008. https://www.heraldnet.com/news/could-weed-and-feed-be-killing-bees/.

Smitley, David. “How to Protect and Increase Pollinators in Your Landscape.” Michigan State University, May 1, 2019. https://www.canr.msu.edu/publications/how_to_protect_and_increase_pollinators_in_your_landscape.

Spivak, Marla, Zac Browning, Mike Goblirsch, Katie Lee, Clint Otto, Matthew Smart, and Judy Wu-Smart. *Why Does Bee Health Matter? The Science Surrounding Honey Bee Health Concerns and What We Can Do About It*. Ames, IA: Council for Agricultural Science and Technology, 2017. https://www.cast-science.org/wp-content/uploads/2018/12/QTA20171_Bee_Health_565CB839D149E.pdf.

Sustainable Development Goals. “With Busy Bees in the Lead, ‘Pollinator Friendly’ Approach Vital for Healthy Agriculture Ecosystems–UN.” May 26, 2016. https://www.un.org/sustainabledevelopment/blog/2016/05/with-busy-bees-in-the-lead-pollinator-friendly-approach-vital-for-healthy-agricultural-ecosystems-un/.

Tirado, Reyes, Gergely Simon, and Paul Johnston. *Bees in Decline: A Review of Factors That Put Pollinators and Agriculture in Europe at Risk*. Amsterdam: Greenpeace International, 2013. https://www.greenpeace.org/switzerland/Global/international/publications/agriculture/2013/BeesInDecline.pdf.

Toplensky, Rochelle. “EU Court Upholds Ban on Insecticides Found to Harm Bees.” *Financial Times*, May 17, 2018. https://www.ft.com/content/4c4abfb0-59ba-11e8-bdb7-f6677d2e1ce8.

Traveset, Anna, Cristina Tur, and Victor M. Eugiluz. “Plant Survival and Keystone Pollinator Species in Stochastic Coextinction Models: Role of Intrinsic Dependence on Animal Pollination.” *Scientific Reports* 7, no. 1 (July 2017). https://doi.org/10.1038/s41598-017-07037-7.

Turton, Shearer. “Comparing Mite Treatments.” Bee Culture, August 23, 2016. https://www.beeculture.com/comparing-mite-treatments/.

United Nations. *Report of the World Food Conference, Rome 5–16 November 1974*. New York: United Nations, 1975. https://digitallibrary.un.org/record/701143/files/E CONF.65_20-EN.pdf.

———. “World Population Projected to Reach 9.7 Billion by 2050.” July 29, 2015. https://www.un.org/en/development/desa/news/population/2015-report.html.

van der Sluijs, Jeroen P., and Nora S. Vaage. “Pollinators and Global Food Security: The Need for Holistic Global Stewardship.” *Food Ethics* 1, no. 1 (June 2016): 75–91. https://doi.org/10.1007/s41055-016-0003-z.

van der Sluijs, Jeroen P., Noa Simon-Delso, Dave Goulson, Laura Maxim, Jean-Marc Bonmatin, and Luc P Belzunces. “Neonicotinoids, Bee Disorders and the Sustainability of Pollinator Services.” *Current Opinion in Environmental Sustainability* 5, no. 3 (September 2013): 293–305.

vanEngelsdorp, Dennis, and Marina Doris Meixner. “A Historical Review of Managed Honeybee Populations in Europe and the United States and the Factors That May Affect Them.” *Journal of Invertebrate Pathology*, 103, supplement (January 2010): S80–S95. https://doi.org/10.1016/j.jip.2009.06.011.

Vanishing of the Bees. Directed by Maryam Henein and George Langworthy. Hive Mentality Films and Hipfuel Films, 2009.

White House. "Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators." Official memorandum. Washington, DC: Office of the Press Secretary, June 20, 2014.

———.*Critical Infrastructure Security and Resilience*. PPD-21. Washington, DC: White House, February 12, 2013. https://obamawhitehouse.archives.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil.

———. "Fact Sheet: The Economic Challenge Posed by Declining Pollinator Populations." White House, June 20, 2014. https://obamawhitehouse.archives.gov/the-press-office/2014/06/20/fact-sheet-economic-challenge-posed-declining-pollinator-populations.

Whitney, Kaitlin Stack. "6 Misconceptions about Saving the Bees." *Macroscope* (blog), June 15, 2015. https://www.americanscientist.org/blog/macroscope/6-misconceptions-about-saving-the-bees.

———. "Pros and Cons of the U.S. Federal Strategy to Protect Pollinators." *Macroscope* (blog), September 17, 2015. https://www.americanscientist.org/blog/macroscope/pros-and-cons-of-the-u.s.-federal-strategy-to-protect-pollinators.

Wilson, William T., Philip E. Sonnet, and Adair Stoner. "Pesticides and Honey Bee Mortality." In *Beekeeping in the United States*, edited by E.C. Martin, Everett Oertel, and William P. Nye, *Agriculture Handbook No. 335*, 129–40. Washington, DC: Government Printing Office, 1980. https://thebeeyard.org/wp-content/uploads/2014/02/Beekeeping.in_.the_.United.States.pdf.

World Bank. *World Development Report 2008: Agriculture for Development*. Washington, DC: World Bank, 2007. http://hdl.handle.net/10986/5990.

World Wide Fund for Nature. "Save Our Bees? EU Pollinator Initiative Lacks Teeth to Address Unsustainable Practices!" June 1, 2018. http://www.wwf.eu/?uNewsID=328674.

Wunderlich, Gooloo S., and Janet Lippe Norwood, eds. *Food Insecurity and Hunger in the United States: An Assessment of the Measure*. Washington, DC: National Academies Press, 2006. https://doi.org/10.17226/11578.

Youngs, Richard. *Climate Change and European Security*. London: Routledge, 2015.

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California