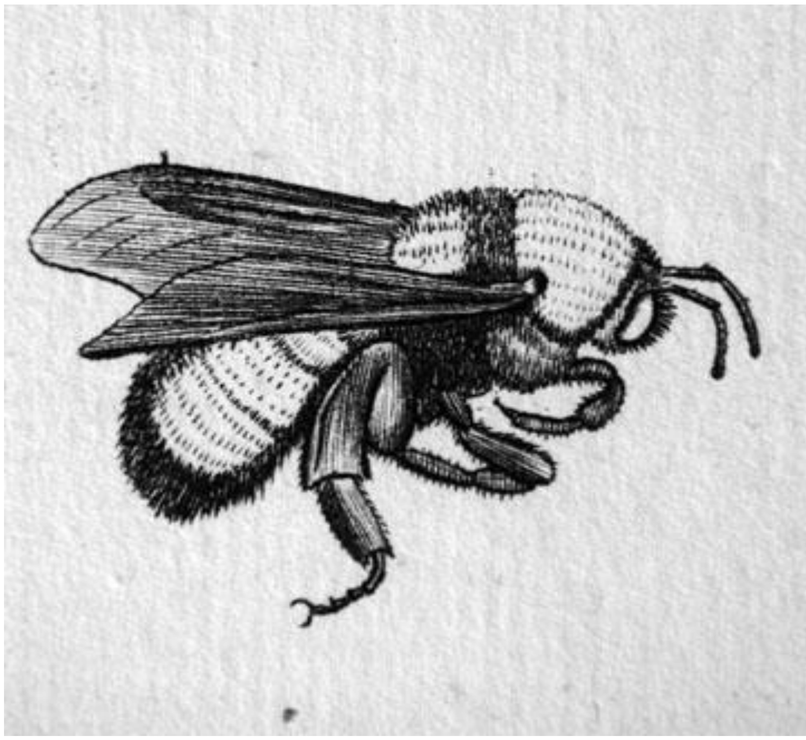
PETITION TO LIST THE AMERICAN BUMBLE BEE
Bombus pensylvanicus (De Geer, 1773)
AS AN ENDANGERED SPECIES
UNDER THE U.S. ENDANGERED SPECIES ACT



Depiction of *Bombus pensylvanicus* from
Memories Pour Servir a L'historie des Insects
by Charles De Geer, 1773

Written and Submitted by

Center for Biological Diversity

and

Bombus Pollinators Association of Law Students

February 1st, 2021

NOTICE OF PETITION

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Pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. § 1533(b); Section 553(e) of the Administrative Procedure Act, 5 U.S.C. § 553(e); and 50 C.F.R. § 424.14(a), the Center for Biological Diversity ("Center") and the Bombus Pollinators Association of Law Students of Albany Law School ("BPALS") hereby petition the Secretary of the Interior, through the United States Fish and Wildlife Service ("FWS," "Service"), to list the American bumble bee (*Bombus pensylvanicus*) under the ESA.

FWS has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on the Service. Specifically, the Service must issue an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). FWS must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." *Id*.

Petitioners also requests that critical habitat be designated for the American bumble bee concurrently with the species being listed, pursuant to 16 U.S.C. § 1533(a)(3)(A) and 50 C.F.R. § 424.12.

Petitioners are the Center and BPALS. The Center is a nonprofit, public interest environmental organization dedicated to the protection of imperiled species and the habitat and climate they need to survive through science, policy, law, and creative media. The Center is supported by more than 1.7 million members and online activists throughout the country. The Center works to secure a future for all species, great or small, hovering on the brink of extinction. The Center submits this petition on its own behalf and on behalf of its members and staff with an interest in protecting the American bumble bee and its habitat. BPALS is a group of current and former students of the Albany Law School in Albany, New York.

Submitted Monday, February 1, 2021.

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Abbreviations

APHIS	Animal and Plant Health Inspection Service
BIML	Native Bee Inventory and Monitoring Lab
BLM	Bureau of Land Management
CRP	Conservation Reserve Program
EQIP	Environmental Quality Incentive Program
ESA	Endangered Species Act
FWS	United States Fish and Wildlife Service
FLPMA	The Federal Land Policy and Management Act
GBIF	Global Biodiversity Information Facility
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
ITIS	Integrated Taxonomic Information System
IUCN	International Union for the Conservation of Nature
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NPS	National Park Service
SGCN	Species of Greatest Conservation Need
SWAP	State Wildlife Action Plan
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
WWF	World Wildlife Fund

Suggested Citation

JESS TYLER, CENTER FOR BIOLOGICAL DIVERSITY AND BOMBUS POLLINATORS ASSOCIATION OF LAW STUDENTS. 2021. PETITION TO LIST THE AMERICAN BUMBLE BEE BOMBUS PENSYLVANICUS (DE GEER, 1773) AS AN ENDANGERED SPECIES UNDER THE U.S. ENDANGERED SPECIES ACT. FEBRUARY 1, 2021.

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The BPALS include: Claire Burke, Connor P. Cooney, Sarah A. Currie, Laurel Dean, David R. Dickinson, Theodore R. Fina, Catherine D. Kemp, Joseph L. Lansing, Emma E. Marshall, Conor P. Rourke, Ryan A. Whelpley, Kristopher P. Wilson, Daniel Young, Emmet Zeller, and Professor Keith Hirokawa.

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The analysis of the population status of the American bumble bee relied on the bumble bee observations held by many private and public entities across the country. We would like to express our appreciation for Dr. Leif Richardson, the Global Biodiversity Information Facility, the USDA-Agriculture Research Service, and numerous universities and private entomology collections for the use of their databases for the purpose of this petition.

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I. Executive Summary

The American bumble bee (*Bombus pensylvanicus* De Geer) is one of the most iconic native pollinators in North America. This highly adaptable pollinator once ranged coast to coast, foraging in the grasslands, fields, and open spaces in 47 of the lower 48 states. Like the endangered rusty-patched bumble bee, it is a generalist that provides essential pollination service to a wide variety of plants—including native plants and cultivated crops, across a vast range. Its loss will have considerable consequences to whole ecosystems and to crop production.

Once the most commonly observed bumble bee in the United States, the American bumble bee has declined by 89 percent in relative abundance and continues to decline toward extinction due to the disastrous, synergistic impacts of threats including habitat loss, pesticides, disease, climate change, competition with honey bees, and loss of genetic diversity. In the last 20 years, the American bumble bee has vanished from at least eight states, mostly in the Northeast, and it is in precipitous decline in many more. For example, in New York it has suffered a catastrophic decline of 99 percent in relative abundance, and in Illinois it has disappeared from the northern part of the state and is down 74 percent since 2004. In sum, the American bumble bee has become very rare or possibly extripated from 16 states in the Northeast and Northwest; it has experienced declines of over 90 percent in the upper Midwest; and 19 other states in the Southeast and Midwest have seen declines of over 50 percent.

The American bumble bee is in serious decline across the upper Midwest and Northeast that is comparable to the decline of the federally endangered rusty patched bumble bee. Across the 27-state range of the rusty-patched bumble bee, it has declined by 90 percent, while across the same area the American bumble bee has declined 83 percent. Unlike the rusty-patched bumble bee, the American bumble bee has also declined across a much larger area and has declined in states where it was historically the most abundant bee.

Existing regulations and public land protections are entirely inadequate to protect the American bumble bee from extinction. The states that have seen some of the largest declines of the American bumble bee within the past 20 years are the same states that have seen the largest quantified increase in pesticide use, including neonicotinoid insecticides and fungicides. Public land presents little refuge from habitat loss and pesticides as only 4% of this species' observations have been on public lands, and even there, they face ongoing threats such as herbicide use and competition and disease from honey bee apiaries. No state adequately mitigates the threats of competition and disease from domesticated bumble bees. The American bumble bee has not been protected under any state endangered species statute.

The American bumble bee, like the rusty patched bumble bee and monarch butterfly, is a once wide ranging insect that, due to threats such as habitat loss, pesticide use, and climate change, now needs the protection of the Endangered Species Act to dodge extinction. Based on the best available science, the Fish and Wildlife Service must list the American bumble bee as endangered under the Endangered Species Act.

II. Introduction and Candidate Background

The health of natural ecosystems and humanity are intricately linked to the health of pollinators (Pollinator Health Task Force 2015 pp. 1,8; IPBES 2016 p. 16). Animal pollination, the vast majority of which is done by bees, is required for successful production of around 90% of wild plants, and 75% of leading global food crops that grow on 35% of global agricultural land (Moissett & Buchmann 2011 p. 2; IPBES 2016 p. 16). Bumble bees are critical pollinators for crops and native plants because they are very effective pollinators and are capable of "buzz" pollination (De Luca & Vallejo-Marrín, 2013 p. 2). However, many species of bumble bees and other wild, native bees have declined in abundance and range in North America (IPBES 2016 pp. 21–22) and are imperiled by a multitude of interacting threats that include habitat loss, agricultural intensification, pesticide use, invasive non-native species, climate change, and pathogens (Pollinator Health Task Force 2015 p. 5; IPBES 2016 pp. 24–29). Compared to pollinators who only visit specific plants or to small, solitary bees; bumble bees pollinate a huge variety of plants and are capable of foraging long distances. The loss of highly versatile pollinators like the American bumble bee, a generalist pollinator, can reduce plant diversity faster than the loss of a specialist pollinator with limited range (Goulson 2008 p. 192).

America's bumble bee fauna are losing ground in a continental-wide change in the makeup of the bumble bee community (Bartomeus et al. 2013 p. 4657). Of the 46 species of bumble bees in North America, 12 are in decline and are classified as vulnerable, endangered, or critically endangered according to the IUCN (Hatfield et al. 2014 entire). Bumble bee species richness in the northeastern United States has declined by 30% in the past 140 years (Bartomeus et al. 2013 p. 4656). The Northeast and upper Midwest have lost once common species like the rusty-patched bumble bee (*Bombus affinis*) and the less common but widespread Ashton cuckoo bumble bee (*Bombus ashtoni)* which relies on the rusty-patched bumble bee as its host species. The decline of the rusty-patched and American bumble bees in the Northeast highlight the serious, widespread threats facing bumble bees. Further, in the west, rare species like Franklin's bumble bee (*Bombus franklini*) and Crotch's bumble bee (*Bombus crotchii*) are declining, as are the common and widespread western bumble bee (*Bombus occidentalis*) and its obligate parasite Suckley's cuckoo bumble bee (*Bombus suckleyi*).

The American bumble bee was historically the most commonly observed bumble bee in the United States until the year 2002 (GBIF 2020). Since 2002, however, it has experienced a rapid decline. This alarming trend has spurred a nationwide effort to document the species' status culminating in the 2015 IUCN assessment for the American bumble bee which found that this species has declined 51% on average across its range (Hatfield et al. 2015 p. 4). The American bumble bee faces numerous, synergistic threats from pathogen spillover, habitat degradation, pesticide, and stress all compounded by a changing climate. This petition shows that threats throughout the species' entire range have led to population level declines. It urgently needs the protections that only ESA listing can provide. Without these necessary protections, the American bumble bee will continue to precipitously decline.

III. Taxonomic Status

The American bumble bee belongs to the genus *Bombus* and is found within the subgenus *Thoracobombus* (Table 1). *Bombus pensylvanicus* (DeGeer) was one of the first bumble bees in North America described in *Mémoires Pour Server à L'Histoire des Insectes* by Charles De Geer in 1773 (De Geer, 1773 p. 575-576). The status of the species was affirmed in 1913 by Henry J. Franklin in *The Bombidae of the New World* (Franklin 1913 p. 399). Most recently, the species was affirmed by Jeffrey D. Lozier *et al.* in *Patterns of Range-Wide Genetic Variation in Six North American Bumble Bee (Apidae: Bombus) Species* (Lozier *et al.*, 2011 entire). *Bombus pensylvanicus* is a full, valid species under the Integrated Taxonomic Information System (ITIS) (ITIS 2020 p. 1).

In the southwestern United States and parts of Mexico, *Bombus pensylvanicus* has lighter color markings and is also sometimes identified as *Bombus sonorous* (Say 1837 p. 413; Williams et al. 2014 p. 147). *Bombus pensylvanicus* and *Bombus sonorus* are regarded as conspecific (Williams, 1998; Franklin, 239, 1913) and likely represent a cline of color variation with individuals of intermediate coloration within Mexico (Williams et al. 2014 p. 147). This petition considers *Bombus pensylvanicus* and *Bombus sonorus* to be conspecific following the current best available science per Hatfield et al. (2015 p. 1) and Williams et al. (2014 p. 147). In the event that, *Bombus sonorous* becomes its own species by the consensus of the scientific community, this petition is intended to cover both *B. pensylvanicus* and *B. sonorous*.

Table 1. Taxonomy of *Bombus pensylvanicus* (ITIS Report)

Kingdom	*Animalia*
Phylum	*Arthropoda*
Subphylum	*Hexapoda*
Class	*Insecta*
Subclass	*Pterygota*
Order	*Hymenoptera*
Family	*Apidae*
Genus	*Bombus*
Subgenus	*Thoracobombus*
Species	*Pensylvanicus*

IV. Species Description

The American bumble bee is found in open farmland and fields of the eastern and central United States, from Mexico to southern Canada as well as in much of the mountain West through California (Williams et al. 2014 p. 149). The American bumble bee is a widespread, long-tongued species that is distinguished from other bumble bees by color pattern and body morphology. Queen body size measures 0.86-1.01 in (22–26 mm) in length (Williams *et al.*, 2014 p. 147) and thorax width measures 0.21 in (5.4 mm) (Cueva del Castillo & Fairbairn 2011 p. 49). Queen and worker heads are long with the cheek (oculo-malar area) just longer than broad (distinguished from *B. terricola, B. occidentalis,* and *B. morrisoni).* The midleg basitarsus corner forms a sharp angle extended into a spine and hindleg tibia have long fringes at the sides to form a corbicula or pollen basket (Figure 1). The hair on the head of the queen is always black (distinguished from *B. appositus, B. auricomus* and *B. nevadensis*) (Williams *et al.*, 2014 p. 149). Hairs on the thorax metasomal T1-3 are yellow more dominant at the midline and T4 is black (distinguished from *B. fervidus*) (Williams et al. 2014 p. 149). Worker coloration is similar to the queen (Figures 1 and 2) and measures 0.52-0.76 in (13–19 mm) in length (Williams et al. 2014 p. 147), with a thorax width of 0.16 in (4 mm) and head size of 0.15 in (3.8 mm) (Cueva del Castillo & Fairbairn 2011 p. 49).

American bumble bee males differ from females in size and coloration (see Figure 3). Males measure 0.58-0.84 in (15–21 mm) in length, with a thorax width of 0.15 in (3.9 mm) and a head width of 0.12 in (3 mm) (Williams et al., 2014 p. 149; Cueva del Castillo & Fairbairn 2011 p. 49). Male antenna length is greater than four times the length of the scape (distinguished from *B. terricola* and *B. occidentalis*). Male coloration is similar to queens and workers expect metasomal T7 is often orange (distinguished from *B. fervidus*) or if T7 is black then T2-3 are entirely yellow (Williams et al., 2014 p. 149). Male faces are mostly black with some yellow hairs intermixed (Williams et al. 2014 p. 149). Male thorax is black on the sides and the upperside of the thorax often with a black band between the wings sometimes with yellow hairs intermixed (Williams et al. 2014. P. 149).

Figure 1. *Bombus Pensylvanicus* Queen
© Discoverlife: Georgia Museum of Natural History

Figure 2. *Bombus Pensylvanicus* Worker
© Discoverlife: Georgia Museum of Natural History

Figure 3. *Bombus Pensylvanicus* Male
© Discoverlife: Georgia Museum of Natural History

V. Biology

A. Life Cycle

The American bumble bee has an annual life cycle (see Figure 4). Queen bees that mated the previous fall emerge in the spring from their overwintering shelters and begin building colonies. Once a new queen has chosen a nesting site, she forages for nectar and pollen for herself and combines pollen and nectar together into provisions called "bee bread" within the nest for her offspring. The queen lays an egg on each provision which hatches and feeds on the provision until entering pupation. Worker bees emerge after they pupate. The colony grows and expands through mid-summer when males are produced. The males leave the colony and go in search of reproductive females from other colonies. Reproductive females are produced at the end of the summer who leave the natal colony, mate, and then find a suitable place to overwinter. The members of the original colony die and the new, mated queens overwinter to begin the cycle the next year (Williams et al. 2014 p. 12-15).

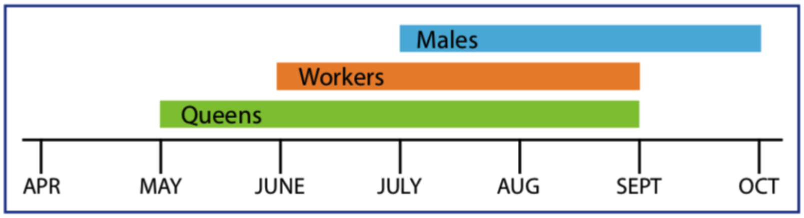


Figure 4. The documented phenology cycle of the American bumble bee colony. This chart was originally published in the USDA report *Bumble Bees of Eastern United States* (Colla *et al.*, 2011 p. 14).

B. Nesting and Overwintering Sites

Like all bumble bees, the American bumble bee requires suitable nesting sites, nectar and pollen resources during the colony formation and rearing period (spring, summer, and fall), and suitable overwintering sites for mated females (Goulson 2010 pp. 5–12). The American bumble bee has been found to nest in grasslands and open farmland, mostly on the surface of the ground among tall grass, but occasionally underground (Williams et al. 2014 p. 149). In general, bumble bees are considered opportunistic nesters that will take advantage of pre-existing holes and depressions below the surface formed by rodents or cavities above the surface created by old logs, stumps, old ground-nesting bird nests, or clumps of grass (Schweitzer et al. 2012 p. 10).

The specific requirements of overwintering nest sites of American bumble bee females are not yet known, but bumble bees are generally known to hibernate in undisturbed sites, close to the ground surface an inch or two under loose soil or under leaf litter or other debris, in sites that have adequate organic material to provide shelter (Williams et al. 2014 p. 15).

The surrounding landscape also plays a significant role in nest location because bumble bees locate their nests near foraging and overwintering sites. Bumble bees use spatial cognition when locating a suitable habitat to place their nests because spatial memory allows the bee to form a cognitive map outlining the landscape to avoid roads, streets, and highways (Herascu 2017 p. 2).

C. Floral Resources and Habitat Characteristics

The American bumble bee is a highly adaptable, forage generalist, and can feed on a wide variety of flowering plants within the bee's primary habitat of open farmland and fields (Williams et al. 2014 p. 149). This kind of habitat is found across the country in many ecosystems and broadly includes the temperate grasslands of the Midwest, forest edges and meadows, low elevation piedmont area of the southeastern U.S., the Atlantic and Gulf coastal plain, and semi-arid/arid desert of the southwestern U.S. This species also persists in urbanized areas where floral resources are available (see Camilo et al. 2017 p. 179 and Evans et al. 2019 p. 18).

Specific habitat requirements for the American bumble bee have only been studied in-depth in southern Ontario, Canada, the northern edge of its range. There, the American bumble bee's habitat is associated with floral and landscape characteristics of open land mixed with some forest (Liczner and Colla 2020 p. 6). The American bumble bee is associated with plants generally found in open or disturbed habitats including: creeping bluet, marsh marigold, and yellow rocketcress in the spring; wood lily, dames rocket, and white clover in the summer; and crownvetch, knapweed, and Canadian tick trefoil in the late-summer (Lizcner and Colla 2020 p. 6). Besides flowers, the American bumble bee's habitat varies by the season and is associated with coarse woody debris, rodent burrows, and a lower native to non-native flowering plant species ratio (compared to *Bombus terricola*) (Liczner and Colla 2020 p. 6).

The American bumble bee is a generalist forager that depends on the availability of a variety of local flowers growing in proximity to nesting resources (Ritchie et al. 2016 p. 909). The American bumble bee is associated with the pollination of a variety of wild-flowers including: vetches, bird's-foot trefoil, clovers, goldenrods, St. John's wort, and Bonesets (Colla et al. 2011 p. 70). The American bumble bee can potentially pollinate many crops including: blueberries, raspberries, chives, cucumbers, apples, blackberries, soybeans, cherries, beans, plums, almonds, apricots, alfalfa, eggplants, nectarines, peaches, and cranberries (Colla et al. 2011 p. 9). Many crops benefit from pollination by bumble bees because they are able to "buzz pollinate" whereby a bumble bee vibrates its wing muscles rapidly while grasping a flower with its mandible which results in greater release of pollen which is then transferred to another flower to facilitate cross-pollination (De Luca & Vallejo-Marrı´n, 2013 p. 2). Buzz pollination combined with the American bumble bee's long tongue makes them highly effective pollinators and vital to the survival of many native plants (Cameron et al. 2011 p. 662).

The American bumble bee relies on flowers throughout the entire growing season, as the amount of nectar and pollen during the early spring and late summer impact the growth of the colony and the production of reproductive females (Westphal et al. 2009 p. 192; Goulson 2010 pp. 208–210). Being relatively more mobile than other insects, bumble bees routinely forage over distances of > 1.25 miles (> 2000 m) (Hatfield & LeBuhn 2007 p. 151), so are able to exploit scattered resources in fields and meadows that often exist in patchy complexes (Hatfield & LeBuhn 2007 pp. 154, 156). Bumble bees, in general, require approximately 815-2500 acres (329-1012 ha) of suitable habitat to sustain viable populations (Goulson 2010 p. 193). The percentage of grasslands, especially native prairie remnants, within 0.3 mi (500 m) of a nest is an important predictor of bumble bee diversity (Hines and Hendrix 2005 p. 1481). The quantity and quality of floral resources within the American bumble bee's range varies greatly, and floral-rich fields and meadows are often interspersed within forests or within a matrix of flower-poor developed or agricultural and range land.

VI. Conservation Status and Need for ESA Protection

The ESA is a "comprehensive scheme with the 'broad purpose' of protecting endangered and threatened species." *Ctr. for Biological Diversity v. U.S. Bureau of Land Mgmt.*, 698 F.3d 1101, 1106 (9th Cir. 2012) (quoting *Babbitt v. Sweet Home*, 515 U.S. 687, 698 (1995)). Congress' plain intent in enacting the ESA was "to halt and reverse the trend toward species extinction." *Tenn. Valley Auth. v. Hill*, 437 U.S. 153, 184 (1978). In pursuit of this purpose, the ESA requires that "all Federal departments and agencies *shall* seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of [these] purposes." 16 U.S.C. § 1531(c)(1) (emphasis added). Endangered and threatened species are "afforded the highest of priorities" *Tenn. Valley Auth.*, 437 U.S. at 174. "Endangered species" are species that are "in danger of extinction throughout all or a significant portion of its range," and "threatened species" are species that are "likely to become endangered species within the foreseeable future" throughout all or a significant portion of range. 16 U.S.C. § 1532(6), (20). The ESA states that a species shall be determined to be endangered or threatened based on any one of five factors: 1) the present or threatened destruction, modification, or curtailment of its habitat or range; 2) overutilization for commercial, recreational, scientific, or educational purposes; 3) disease or predation; 4) the inadequacy of existing regulatory mechanisms; and 5) other natural or manmade factors affecting its continued existence. *Id.* § 1533(a)(1).

The American bumble bee has been recognized as imperiled and needing protection by international and state entities. It has a NatureServe ranking of G3 or vulnerable from 2018 (NatureServe 2020 p. 1) and is considered vulnerable by the IUCN (Hatfield et al. 2015 p. 1). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has considered the American bumble bee as a "species of concern" since 2018 (COSEWIC 2018 p. 4). The American bumble bee is not formally protected by any state endangered species act. The American bumble bee has been determined to be a "species of greatest conservation need" (SGCN) in 18 states including: Colorado, Connecticut, Delaware, Illinois, Louisiana, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Oklahoma, Texas, Vermont, Virginia, and Wisconsin (see Table 2)

This once common, dominant species has seen a devastating loss in relative abundance losing area in the northern part of its range in the Northeast, Northwest, upper Midwest, and in the Southwest. The American bumble bee exists at only 11% of its historic relative abundance and its current range has contracted by 19% according to the IUCN assessment (Figure 5 and 7) (Hatfield et al. 2015 p. 4). The American bumble bee has been observed in all of the lower 48 United States, except Washington, but it has seen declines in states where it was historically abundant and has nearly disappeared from northern states where it was historically rare. The number of recent observations in the Northeast and Northwest have been reduced to zero or near zero in several states including: Oregon, Idaho, Montana, Wyoming, Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. A total of 16 Northwestern, Northeastern, and Midwestern states have seen declines of >90%, which meets the IUCN criteria (IUCN 2019 p. 16) for critically endangered: Connecticut, Delaware, Idaho, Maine, Massachusetts, Michigan, New Hampshire, North Dakota, New York, Oregon, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wyoming (Richardson 2020) (see Table 2).

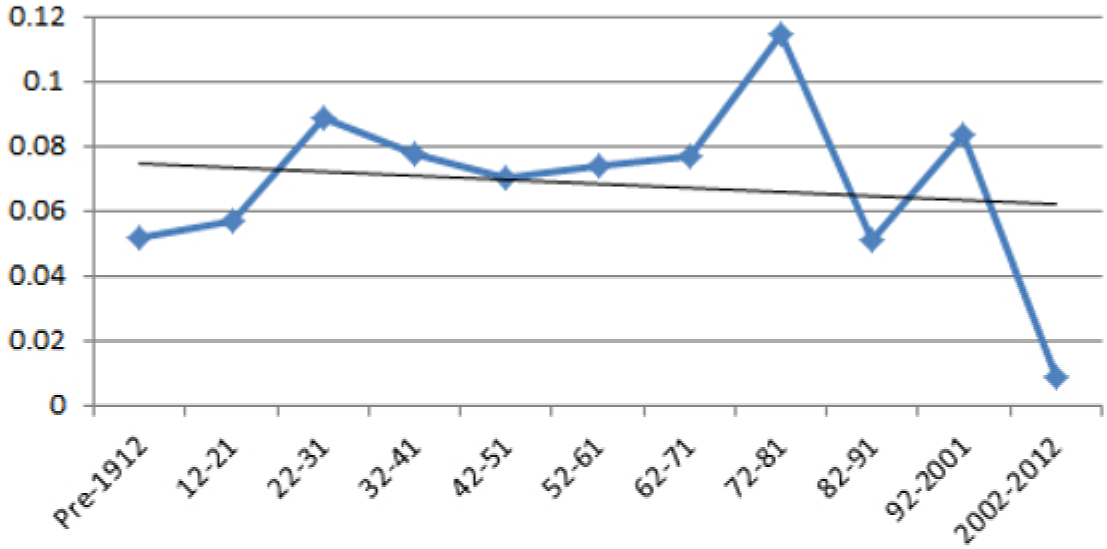


Figure 5. Relative abundance of the American bumble bee as a faction of all bumble bee observations from over 100 years of available records. Taken from Hatfield et al. (2015 supplemental material).

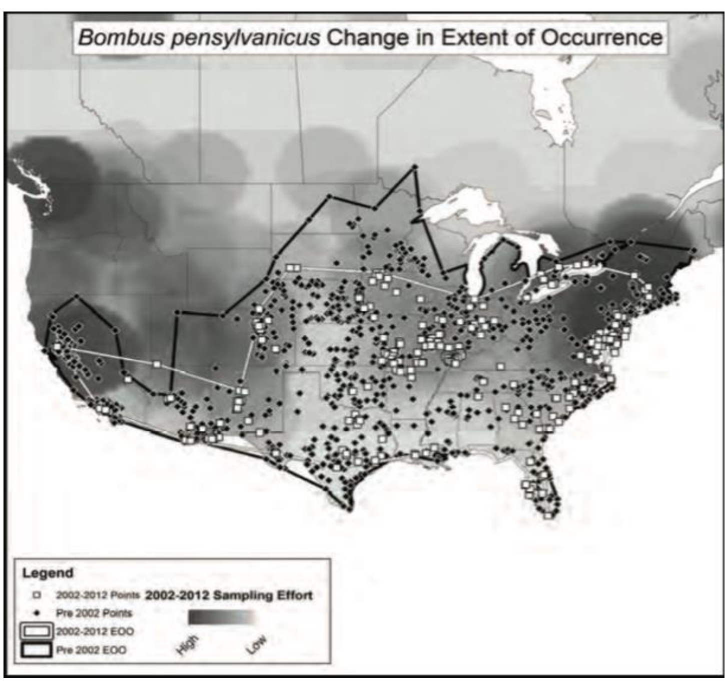


Figure 6. The historic range (pre-2002) of the American bumble bee is represented by the bigger, solid black line. The black dots represent pre-2002 sampling. The current range (2002–2012) of the American bumble bee is

represented by the smaller, solid white line. The white dots represent 2002–2012 sampling. The map for this Figure was originally published in the Hatfield *et al.* (2015 supplemental material).

Even more alarming, the American bumble bee has seen large declines in states with large amounts of once suitable habitat where it was once abundant such as Arkansas (72% decline), Georgia (74% decline), and Illinois (69% decline) (GBIF 2020). Currently, 11 States have seen a relative decline of >70% which meets the IUCN criteria (IUCN 2019 p. 16) for Endangered: Georgia, Illinois, Indiana, Maryland, Minnesota, Nebraska, New Jersey, Ohio, South Dakota, Virginia, and Wisconsin (Richardson 2020). And eight mostly Midwestern States have seen declines of >50% which meets IUCN criteria for Vulnerable: Arkansas, Iowa, Kansas, Mississippi, Missouri, North Carolina, New Mexico, and Tennessee (Richardson 2020).

The population of the American bumble bee will continue to decline in the coming decades without ESA listing to protect the species. The rate of decline (Figure 5) over the past decade has been very steep as this species moved past a tipping point around the year 2000. Populations of declining species often continue to decline slowly after an initially sharp decline until they can recover. The rusty-patched bumble bee was projected to decline in the Species Status Assessment (Szymanski et al. 2016 Figure 7.3) for years after it was petitioned in 2013 and recent data indicates that it has continued to decline after 2013 (Richardson 2020). It is therefore unlikely that we have seen the full decline of the American bumble bee.

The combination of threats facing the American bumble bee of disease spread, wide-spread pesticide use, and habitat degradation are likely to continue unmitigated. The use of the pesticides most directly harmful to bumble bees—insecticides like neonicotinoids and numerous fungicides—face few regulatory hurdles and show no signs of losing popularity among farmers. The five most used neonicotinoids will likely be re-registered by the Environmental Protection Agency (EPA) in 2021, allowing their widespread use for at least another 15 years. The heavy use of herbicides on hundreds of millions of acres, largely driven by the adoption of commodity crops genetically engineered to withstand what would normally be lethal doses of herbicides, continues to expand, with the EPA reapproving dicamba use for over-the-top use on major commodity crops. Disease will likely remain a major threat or even worsen with no recent movement at the state or federal level to address disease spread and spillover from domesticated bumble bees or honey bees. Grasslands conversion, urban development, and climate change all further imperil the American bumble bee. None of these threats are temporary and all will remain a threat for the indefinite future.

The best available science shows the American bumble bee is in danger of extinction in a significant portion of its range. The American bumble bee's imperilment is known to be caused by ESA listing factors one, three, four and five. Its dramatic decline in recent years, the likelihood of continued decline, the increasing threat of disease transmission from domesticated bumble bees, ongoing habitat loss, and ever-increasing pesticide use, indicate that this bee warrants protection as threatened or endangered under the ESA.

FWS must issue a prompt decision to list the American bumble bee to ensure that the bee does not continue to decline towards extinction.

Table 2. State conservation status, relative population change, and assessment for the American bumble bee. The assessment category is based on the IUCN assessment guidelines (IUCN 2019 p. 16): >90% decline "Critically Endangered", >70% decline "Endangered", >50% decline "Vulnerable", <50% decline "Least Concern". Abbreviations: NU "Nation Unranked", N3 "Nation Vulnerable", SGCN "Species of Greatest Conservation Need"

State	State Conservation Status	Relative Population Change	Assessment Category
Global	**--**	**--**	**Vulnerable (IUCN)**
United States	**Not Listed**	**60%**	**NU (NatureServe)**
Canada	**Special Concern**	**--**	**N3 Vulnerable (NatureServe)**
Idaho	--	-100%	Critically Endangered
Maine	SGCN Tier 2	-100%	Critically Endangered
New Hampshire	SGCN	-100%	Critically Endangered
North Dakota	--	-100%	Critically Endangered
Oregon	--	-100%	Critically Endangered
Rhode Island	--	-100%	Critically Endangered
Vermont	SGCN High Priority	-100%	Critically Endangered
Wyoming	--	-100%	Critically Endangered
Connecticut	SGCN	-99%	Critically Endangered
Massachusetts	SGCN	-99%	Critically Endangered
Michigan	--	-99%	Critically Endangered
West Virginia	--	-99%	Critically Endangered
New York	SGCN	-98%	Critically Endangered

Pennsylvania	--	-98%	Critically Endangered
Delaware	SGCN Tier 1	-92%	Critically Endangered
Ohio	--	-89%	Endangered
Minnesota	SGCN	-88%	Endangered
Wisconsin	SGCN	-87%	Endangered
Maryland	SGCN	-85%	Endangered
New Jersey	SGCN	-85%	Endangered
Ontario	Special Concern	-85%	Endangered
South Dakota	--	-85%	Endangered
Virginia	SGCN	-78%	Endangered
Indiana	--	-77%	Endangered
Georgia	--	-75%	Endangered
Illinois	SGCN	-74%	Endangered
Nebraska	--	-71%	Endangered
Arkansas	--	-67%	Vulnerable
Mississippi	--	-66%	Vulnerable
Tennessee	--	-60%	Vulnerable
Missouri	--	-56%	Vulnerable
Iowa	--	-54%	Vulnerable
North Carolina	SGCN	-54%	Vulnerable
Kansas	--	-53%	Vulnerable
New Mexico	--	-50%	Vulnerable
California	--	-45%	Least Concern
Arizona	--	-41%	Least Concern
Oklahoma	SGCN Tier 2	-25%	Least Concern
South Carolina	--	-25%	Least Concern
Louisiana	SGCN Tier 3	-23%	Least Concern
Florida	--	-14%	Least Concern
Texas	SGCN	-0.1%	Least Concern
Alabama	--	+18%	Least Concern
Colorado	SGCN	+95%	Least Concern
Montana*	--	+51%	Least Concern
Nevada*	--	+25%	Least Concern
Kentucky*	--	+189%	Least Concern
Utah*	--	+898%	Least Concern

*These states that have seen an increase in the relative abundance of the American bumble bee had very few observations of the American bumble bee historically and relatively low numbers of bumble bee observation in general. The contribution of new systematic surveys and of community science efforts like bugguide.net, iNaturalist, and Bumble Bee Watch have increased the total number of recent bumble bee observations and are the likely reason for the increase in some or all areas with increasing numbers. In addition, in some states the increase still reflects very small numbers. For example, in Utah, the 898% increase indicates the change from historically making up 0.01% (1 observation) of all observed bees to recently making up 0.15% (7 observations) of all observed bees for the entire state (Richardson 2020).

VII. Distribution and Population Status

A. Historic Distribution and Abundance

The historic range of the American bumble bee was among the broadest geographic ranges of any bumble bee species in North America (Cameron et al. 2001 p. 663; Williams et al. 2014 p. 148). The American bumble bee was broadly distributed across: the northeastern US (Jacobson et al. 2018 p. 441; Cameron et al., 663, 2011); the southeastern US (Figueroa & Bergey, 2015 p. 421; Tripodi & Szalanski, 2015 p. 4), the upper Midwest (Koch 2011 p. 5); the eastern Rocky Mountains (Kearns et al. 2017 p. 68); the mountainous regions of southern Arizona, central Mexico, and north into California (See Figure 6); Texas (Beckham & Atkinson 2017 p. 2); and southern Ontario in Canada (Colla & Packer, 2008 p. 1387).

The American bumble bee was historically the most commonly observed bumble bee in the United States accounting for 10.6% of all observations prior to 2002 (Richardson 2020) and ~45% of all bumble bees east of the rocky-mountains (Cameron et al. 2011 p. 664).

B. Current Range and Population Status

Although once common, the American bumble bee has declined by 51% on average according to the IUCN assessment (Hatfield et al. 2015 p. 4) and exists at only 11% of its historic relative abundance (Figure 5) (Hatfield et al. 2015 p. 4). The current range of the American bumble bee has contracted by 23% according to the IUCN assessment (Hatfield et al. 2015 p. 1)—losing key habitat in the northern part of its range in the Northeast, Northwest, upper Midwest, and in the Southwest (Figure 6).

The alarming IUCN assessment of the decline of the American bumble bee was based on a nationwide collaborative effort to document bumble bee species population trends. Entomologists and researchers from numerous institutions contributed more than 17,000 bumble bee observations from 2007 to 2010 to this effort. Based on this enormous survey effort, Cameron et al. (2011) compared over 16,000 bumble bees observations to more than 73,000 historical bumble bee specimens and revealed that the historic geographic range of the American bumble bee has decreased by 23% (See Figure 7) (Cameron et al. 2011 p. 664). Cameron et al.

(2011) did not observe the American bumble bee across most of its historic northern and eastern range (Cameron et al. 2011 p. 662-63). Their analysis showed that the American bumble bees east of the rocky-mountains have declined in relative abundance from ~45% to ~10%--a 78% relative decline (Cameron et al. 2011 p. 664). Cameron et al. (2011) and the IUCN assessment show comparable declines in range and relative abundance (see Figures 6 and 7).

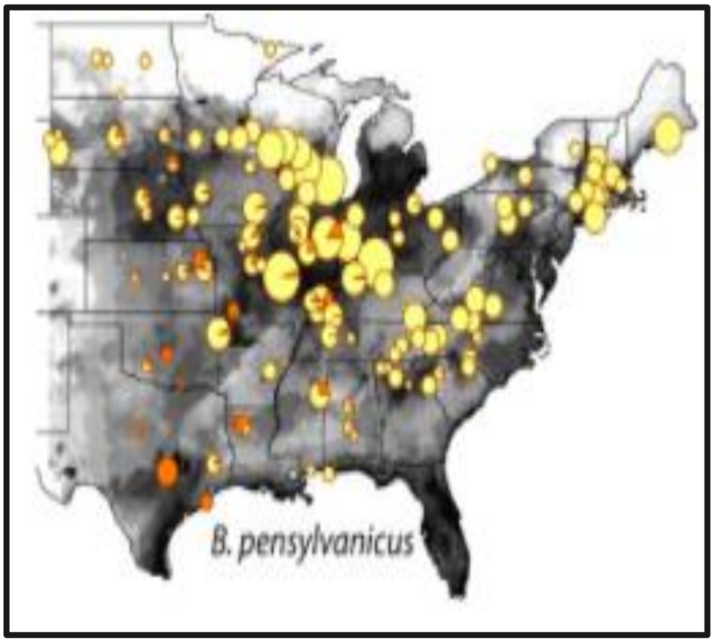


Figure 7. The eastern historic range of the American bumble bee represented by the gray scale shading. The size of the pie charts indicates the total number of bees surveyed at each site and the size of the orange segment indicates the fraction of the American bumble bee collected at that site. The map for this figure was originally published in the Cameron *et al.* (2011).

Koch et al. (2015) elaborated on this work to assemble a dataset of bumble bees across 397 locations throughout 55 ecoregions and recorded 17,930 individuals across 39 species (Koch et al., 2015 p. 2). The American bumble bee represented ~3% of all individuals and was only reported in 16 of the 55 ecoregions (Koch et al. 2015 p. 7). The remaining ecoregions that best support the American bumble bee are classified as critically endangered or endangered by the World Wildlife Fund (WWF) (Koch et al., 2015 p. 7).

We conducted our own analysis of the more than 519,000 bumble bee records databased by Leif Richardson and 378,000 records available on the Global Biodiversity Information Facility (GBIF) divided into two groups: historic observations (prior to 2002), and recent observations (all observations from 01/01/2002 to 6/18/2020) following the recent period described in the IUCN assessment. Richardson's database is generally considered to be the most comprehensive collection of *Bombus* records in the United States. Additionally, GBIF contains records from 74 separate institutions including notably: USDA-Agriculture Research Service, Biodiversity

Information Serving Our Nation (BISON) of the USGS, the University of Arkansas at Monticello, iNaturalist, and the US Museum of Natural History.

Our analysis shows that the American bumble bee has seen the largest drop in relative abundance of all bumble bees over the last 20 years declining from 10.6% to 4.3% of all bumble bees collected since 2002—a 60% relative decline (Richardson 2020) (See Figure 8 and Table 2 for a state-level breakdown). This drop is larger than the decline of the ESA listing candidate western bumble bee (*Bombus occidentalis* Greene) which has declined from 6.5% to 2.3% of all bumble bee records (GBIF).

The American bumble bee has declined across an area larger than the entire range of the rusty-patched bumble bee. Across 27 states, the rusty-patched bumble bee has declined by 90% in relative abundance (10.75% to 1.11%) (Richardson 2020), while across the same area the American bumble bee has declined 83% (10.06% to 1.68%) (Richardson 2020).

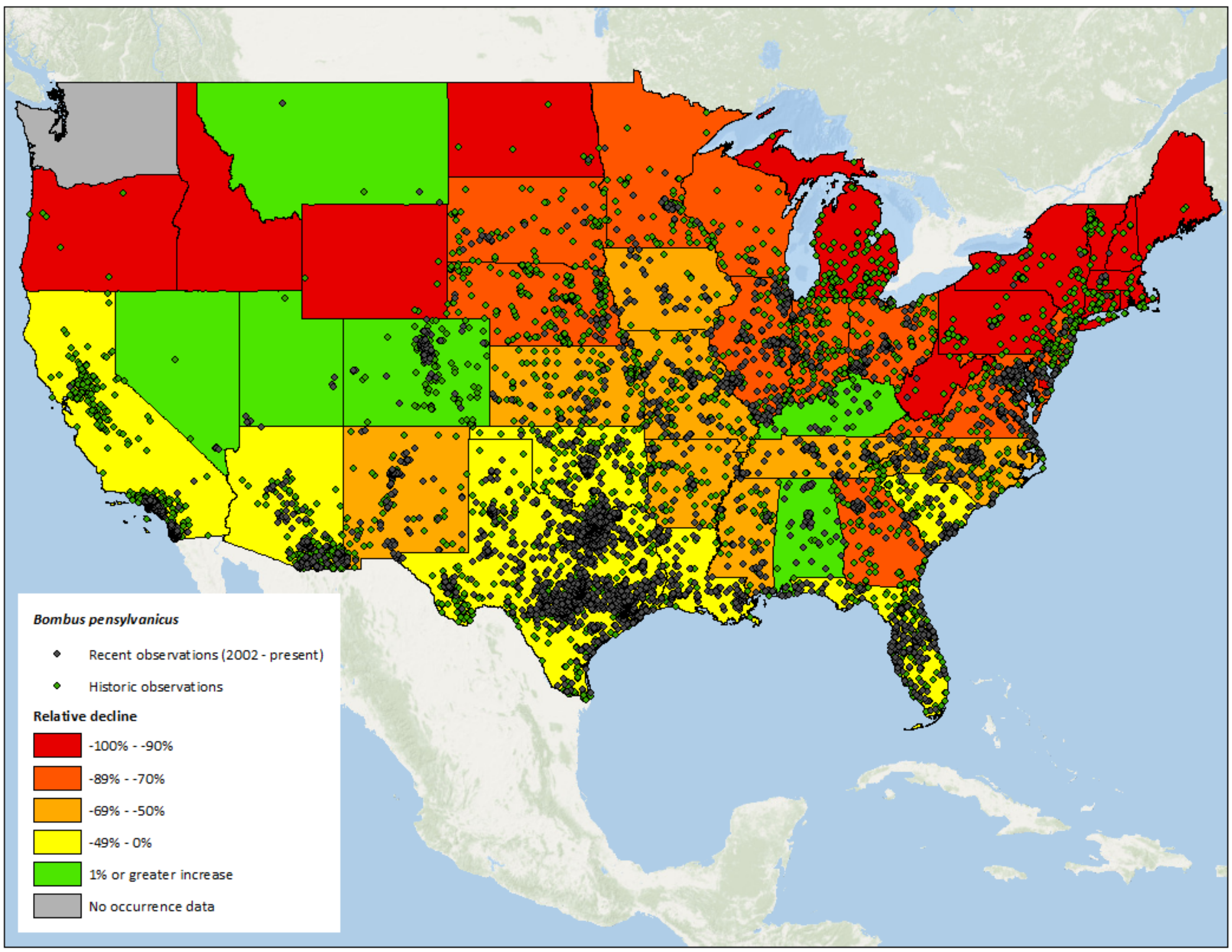


Figure 8. Decline in relative abundance of the American bumble bee with historic and recent observations. The change for each state represents the relative decline or gain of relative abundance from historic relative abundance to recent relative abundance. The recent period is 2002-2020.

The pattern of decline is clear, as the American bumble bee has become nearly extirpated in states throughout the northern part of its range and has severely declined in the western part of its range (Richardson 2020) (Table 2 and Figure 8). The American bumble bee has also seen declines in abundance across its range even in previous stronghold states in the Midwest and Southeast (Richardson 2020) (Table 2).

In addition to these national studies, other regional and statewide surveys and accounts, as presented below, have documented both reductions in the geographic range and declines in population abundance of the American bumble bee (See Table 3 for a list of published surveys from 2002 until 2019).

1. Northeast and Ontario, Canada

The northeastern states have seen the American bumble bee nearly disappear since 2002. Of the 13 states plus Ontario, six states have not had any observations of the American bumble bee in the last decade. The American bumble bee is endangered or critically endangered in every state in this region with relative declines >78% (Table 2). Due to its precipitous decline, ten states in this region have recognized the American bumble bee as a species of greatest conservation need. Recent survey information in specific areas is outlined for each state and summarized in Table 3.

Connecticut, Maine, Rhode Island, and Vermont

The American bumble bee was not historically abundant in these states (GBIF 2020). The American bumble bee has not been observed in these states since 2009 (GBIF 2020; Richardson 2020; USBombus). The Maine bumble bee atlas—a community science project—has failed to find the American bumble bee since the project began in 2010 (Maine bumble bee atlas 2020 p. 2).

Delaware

A long term monitoring project from the USDA Native Bee Inventory and Monitoring Lab compiled a database of 149 *Bombus* specimens caught in pan traps in Delaware from 2002-2016 and recorded one American bumble bee in 2007 which represents a relative abundance of 0.7% (Kammerer et al. 2020 supplemental data). Overall, the American bumble bee had declined from 16% of all bumble bees recorded (pre 2002) to 1.3% of bumble bees (2002-2020) with the last confirmed observation in 2007 (Richardson 2020).

New Hampshire

New Hampshire has reported low numbers of the American bumble bee historically representing <1% of all bumble bees, but the population there has collapsed with no recent observations (GBIF 2020; Richardson 2020). Jacobson *et al.* (2018 p. 439) collected a total of 3,333 bumble bee specimens from 16 bumble bee species over a 150-year period but only collected six American bumble bee specimens in New Hampshire (Jacobson *et al.* 2018, 442-43). The

American bumble bee was last seen in New Hampshire in 1975 (Richardson 2020; Jacobson et al. 2018, Supplemental Table 1) and none were observed during field surveys from 2014-2016 (Jacobson et al. 2018, Supplemental Table 1).

New Jersey

The American bumble bee historically made up 6.0% of all bumble bees in New Jersey (pre 2002), but recently (2002-2020) has only accounted for 0.9% of bumble bees observed in the state (Richardson 2020).

New York

In New York, the New York Department of Environmental Conservation published a synopsis of surveys in New York that stated the American bumble bee has "suffered catastrophic decline" of 99% with only a single observation since the year 2000 in Saratoga county in New York (N.Y. Dep't of Envtl. Conservation, 2018 p. 15). Surveys referenced in Cameron et al. (2011) and Koch et al. (2015) did not observe the American bumble bee in New York (USBombus). The relative abundance of the American bumble bee has decreased from 3.2% (pre 2002) to 0.1% (2002-2020) (Richardson 2020). A 2014 survey on Gardiner's Island in Suffolk County produced no records despite historic records from the area (Ascher et al. 2014 p. 59).

Maryland

In Maryland, the American bumble bee made up 16.4% of all bumble bee observations historically (pre 2002), but has declined to 2.8% (2002-2020) (Richardson 2020). A long term monitoring project from the USDA Native Bee Inventory and Monitoring Lab compiled a database of 1171 *Bombus* records caught in pan traps in Maryland from 2002-2016 and recorded 19 American bumble bees which represents a relative abundance of 1.6% (Kammerer et al. 2020 supplemental data).

Massachusetts

The American bumble bee was found in low numbers in Massachusetts historically (pre 2002) representing 2.7% of all bumble bees (Richardson 2020). The last observation of the American bumble bee in Massachusetts was in 2012 (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) did not find any American bumble bees in Massachusetts (USBombus).

Pennsylvania

In Pennsylvania, several counties were surveyed for bumble bee species as part of a larger national survey from 2007–2009, but surveyors did not record any American bumble bees (USBombus). The relative abundance of the American bumble bee has decreased from 7.6% (pre 2002) to 0.1% (2002-2020) (Richardson 2020).

Virginia
The American bumble bee has declined in relative abundance from 14.1% (pre 2002) to 3.1% (2002-2020) in Virginia (Richardson 2020). A community science survey along the Blue Ridge Parkway in Virginia did not record any American bumble bees (Hands on the Land.org 2015). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) did not find any American bumble bees in Virginia (USBombus).

West Virginia
The relative abundance of the American bumble bee was historically (pre 2002) less than in nearby Virginia (6.3%), but has been very seldom detected in recent times. There have been only three observations in West Virginia in the last 10 years (Richardson 2020). A survey in Kanawha county by Aliff and Collins in 2015 failed to record the American bumble bee (Collins 2020, personal correspondence).

Ontario, Canada
The Committee on the Status of Wildlife in Canada (COSWIC) assessment of the American bumble bee indicates that this bee has decreased in relative abundance from on average of 2% of all bumble bee observations prior to 1987 to 0.7% of all observations from 1987-2016 (COSWIC 2018 p. 24). Analysis by MacPhail et al. (2019) showed that the American bumble bee has decreased 89% in relative abundance and decreased 70% in range in Ontario and Quebec in Canada and they recommend this species for Critically Endangered status in Canada under the framework of the IUCN (MacPhail et al. 2019 p 603-604). Recent surveys have failed to find the American bumble bee in Algonquin Provincial Park (MacPhail et al. 2019 p. 599) or in three municipalities in the Niagara region of Ontario (Onuferko et al. 2015 p. 7-8).

2. Upper Midwest

The upper Midwest once supported the American bumble bee in large numbers but has seen serious losses of this iconic species. The American bumble bee was much more common in the midwestern states than in most northeastern states with an average relative abundance of 19% (pre 2002). Recent systematic surveys—summarized in Table 3—all reach the same conclusion that the American bumble bee has become extirpated or very rare in areas where it was once common. While the American bumble bee is potentially extirpated from two states (North Dakota and Michigan), awareness of its decline is lagging behind and only three states recognize it as a SGCN (see Table 2). The average relative abundance decline for the region is 78%.

Illinois
Multiple lines of evidence indicate that the American bumble bee in Illinois has seriously declined. Illinois has the best record of bumble bee population trends in the Midwest as published in Grixti *et al.* (2009). This study collected 3,500 bumble bee specimens at 56 sites in

Illinois across three-time periods and revealed that the American bumble bee was found in fewer areas and at lower abundance during the current period when compared to the historical time periods (Grixti *et al.*, 2009 p. 80). The American bumble bee accounted for 28.1% of all bumble bees sampled in Illinois from 1900–1949, but now represents only 4.4% of the current (2000–2007) bumble bee observations (Grixti *et al.*, 2009 p. 80). Furthermore, the study determined that the American bumble bee, which was once historically common throughout Illinois, was no longer found in northern Illinois (Grixti *et al.*, 2009 p. 80). Analysis of Richardson records for the American bumble bee show a similar decline in relative abundance from 23.3% (pre 2002) to 6.0% (2002-2020) (Richardson 2020). A study at Western Illinois University found only a single American bumble bee out of 110 bumble bees collected (Geroff 2014 p. 954). A survey of the Midewin National Tallgrass Prairie found the American bumble bee to be 2.5% of all bumble bees (Hughes 2018 p. 6). Additionally, a citizen science project out of the University of Illinois-Urbana-Champaign that has gathered bee observations across several midwestern states also verifies the lower relative abundance of the American bumble bee with their records showing that the American bumble bee represented only 4.5% of bumble bee observations from 2007 to 2019 (Bee Spotter 2019).

Indiana

Indiana, like Illinois, supported large numbers of the American bumble bee, but has seen a very large decline. The American bumble bee has declined from 20.8% of all historic bumble bee observations (pre 2002) to 4.9% of recent observations (2002-2020) (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) found a relative abundance of the American bumble bee of 0.5% (USBombus).

Iowa

The relative abundance of the American bumble bee in Iowa has declined from 23.6% (pre 2002) to10.8% (2002-2020) of observations (Richardson 2020). Surveys at the Neal Smith National Wildlife Refuge, and in parts of the Upper Mississippi National Wildlife Refuge in 2012 and 2013 detected the American bumble bee at relative abundance of 33% and 7% respectively (Arduser 2015 supplemental data). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) found the American bumble bee at relative abundance of 4.4% in Iowa (USBombus).

Kansas

The majority of bumble bees observed in Kansas were historically the American bumble bee but the state has seen a more than 50% decline in the relative abundance of the American bumble bee from 53.7% (pre 2002) to 25.4% (2002-2020) (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) observed the American bumble bee at a relative abundance of 24.7% (USBombus).

Michigan
Michigan hosted a moderate number of American bumble bees with nearly 9% of historical bumble bee records (pre 2002) (GBIF 2020), however their population has plummeted and there have been no observations in Michigan since the year 2000 (Richardson 2020).

Minnesota
The American bumble bee in Minnesota has declined from 1.7% (pre 2002) to 0.2% (2002-2020) of all bumble bee records (Richardson 2020). Citizen science efforts from iNaturalist and Bumble Bee Watch have produced 25 records of the American bumble bee since 2002 (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in Minnesota (USBombus). However, the American bumble bee persists in the Twin Cities metro area (Evans et al. 2019 p. 18). Surveys by the USFWS at the Litchfield Wetland Management District and the Glacial Ridge National Wildlife Refuge failed to detect the American bumble bee (Arduser 2015 supplemental data). Surveys of private conservation land referenced by Otto et al. (2020 supplemental data) found one American bumble bee in Minnesota.

Missouri
The American bumble bee in Missouri has declined by more than half according to Richardson records from 30.4% of all bumble bee records historically (pre 2002) to 13.5% of all bumble bees recently (2002-2020) (Richardson 2020). Surveys from 2012 and 2013 at the Big Muddy National Wildlife Refuge, Squaw Creek National Wildlife Refuge, and the Mingo National Wildlife Refuge recorded relative abundances of the American bumble bee of 16%, 33%, and 14%, respectively (Arduser 2015 supplemental data). Surveys during the same year failed to detect the American bumble bee at the Two Rivers National Wildlife Refuge (Arduser 2015 supplemental data). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) found the American bumble bee at 10.8% relative abundance (USBombus).

The American bumble bee has been consistently found in the St. Louis metro area (Camilo et al. 2017 p. 179).

Nebraska
In Nebraska, the decline in abundance of the American bumble bee has been similar to neighboring Missouri with a decline of about 70% from a historic (pre 2002) relative abundance of 28.3% to a recent (2002-2020) relative abundance of 8.2% according to our records (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) recorded the American bumble bee as 5.6% of all bumble bees recorded in Nebraska (USBombus).

North Dakota
In North Dakota, the American bumble bee has not been detected since 2000, and has declined from 2.7% (pre 2002) to 0.0% (2002-2020) of all bumble bee records (Richardson 2020). Surveys referenced by Cameron et al. (2011), Koch et al. (2015), and Otto et al. (2020) failed to find any American bumble bees in North Dakota (USBombus; Otto et al. 2020 supplemental data).

Ohio
In Ohio, according to survey data referenced by Cameron et al. (2011) and Koch et al. (2015) the population abundance of the American bumble bee was extremely low with only 1 out of the 250 bumble bee specimens documented was the American bumble bee (USBombus). Historically (pre 2002), the American bumble bee made up 12.8% of all bumble bee records (GBIF 2020).

South Dakota
The American bumble bee was quite common in South Dakota accounting for 18.7% of all bumble bee observations pre-2002, however this species has declined almost 16 percentage points to account for only 2.8% of all recent observations (2002-2020) (Richardson 2020). Surveys of private conservation land referenced by Otto et al. (2020 supplemental data) failed to find the American bumble bee in South Dakota.

Wisconsin
The state of Wisconsin has also seen a near collapse of the American bumble bee population. The relative abundance decreased from 2.0% (pre 2002) to 0.3% (2002-2020) relative abundance (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in Wisconsin (USBombus). A 2015 survey of Portage, Waushara, and Adama Counties failed to record any American bumble bees within vegetable crop agricultural areas in Central Wisconsin (Prince 2016 p. 93). Surveys by the USFWS at the Upper Mississippi National Wildlife Refuge—LaCrosse failed to produce any observations of the American bumble bee (Arduser 2015 supplemental data).

3. <u>Southeastern United States</u>

The southeastern United States was a stronghold for the American bumble bee, but many states have seen alarming declines. Despite the historic abundance of the American bumble bee in this region, only two states have not seen a decline in relative abundance since 2002 (Texas and Alabama). Declines in this region represent alarming declines in the number of bumble bees. For example, in Arkansas the American bumble bee has been reduced from three out of every five bumble bees to only one out of five which translates to a massive number of missing bumble bees on the landscape. A total of five states in this region have seen their amount of American bumble bees decrease by >50%. Only four states acknowledge the American bumble bee as a

SGCN (Table 2). Recent survey effort is outlined for each state as well as summarized in Table 3.

Alabama

Alabama has seen a modest increase in the relative abundance of the American bumble bee increasing from 14.8% (pre 2002) to 17.4% (2002-2020) (Ricahrdson 2020). However, surveys referenced by Cameron et al. (2011) and Koch et al. (2015) found only a 2.5% relative abundance (USBombus), indicating a need for additional study before a trend for Alabama can be determined.

Arkansas

The American bumble bee has declined in relative abundance and range in Arkansas. The best available records show a drop from 60.1% (pre 2002) to 20.0% in the recent period (2002-2020) (Richardson 2020). Tripodi and Szalanski (2015) compared current data (consisting of citizen science collections and field studies) to a 1965 survey to detect changes in bumble bee distributions throughout Arkansas and found that the American bumble bee has decreased by 39% in occurrence records (Tripodi and Szlanski 2015 p. 6). The number of occupied counties of the American bumble bee (50% contemporary period) is about one-third lower than its historic number of occupied counties (82% historic period) (Tripodi & Szalanski, 2015 p. 6). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) found a lower relative abundance of 3.2% in Arkansas (USBombus).

Florida

The American bumble bee was historically (pre 2002) a very common bee representing 42.8% of all bumble bee records (Richardson 2002). Recently, the relative abundance of this bee has declined to 36.9% of all bumble bees (2002-2020) (Richardson 2020).

Georgia

In Georgia, the American bumble bee had declined to nearly one-fourth of historic levels. Records show that the American bumble bee has declined from 42.8% of all bumble bee observations historically (pre 2002) to 10.8% of bumble bee observations recently (2002-2020) (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) did not find any American bumble bees in Georgia (USBombus).

Kentucky

The population trend data for Kentucky is conflicting, indicating a need for additional survey efforts. Analysis of GBIF and Richardson records indicate there has been an increase in the relative abundance of the American bumble bee increasing from 3.2% (pre 2002) to 11.3% (2002-2020) of the relative number of bumble bee observations (Richardson 2020). However, surveys referenced by Cameron et al. (2011) and Koch et al. (2015) contradict this increase in relative abundance finding a relative abundance of 2.4% (USBombus).

Louisiana

The American bumble bee has declined about 14 percentage points in Louisiana declining from 61.5% historically (pre 2002) to 47.7% recently (2002-2020) (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) found the American bumble bee to represent 79.3% of observed bumble bees (USBombus).

Mississippi

Mississippi as seen the American bumble bee decline by half in relative abundance from the majority of bumble bees at 54.0% (pre 2002) to 18.2% in the recent period (2002-2020) statewide (Richardson 2020). However, bee surveys of prairie remnants in Chickasaw, Oktibbeha and Lowndes County found the American bumble bee be common there (Smith et al. 2012 p. 45). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) found the American bumble bee to be relatively abundant representing 23.7% of observed bumble bees (USBombus).

North Carolina

The American bumble bee in North Carolina has declined from 17.3% historically (pre 2002) to 7.9% in the recent period (2002-2020) (GBIF 2020). The relative abundance in the recent period has been verified by surveys referenced by Cameron et al. (2011) and Koch et al. (2015) that found a 6.7% relative abundance of the American bumble bee (USBombus). A community science survey along the Blue Ridge Parkway in North Carolina did not record any American bumble bees (Hands on the Land.org 2015).

Oklahoma

A statewide analysis of historic and field survey records by Figueroa and Bergey (2015) shows that the American bumble bee continues to be the most common bumble bee species in Oklahoma at 76% relative abundance in their 2013 survey (Figueroa & Bergey 2015 p. 422). The relative abundance in their 2013 field survey is comparable to historic records which varied from 42% to 76% (Figueroa & Bergey 2015 p. 422). This relative abundance is comparable, but slightly higher than surveys referenced by Cameron et al. (2011) and Koch et al. (2015) which found the American bumble bee at 64% relative abundance (USBombus). However, analysis of Richardson records indicate a steep decline from 74.5% historically (pre 2002) to 55.9% recently (2002-2020) (Richardson 2020).

South Carolina

South Carolina has seen a modest decline in relative abundance declining from 29.5% (pre 2002) to 22.0% (2002-2020) (Richardson 2020). However, surveys referenced by Cameron et al.

(2011) and Koch et al. (2015) found a 2.3% relative abundance of the American bumble bee (USBombus).

Tennessee
In Tennessee, the relative abundance of the American bumble bee has declined by over half, from 25.9% of the historic observations (pre 2002) to 10.5% of observations (2002-2020) (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) found only a single American bumble bee and relative to other species it represents only 0.45% relative abundance (USBombus).

Texas
A comprehensive survey of bumble bee fauna in Texas by Beckham and Atkinson (2017)—which complied Texas bumble bee records from several museum collections, citizen science records, and targeted field surveys—reported a total of 3,010 observations or collections of the American bumble bee in Texas from 1897–2016 (Beckham and Atkinson, 2017 p. 15). The study revealed that the American bumble bee was common and widespread in Texas accounting for 84% of the Texas bumble bee specimens (Beckham and Atkinson, 2017 p. 10). The American bumble bee is most likely to be found in central and eastern Texas (Beckham and Atkinson, 2017 p. 10) which represent the areas of greatest conservation value. Richardson (2020) records show a slight dip in relative abundance from 88.7% (pre 2002) to 88.0% (2002-2020) in Texas, and surveys referenced by Cameron et al. (2011) and Koch et al. (2015) found the American bumble bee to represent 78.2% of observed bumble bees (USBombus).

4. <u>Western States</u>

The western U.S. has also seen declines, but with a greater variability than other regions. The American bumble bee was present historically in every western state except Washington with the largest populations in southern Arizona, New Mexico, and California. Recent surveys in the region are outlined for each state and summarized in Table 3. The American bumble bee is adaptable enough to inhabit open areas throughout the West, however, it has recently disappeared from states in the northwestern part of its range and has lost its entire range in California's central valley. States which previously hosted large numbers of the American bumble bee have all experienced significant declines between 40 and 50 percent including Arizona, New Mexico, and California. Yet, certain areas have seen an increase in the relative abundance including southern Nevada, southwestern Utah, and along Colorado's front-range. Variation in sampling effort is likely responsible for increases in the American bumble bee. States like Montana were not well surveyed historically, so they did not detect many individuals. Recent surveys and the contribution of community science efforts like BugGuide and iNatuaralist have contributed to finding more bumble bees recently especially around populated areas like St. George, Utah.

Arizona
Analysis of all bumble bee records on GBIF shows that the American bumble bee (*Bombus pensylvanicus* and *Bombus sonorus*) records are about 40% lower compared to historic observations. The relative abundance has decreased from 56.6% (pre 2002) to 33.2% (2002-2020) (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in Arizona (USBombus).

California
The 2014 IUCN report indicates that the American bumble bee's range historically extended throughout California, but in the past 20 years the range has contracted significantly from northern and central California (see Figure 6). In terms of relative abundance, the American bumble bee has decreased from 4.7% of all historic bumble bee observations (pre 2002) to 2.6% of all observations since 2002 (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in California (USBombus).

Colorado
The American bumble bee remains present in Colorado at low numbers with a slight increase in relative number of observations from 2.8% historically (pre 2002) to 5.4% since 2002 (Richardson 2020). Colorado's front range continues to support the American bumble bee in Boulder County (Kearns et al. 2017 p. 68) and in 15 counties throughout the state over the past 10 years (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in Colorado (USBombus).

Idaho and Oregon
Historically, there have been very few observations of the American bumble bee in these states, with 2 and 10 observations in Idaho and Oregon respectively (Richardson 2020; GBIF 2020). The American bumble bee has not been observed in Oregon or Idaho in the last 50 years (Best 2020 pers comm.; Xerces Bumble Bee Atlas 2020). Surveys in prairie areas in eastern Washington and western Idaho failed to detect the American bumble bee (Rhoades et al. 2017 p. 15). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in these states (USBombus).

Montana
Montana is on the northern edge of the American bumble bee's range. It has only two historic observations (pre 2002) in the state (Richardson 2020). Dolan *et al.* (2017) completed the first statewide bee survey for Montana and analyzed 12,000 historic and current records and found five total and four recent records of the American bumble bee in four counties of Montana (Dolan *et al.*, 2017 p. 7). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in Montana (USBombus).

Nevada

Nevada has 16 historic observations (pre 2002) of the American bumble bee representing 0.6% of all bumble bees (Richardson 2020). There have only been a handful of recent observations (2002-2020) in Clark County, Nevada provided through iNaturalist and Bug Guide that represent 0.8% of all bumble bee observations in Nevada (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in Nevada (USBombus).

New Mexico

The American bumble bee was less common historically in New Mexico than in Arizona representing 15.6% of all bumble bees (pre 2002), but the relative abundance of the American bumble bee has declined by half to 7.8% (2002-2020) (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in New Mexico (USBombus).

Utah

The state of Utah has one historic observation of the American bumble bee from 1906 (Richardson 2020), but thanks to community science initiatives like iNaturalist, Bumble bee Watch, and Bug Guide we know that the American bumble bee is still present in Utah (Richardson 2020; GBIF 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in Utah (USBombus).

Wyoming

There are 11 records of the American bumble bee in Wyoming and the last observation was made in 1997 (Richardson 2020). Surveys referenced by Cameron et al. (2011) and Koch et al. (2015) failed to find any American bumble bees in Wyoming (USBombus).

Table 3. Recent survey effort (2012-2020) for *Bombus pensylvanicus*.

Author	State	Extent	Number of Observations	Relative Bumble Bee Abundance
Northeast and Ontario Canada				
Maine Bumble Bee Atlas 2020	Maine	Statewide	0 records	0%
Selfridge et al. 2017	Maryland	Worchester County, 30 forested dune study sites	2 records	10%

Kammerer et al. 2020	Maryland, Delaware, District of Columbia	Statewide	19 records in Maryland 1 record in Delaware	1.6% Maryland 0.1% Delaware
Jacobson et al. 2018	New Hampshire	Statewide	0 records	0%
Ascher et al. 2014	New York	Gardiner's Island, Suffolk County	0 records	0%
Nardone 2013	Ontario	Algonquin Park	0 records	0%
Onuferko et al. 2015	Ontario	Cities of St. Catharines, Port Colborne, and Wainfleet	0 records	0%
Hands on the Land.org 2015	Virginia and North Carolina	Blue Ridge Parkway	0 records	0%
Aliff and Collins 2016 (Collins personal communication)	West Virginia	Kanawha County	0 records	0%
Upper Midwest				
Hughes 2018	Illinois	Midewin National Tallgrass Prairie	20 records	2.5%
Geroff et al. 2014	Illinois	Western Illinois University, Life Science Station	1 record	<1%
Evans et al. 2019	Minnesota	Twin Cities Metro Area	28 records	2%
Camilo et al. 2017	Missouri	St. Louis	Consistently found in three locations	Not provided
Otto et al. 2020	Minnesota, North Dakota, South Dakota	Private CRP and EQIP land	1 record	2.8%
Prince 2016	Wisconsin	Portage, Waushara, and Adama Counties	0 records	0%

Arduser 2015	Iowa, Illinois, Minnesota, Missouri, Wisconsin	Nine National Wildlife Refuges	Present at 5 National Wildlife Refuges 44 records	9.4%
Bee Spotter 2007-2019	Illinois, Iowa, Indiana, Ohio, Missouri, Virginia, Michigan, Wisconsin, Maryland	Statewide	224 records	4.6%
South East				
Tripodi and Szalanski 2015	Arkansas	Statewide	Present in 18 counties	Not provided, but present in only 50% of historic counties
Smith et al. 2012	Mississippi	Black belt prairie in Chickasaw, Oktibbeha and Lowndes County	640 records	Not provided
Figeroa and Bergey 2015	Oklahoma	Statewide	205 records	76%
Beckham and Atkinson 2017	Texas	Statewide	3010 records	84%
Western States				
Kearns et al. 2017	Colorado	Boulder County	57 records	Not provided
Dolan et al. 2017	Montana	Statewide	5 records in 4 counties	<1%
Oregon Bee Atlas 2018-2019 (Lincoln Best personal communication)	Oregon	Statewide	0 records	0%
Rhoades et al. 2017	Washington and Idaho	Palouse Prairie sites (~3600km^2)	0 records	0%
PNW BBA Xerces	Washington, Oregon, Idaho	Statewide	0 records	0%

VIII. Current and Potential Threats

A. The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

Landscape changes that destroy or modify the presence of diverse flora, nesting, and overwintering sites are detrimental to the survival of American bumble bee. Habitat loss is the number one driver of insect declines worldwide (Sánchez-Bayo & Wyckhuys 2019 p. 19). The American bumble bee has lost habitat through the destruction and modification of habitat by intensive agriculture, livestock grazing, and widespread pesticide use that limits access to floral resources, lowers floral richness, and limits nesting sites across its range (Szabo et al. 2012 p. 236, Grixti et a. 2009 p. 81, Goulson 2010 pp. 181–186). Diminished habitat quality contributes to the decline of the American bumble bee.

The American bumble bee relies on open farmland and field habitat (Williams et al. 2014 p. 149) that is often degraded. Open-field habitat has seen an enormous disturbance over 150 years of westward expansion in America by European settlers. It is not practical to outline the changes to the many possible habitat types for the American bumble bee, but present, substantial threats to current open-field habitat remain across the country. Temperate grasslands make up a large portion of American bumble bee habitat, but they are among the least protected and most impacted of all biomes where habitat conversion exceeds habitat protection by a factor of 10 to 1 (Hoekstra et al. 2005 p. 25). Temperate grasslands including native prairie ecosystems have declined by up to 99.9% (Samson and Knopf 1994 p. 418; Noss et al. 1995 Appendix A and B). Native, biodiversity-rich grasslands, that are not destroyed completely are often replaced with open-fields that consist primarily of introduced grasses or monoculture forage crops that are generally less suitable to bumble bees (Black et al. 2011 p. 9). Urban land expansion is also expected to more than double in area by 2050 (Nowak and Walton 2005 p. 385; Huang et al. 2019 p. 3) and is a threat to open-field land when farmland or semi-natural areas are replaced with roads or other uses that diminish floral and nesting resources. These are just some of the broad scale changes that presently threaten open, field habitat for the American bumble bee.

Human-caused disturbance decrease native floral diversity and decrease nesting habitat throughout the American bumble bee's range (Goulson 2010 pp. 181–186; Hines and Hendrix 2005 p. 1481). The American bumble bee requires forage and adequate nesting habitat during its entire lifecycle to raise their colonies and overwinter (see species biology section). Bumble bee colonies that are food limited simply grow less, especially when the limitation is in the early spring. Inadequate nutrition significantly affects and survival of queen bumble bees and is most important in the first few days as emerged adults in the late summer as well as in the early spring post-diapause (Woodard et al. 2019 p. 6-7). Food limitation also reduces the number of males produced (Rotheray et al. 2017 p. 18). Fragmentation of nesting and floral resources by human-caused disturbances impacts bumble bee abundance and species richness across a landscape

(Hatfield and LeBuhn 2007 p. 155; Hines and Hendrix 2005 p. 1481). Habitat fragmentation creates isolated patches of suitable habitat surrounded by large areas of unsuitable habitat that constrain bumble bee colonies (Darvill et al. 2006 pp. 608-609). Bumble bees struggle to utilize isolated feeding and nesting areas which negatively impacts their population dynamics (see threat section D.2).

Land-use change continues to fragment and degrade habitat for the American bumble bee. Specific threats from agricultural intensification, livestock, and pesticide use are outlined in more detail below.

1. Agricultural Intensification

Modern, intensive agriculture has accelerated the fragmentation and degradation of habitat for the American bumble bee and many other species (Schweitzer et al. 2012 pp. 7-8). The transition to intensive agriculture has led to vast monoculture crop systems that rely on much higher inputs of fertilizer and pesticide (Goulson 2020 p. 1). The increased reliance on pesticide—and accompanying diminished floral resources—have a demonstrable negative relationship to populations of the American bumble bee (Szabo et al. 2012 p. 236). Expanding agriculture takes away floral resources that are essential to this species' survival because more than anything else floral resources are the most important factor affecting the presence of the American bumble bee (Liczner and Colla 2020 p. 6).

Agricultural intensification has reduced the amount of floral and nesting resources for the American bumble bee. When florally diverse prairies and meadows are destroyed on a large scale, bumble bees lose the floral resources they need to have adequate nutrition and calories throughout the entire growing season (Goulson 2010 p. 182-184). Removing flowering plants from the landscape reduces bumble bee colony growth and the number of reproductives, especially when the limitation is in the early spring (Rotheray et al. 2017 p. 18). Food limitation in the early spring and in the fall have significant consequences for the establishment of new queens (Woodard et al. 2019 p. 6-7). Common bumble bees rely on the grassy strips at field boundaries, forest edges, and along roadsides (Hines and Hendrix 2005 p. 1483). Bringing back pollinator habitat with hedgerows, roadside plantings, and wildflower strips are effective for once common species like the American bumble bee (Kleijn et al. 2015 p. 4).

Changes in agricultural practices and continued expansion occurred primarily between 1940 and 1960 and contributed to broad declines in bumble bee richness (Grixti et al. 2009 p. 81). Historic records show that the American bumble bee survived the initial settlement and conversion of land to agriculture in the United States (before 1940) (Grixti et al. 2009 p. 79, Jacobson et al. 2018 p. 437, Hatfield et al. 2014 p. 4) because it does not rely on biologically intact prairie or grassland (Grixti et al. 2009 p. 81; Williams et al. 2014 p. 149). However, many farmers in the great plains continue to plow prairie and grassland at a rate of four football fields per minute to expand the production of primarily corn, soy, wheat (WWF 2020 p. 1).

2. Livestock Grazing

Livestock production has intensified in recent decades which puts more pressure on landscapes, directly and indirectly harming the American bumble bee and other native pollinators. Between 1982 and 2015 the United States lost ~23.5 million acres of land for grazing (USDA 2018a p. 3-46), primarily to crop production and development, yet beef production increased from 39.7 million pounds in 1988 to 44.8 million pounds in 2019 (USDA 2020a p. 1). All cows begin their lives on pasture, and America is producing more meat on fewer acres, which has led to soil erosion, loss of biologic integrity, invasive species, and general degradation (Fleishner 1994 p. 631; Belsky and Gelbard 2000 entire). Open habitat suitable for grazing livestock can also be quite suitable habitat for the American bumble bee, but this land continues to become more degraded around the country (USDA 2018b pp. 4-5).

Several areas around the country that previously supported the American bumble bee have been hit hard by habitat loss and degradation. The states of Rhode Island, New York, New Jersey, and Maine have all lost between 33% and 50% of their pasturelands and now have very few or no recent observations of the American bumble bee (USDA 2018b Table 2;Richardson 2020). Illinois—lost 30% of its pastureland—and Michigan—lost 25% of its pastureland—both have seen large declines in the American bumble bee (USDA 2018b Table 2; Richardson 2020). The California Central Valley does not have any observations of the American bumble bee since 2002, but previously supported populations in large areas of perennial grasslands that are now gone (USDA 2018b Table 2; Richardson 2020). New Mexico now has the greatest proportion of rangeland with moderate to severe erosion and moderate to severe loss of biological integrity (USDA 2018b p. 18) and has also lost 50% of their American bumble bee relative abundance (Richardson 2020).

Degradation of grassland resources is known to harm bees. Overstocking and heavy grazing, especially during the spring and summer, reduces the amount of floral resources and degrades grassland habitat for bumble bees (Goulson 2010 p. 210-211). Domestic grazing animals can harm bumble bees by trampling soil, removing floral resources, and degrading bumble bee habitat (Hatfield & LeBuhn 2007 p. 153, 156; Yoshihara et al. 2008 p. 2384) which can lead to a linear decline in bee abundance and richness (Yoshihara et al. 2008 p. 2384; Tadey 2015 p. 455; Lázaro et al. 2016 p. 408). Grazing livestock have considerable, adverse effects on grassland ecosystems by altering plant species composition and reducing flowering forb species diversity (Fleischner 1994 p. 631; Black et al. 2011 p. 10). In addition, grazing animals cause soil compaction which negatively affects the American bumble bee's ability to find shelter in abandoned rodent holes or develop new nest sites that are not at risk of being trampled (Black *et* *al.*, 2011 p. 10; Bueno et al. 2012 p. 5, 6; Kimoto et al. 2012 p. 7, 8). Pastures and fields consistently cut short for hay also severely affects the survival of surface nests (Williams & Osborne, 2009 p. 372).

3. Pesticide Use

Pesticides have direct, indirect, and cumulative effects on bumble bees that forage in and around areas of intensive agriculture, in landscaping, in pesticide treated forests and rangelands, along roadsides and other rights of way, and in a wide array of other areas. Pesticide use has been cited as a major contributor to the decline in bumble bee populations across North America and Europe (Goulson et al., 2008 p. 194-195; Cameron and Sadd 2019 p. 2). The threats outlined below are a small overview of the potential harms to the American bumble bee from pesticide exposure. The increased use of pesticides in agricultural and urban settings expose bumble bees to a pesticide "cocktail" that includes fungicides, herbicides, and insecticides whose synergistic effects EPA does not consider in its pesticide regulatory process, but which independent studies have shown create more potent toxic effects (Goulson *et al.*, 2015 p. 1). These experimental chemical cocktails, found in most non-protected landscapes, contaminate pollen, wax, brood, and adult honey bees with as many as 120 different pesticides (Mullin *et al.*, 2010 p. 3). As many as 60% of bumble bees have detectable levels of at least one pesticide (Botias et al. 2017 p. 7). There is still much to be learned about pesticide synergistic effects, however as an example, we do know that when commonly used ergosterol biosynthesis inhibitor fungicides are mixed with other commonly used neonicotinoids and pyrethroids, the toxicity of the mix is increased 1,000-fold (Goulson *et al.*, 2015 p. 6). These mixtures are absolutely ubiquitous throughout managed landscapes in the U.S.

Bumble bee exposure to pesticide occurs in a variety of ways including: direct contact with spray drift, orally when residues are present in ingested nectar or pollen, and through contact with contaminated soil (Fisher and Moriarty 2014 p. 53-54). Nectar uptake is likely the main source of exposure and poses the largest threat because bumble bees consume large quantities of nectar and pesticides accumulate in high concentrations in nectar (Goulson *et al.*, 2008 p. 194). Bumble bees are also exposed to pesticides via the soil from treated seeds and surface applications that contaminate bumble bee underground nests and overwintering sites (Hopwood et al. 2016 pp. 14-15). Pesticide contamination can also occur through water sources on and around plants that bees rely on during foraging (Lu et al, 2020 p. 4). Pesticide exposure during the spring is especially harmful when colonies are small and queens are foraging (Goulson *et al.*, 2008 p. 194).

Herbicide

The American bumble bee is losing essential flower forage in agricultural areas because of the overuse of herbicides like glyphosate and dicamba. Herbicide use has massively increased over the past 20 years as a result of the widespread planting of genetically-engineered, herbicide-resistant corn and soybeans in the Corn Belt region of the United States and to planting of genetically-engineered cotton in California (Malcolm 2018 p. 282). The Corn Belt states historically hosted an abundance of the American bumble bee; but after the nearly ubiquitous adoption of glyphosate-resistant "Roundup Ready" corn and soybeans, there has been a precipitous decline of common milkweed and many other common flowering weeds (Pleasants and Oberhauser 2013 p. 136). Monsanto introduced Roundup Ready soybeans in 1996 and Roundup Ready corn in 1998, and by 2020, genetically-engineered herbicide-resistant varieties comprised 94 percent of soybeans,79 percent of corn, and 83 percent cotton grown in the United States (USDA 2020 entire). Glyphosate is not only being applied to vastly more acres than ever before, it is being applied more intensively to the acres that are treated with it. Between 1995, the year before Roundup Ready soybeans were introduced, and 2013 total glyphosate use on corn and soybeans rose from 10 million to 204 million pounds per year—a 20-fold increase (USGS 2017 p. 3). Roundup Ready crops have also shifted the application period later into the growing season which destroys a wider range of flowering weeds that the American bumble bee depends upon.

The overall loss of floral resources caused by this explosion of herbicide use for the American bumble bee is staggering. We know that for the common milkweed, it is estimated that in Iowa cropland alone lost 98.7 percent of its milkweed from 1999 to 2012 (Malcolm 2018 p. 283). In just the 11 years from 1999 to 2010, it is estimated there was a 58% percent decline in overall milkweed in the Midwest, most of which was from croplands (Pleasants and Oberhauser 2013 p. 139). Common milkweed is an umbrella species for other plants that occupy fields and agricultural land. The decline of the milkweed and other pollinator host plants caused by increased herbicide use has dire implications for the monarch butterfly and the American bumble bee.

American bumble bee habitat is further threatened by heavy use of herbicides on newer herbicide-resistant crops that are genetically engineered to be resistant to multiple herbicides including 2,4-D, dicamba, or glufosinate, that are mixed with glyphosate to be even more effective at killing all plants except the desired commodity crop. These relatively new genetically engineered crops will lead to sharply increased herbicide use and the continued elimination of field-margin plants from cropland. Dicamba is notoriously drift-prone moving far beyond the boundaries of crop fields to affect wild plants growing nearby. The scale of off-target movement of dicamba has the potential to degrade habitat on a level that has not been seen since glyphosate use began to explode 20 years ago. Plants that exist in the margins between agricultural fields are some of the only sources of biodiversity in the sea of crop monocultures that extend across much of the Midwest. This plant diversity is absolutely necessary to sustain animal populations that need nectar, pollen and food throughout the year in these regions. Dicamba levels far below those estimated to be contained in particle and vapor drift are known to reduce plant diversity (Egan et al. 2014 p. 80). Similarly, drift-level rates of dicamba were found to reduce flowering of multiple plants, a reduction that scientists have found coincides with reduced visitation by pollinators (Bohnenblust et al. 2016 p. 147). The American bumble bee will continue to decline in an environment sterilized of plants that are vital to its survival.

Fungicide

Many commonly used fungicides used in agriculture cause serious sublethal harm to the American bumble bee. Fungicides interfere with a bee's microbiome and cellular processes which impact their overall health and immune system that increase the disease risk from the microsporidian *Nosema spp*. (see threats section C.2). Exposure to fungicide has been shown to correlate with higher pathogen loads (Pettis et al. 2013 p. 4), and in particular, chlorothalonil usage was the strongest predictor of *Nosema* infection among declining bumble bees in the United States, including the American bumble bee (McArt et al. 2017 p. 6). Chlorothalonil and triazole fungicides inhibit compounds and enzymes in honey bees that detoxify compounds within the cell and downregulate genes involved in producing energy in the mitochondria (Mao et al. 2017 p. 5). These fungicides reduce a bee's ability to extract energy from pollen and nectar and reduce the ability to detoxify its body resulting in a build-up of toxic compounds that weaken the bee (Mao et al. 2017 p. 5) making them more susceptible to infection.

Fungicides are ubiquitous in agricultural settings and at least 40 compounds have been found in honey (Sanchez-Bayo and Goka 2014 p. 5). Commonly used fungicides have been found in the great majority (88%) of bumble bees in a farmland survey (Botias et al. 2017 p. 7). The use of one popular fungicide chlorothalonil—that is banned in the European Union (Carrington 2020 p. 1)—ranges from 8-12 million pounds per year across the US which is more pounds of active ingredient than all five of the most popular neonicotinoid insecticides combined (USGS 2017).

While fungicides are not acutely toxic to bumble bees, mixtures of fungicides and certain pyrethroids and neonicotinoids are known to have acute synergistic effects (Pilling and Jepson 1993 p. 296; Raimets et al. 2018 p. 543) by greatly increasing the toxicity of the insecticide. Colonies exposed to fungicides like chlorothalonil have fewer workers, less biomass, and smaller queens (Bernauer et al. 2015 p. 481) and fungicides kill beneficial fungi that are naturally present in nectar and pollen. Even when fungicides are sprayed prior to bloom, the nectar and pollen of flowering crops like almonds have reduced fungal richness which can have consequences for the natural fermentation of pollen provisions—"bee bread"—including increasing fungal infections like chalk brood in honey bees (Yoder et al. 2013 p. 596).

Insecticides

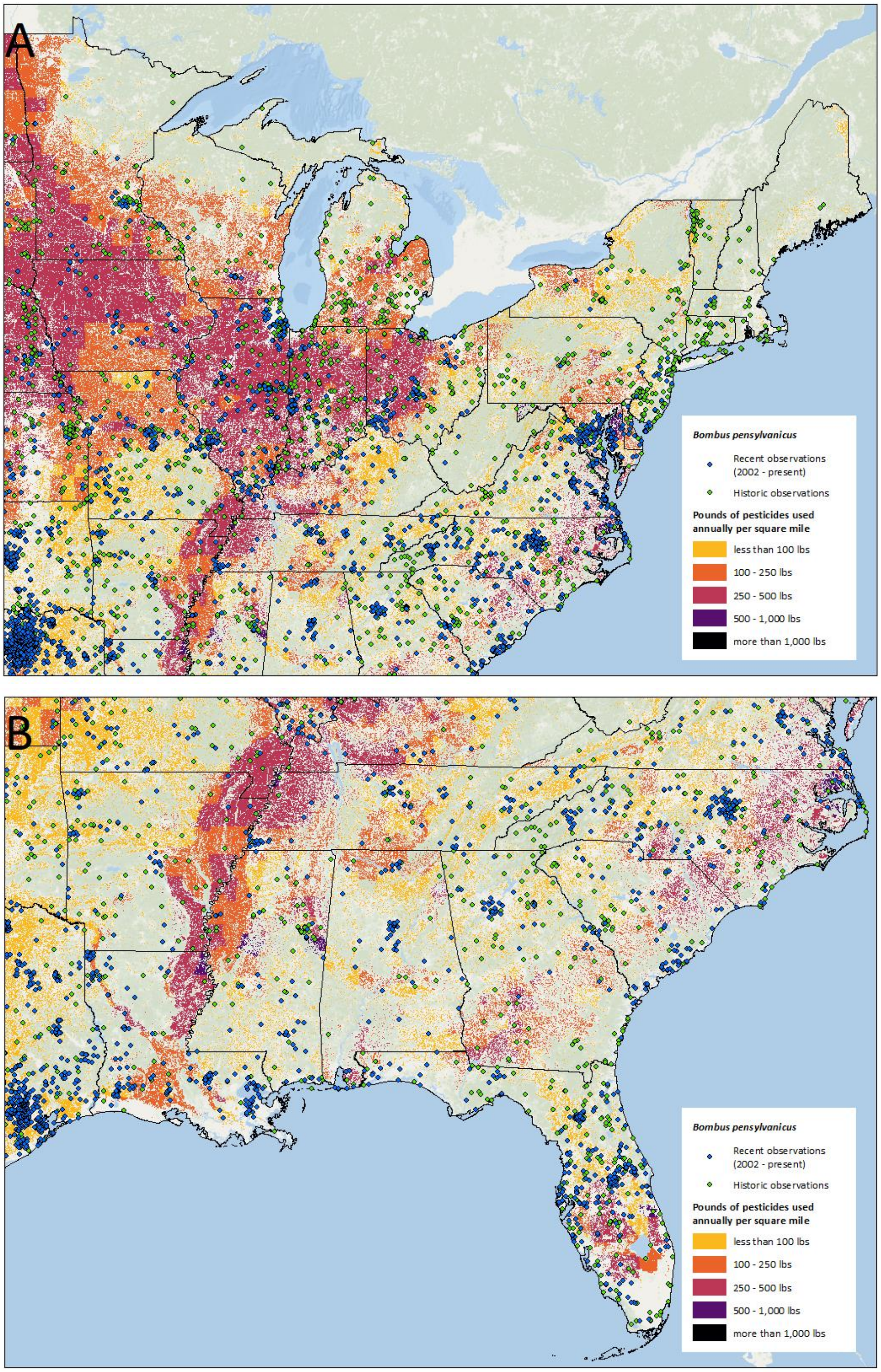
Insecticides threaten the American bumble bee because they are acutely toxic and also persist in the environment resulting in chronic, low dose exposure. The most commonly used class of insecticides in America (and globally) are neonicotinoids (Simon-Delso et al. 2015 pp. 8-11) which are a group of synthetically produced, systematic pesticides that are strongly implicated in bumble bee declines (Goulson *et al.*, 2015 p. 5). Since 2009, more than 90% of neonicotinoid literature has shown direct or indirect harms to bees associated with sub-lethal exposure to neonicotinoids (Lu et al., 2018 p. 12). Neonicotinoids are used on at least 140 different crops (Simon-Delso et al. 2015 p 8) on over half of the cropland in the United States (DiBartolomeis et al. 2019 p. 7).

The American bumble bee inhabits open farmland and fields (Williams et al. 2014 p. 149) across its entire range that are near where neonicotinoids are used on a variety of crops (Figure 9). The largest potential non-seed coating use of neonicotinoids are on the top crops in the country: corn, soy, cotton, and wheat (Dibartolomeis et al. 2019 p. 7). The largest corn and soy producing states are in the Midwest (USDA 2020b Table 1-36) where the American bumble bee was once abundant, but now has seriously declined (Richardson 2020). Several states are known for their production of specialty orchard, vineyard, and vegetable crops which rely on the most popular neonicotinoid—imidacloprid—to control their pests (USGS 2020 p. 3). The production of apple crops in New York (USDA 2019a p. 1) and Michigan (USDA 2019b p. 1), pecans in Georgia (USDA 2019c p. 1), and almonds and grapes in California (USDA 2019d p. 3) all involve large amounts of insecticides being released into the environment, contaminating the nectar and pollen from the fruit trees and surrounding pollen and nectar sources. The states that have seen some of the largest declines in the American bumble bee within the past 20 years are the same states that have seen the largest increases in quantified neonicotinoid use (Richardson 2020; USGS 2020 p. 3).

Neonicotinoid use has increased significantly since 2014 and represent the largest contribution to toxic loading for bees in the landscape (DiBartolomeis et al. 2019 p. 11). The fastest growing and most worrisome use of neonicotinoids is as prophylactic seed treatment, which greatly increases the toxic loading in the soil (DiBartolomeis et al. 2019 p. 4). Neonicotinoids have long half-lives of up multiple years, are water soluble, travel in soil, and systemically distributed in plant tissue and thus are found in soil and non-crop plants within non-agricultural environments (Wood & Goulson 2017 pp. 17291–17300; Bredeson & Lundgren 2019 pp. 4–5). Neonicotinoids are applied on over half of the cropland in the U.S., including on cotton, wheat, soybeans, corn, and alfalfa (DiBartolomeis et al. 2019 p. 7). Despite fewer pounds of pesticide being applied the toxic loading in the environment has markedly increased with the popularity of neonicotinoids because they are more potent insecticides and are being applied over a larger area especially as seed treatment (DiBartolomeis et al. 2019 p. 19). The EPA refuses to regulate pesticides used as seed treatments (Hitaj et al. 2020 p. 395).

Even with some countries banning or phasing out neonicotinoids, in July 2019, the EPA granted new approvals for the relatively new neonicotinoid sulfoxaflor to be used on a massive scale on ornamental plants and crops that are highly attractive to pollinators (U.S. EPA 2019 p. 2). Sulfoxaflor in nectar at field-realistic concentrations was recently found to reduce survival and impair foraging (Boff et al. 2021 p. 3).

Neonicotinoid insecticides adversely affect all members of a bumble bee colony, especially reproductive members. At sub-lethal levels, neonicotinoids impair reproduction: for example thiamethoxam impairs ovary development in bumble bees (Baron et al. 2017 p. 4) and imidacloprid causes reductions in both reproductive success and production of reproductive females (Whitehorn et al. 2012 pp. 1–2; Raine 2018 p. 1; Wu-Smart & Spivak 2018, 2018 pp. 4–5). In addition to reproductive consequences, neonicotinoids impair normal functioning of colonies making them less social, less able to learn and remember (Siviter et al. 2018 p. 5), can reduce their foraging motivation (Lämsä et al. 2018 p. 4), and reduce foraging efficiency (Feltham et al. 2014 p. 9). Impacts to workers reduce the foraging potential of the colony and therefore the queen cannot produce as many new reproductive females.


A
Bombus pensylvanicus
Recent observations (2002 - present)
Historic observations
Pounds of pesticides used annually per square mile
less than 100 lbs
100 - 250 lbs
250 - 500 lbs
500 - 1,000 lbs
more than 1,000 lbs
B
Bombus pensylvanicus
Recent observations (2002 - present)
Historic observations
Pounds of pesticides used annually per square mile
less than 100 lbs
100 - 250 lbs
250 - 500 lbs
500 - 1,000 lbs
more than 1,000 lbs

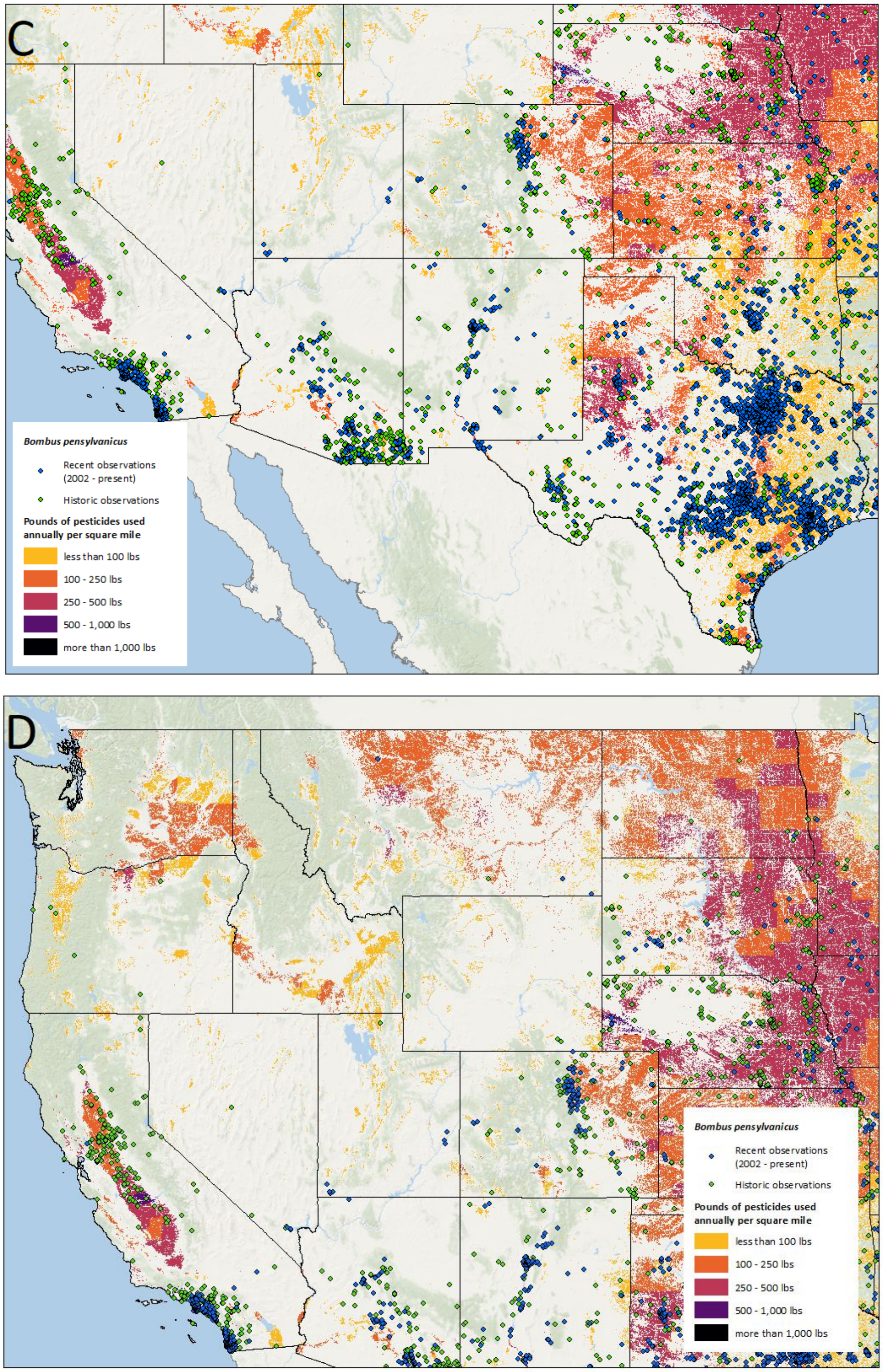


Figure 9. Historic and recent observations of the American bumble bee and pounds of pesticide applied annually per square mile throughout the United States. Maps correspond to broad quadrants of the United States: northeast (A), southeast (B), southwest (C), and northwest (D). Pesticide usage data from USGS Pesticide National Synthesis Project. Observation data from Richardson 2020.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Common bumble bees like the American bumble bee provide some of the most pollination service value for crops—potentially as much as $390 per acre (Kleijn et al. 2015 p. 2). Given the abundance and range of the American bumble bee, there can be no doubt that American bumble bees around the country contribute substantially to the pollination of crops which directly impact local economies. Bumble bees carry greater amounts of pollen than honey bees, so their visitation to crop flowers is more productive per visit (Reilly et al. 2020 p. 4) and they are capable of "buzz" pollination (De Luca & Vallejo-Marrı́n, 2013 p. 2) that produces greater production in certain crops like tomatoes. Several crops are frequently pollination limited across the country including apples, cherries, and blueberries (Reilly et al. 2020 p. 4). Apples, especially, need pollination by a diverse and abundant pollinator community to have the optimal fruit production (Grab et al. 19 p. 3). The loss of the American bumble bee in states like Michigan and Pennsylvania may be driving down the number of pollinators to these crops.

The American bumble bee face multiple perils while visiting these crops, including contamination with pesticides, disease transmission on shared flowers, and suffer impacts from poor nutrition which may be detrimental to populations a whole (see threats section A.2). As agricultural operations intensify there is less room for bumble bees to find adequate forage and undisturbed nesting areas. Through the combination of habitat loss, fragmentation, disease exposure, and poisoning with chemicals, these under-valued workers are being harmed and exploited for economic gain.

C. Declines Due to Disease or Predation

1. Pathogen Spillover Generally

Pathogen spillover from domesticated bees is a major contributing factor to the declines of bumble bees (Cameron & Sadd 2019 pp. 10.9-10.11), and no government at any level has taken meaningful action to address this treat, despite the fact that it was known early on that the transport of domesticated bees could quickly introduce new diseases and parasites that could negatively affect wild bumble bee populations (Daszak *et al.*, 2000 p. 446). The American bumble bee's decline started around the year 2000 (Figure 5) which coincides with rapid increases in the use of domesticated bumble bees (primarily *Bombus impatiens*) to pollinate crops in greenhouses and for outdoor crops (Velthius and Vandoorn 2006 p. 429) as well as an explosion in the use of neonicotinoid insecticides which weaken bumble bee's ability to fight infection (see threat section A.3). Domesticated bumble bees have only been widely used for crop pollination since the late 1990s and early 2000s (Velthius and Vandoorn 2006 p. 429), but their use is expected to continue to increase (*see* e.g. Velthius and Vandoorn 2006 p. 433) because the demand for greenhouse pollination service is increasing, with the greenhouse area under production for tomatoes increasing by almost 50% from 2007-2017 and the area under production for other vegetables increasing 75% from 2002-2017 (USDA AgStats 2020). Commercially raised bumble bees often have high levels of infection and have been shown to spread parasites to wild bumble bees outside greenhouses (Colla et al. 2006 pp. 463-465; Graystock et al. 2013 p. 1210). Szabo et al. (2012, p.235) demonstrated that the rising use of domesticated bumble bees correlated with the decline of the American bumble bee and showed a tight connection, even more demonstrable than other causes of decline such as pesticide use and habitat destruction. The Northeast and the upper Midwest have seen the greatest increase in the number of farms using greenhouses that require bumble bees for pollination (Figure 10) and these areas have also seen the greatest declines of the American bumble bee (Figure 7).

The American bumble bee is particularly vulnerable to the spread of pathogens because they have lower genetic diversity relative to other bumble bees, which limits the natural variation in the species that would provide immunity to diseases (Lozier 2011 p. 4883-4884). Surveys of north American bumble bees showed that 15.2% of American bumble bees sampled were infected with the microparasite *Nosema bombi* which is a higher rate compared to North American bumble bee species with stable populations (Cameron et al. 2011 p. 664). American bumble bee specimens from museums had very low rates of infection of *N. bombi* before 1980 and significantly higher rates of infection in specimens from after the late 1990s (Cameron et al. 2016 p. 4387). The combination of lower genetic diversity and increasing spread of parasites presents a major threat to the American bumble bee which is not adequately addressed by current laws governing the inter-state movement of domesticated bumble bees (see threat section E.2).

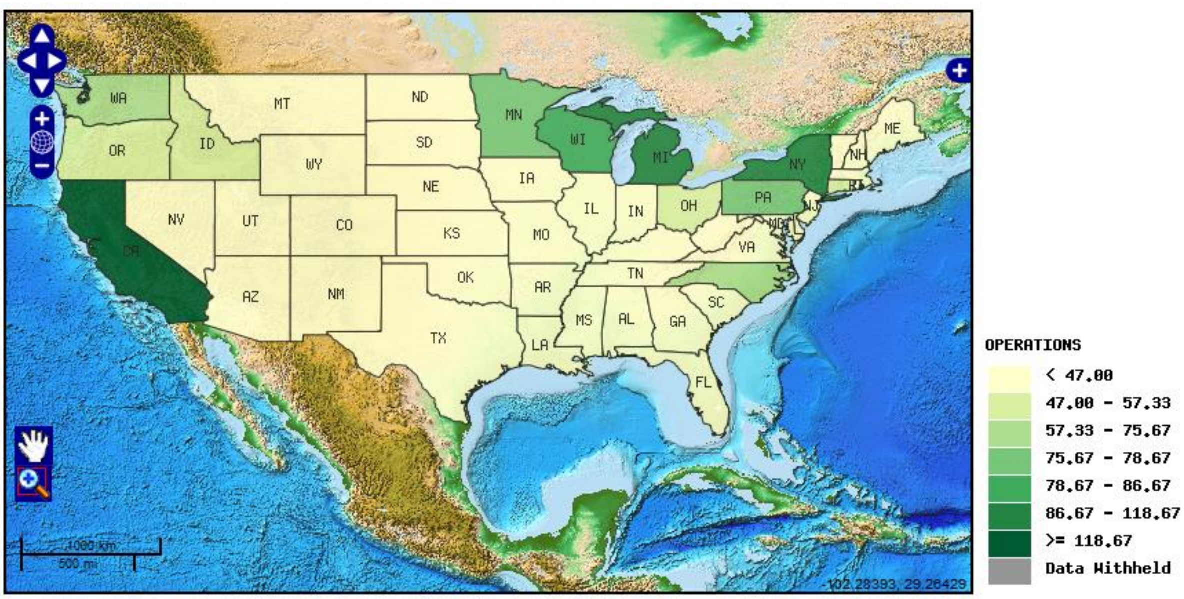


Figure 10. Number of operations growing vegetables (excluding tomatoes) under greenhouse protection based on 2017 data from USDA National Agriculture Statistics Service.

2. <u>Nosema bombi and ceranae</u>

The microsporidians *Nosema bombi* and *N. ceranae* contribute significantly to the American bumble bee population decline by spreading from domesticated colonies (Szabo et al. 2012 p. 235). *Nosema sp*. are parasites related to fungi that spread through the release of highly resistant, long-lived spores in feces (Otti and Schmid-Hempel 2007 p. 119). *N. bombi* replicates within the midgut of the bee by infecting and damaging cells and then is excreted in the hive or onto flowers (Otti and Schmid-Hempel 2007 p. 119). Contaminated feces from commercially reared bumble bees and infected wild bees are spread onto flowers that are visited by non-infected wild bumble bee populations (Szabo et al. 2012 p. 232; Colla et al. 2006 p. 465).

Both *N. bombi* and *N. carinae* infect bumble bees and spillover from honey bees and domesticated bumble bees, negatively impacting wild colony growth, immune function, and reproduction (Furst et al. 2014 pp. 3-4; Graystock et al. 2013a p. 1212; Graystock et al. 2016 p. 68). *N. bombi* is known to infect North American bumble bees prior to the introduction of domesticated colonies and causes lowers colony-level fitness in lab and field experiments by reducing the number of reproductive members and the number of workers (Otti and Schmid-Hempel 2008 p. 579). It is likely that *N. bombi* spilled over into domesticated colonies which then facilitated the spread of *N. bombi* to other wild bumble bees because of their transportation and propagation (Graystock et al. 2016 p. 69). On the other hand, *N. ceranae* is a parasite of the Asian honey bee (*Apis ceranae*) that infects the European honey bee (*Apis mellifera*) and is known to spillover from honey bees to wild bumble bees wherever there are European honey bees nearby (Graystock et al. 2016 p. 68). *N. ceranae* reduces bumblebee survival with additional sub-lethal effects on behavior (Graystock et al. 2013b p. 116-117). The spillover of both of these parasites is made worse because of the movement of domesticated bumble bee colonies around the country and their potential to contaminate flowers that are shared with wild bumble bees.

D. Other Natural or Manmade Factors Affecting the American Bumble Bee

1. <u>Climate Change</u>

Global climate change poses a major indirect threat to the American bumble bee's environment (Cameron and Sadd 2019 pp. 10.8-9). Human activities have increased global average temperatures 0.8-1.2°C above pre-industrial levels with a trend of about 0.2°C per decade due to past and current emissions (Intergovernmental Panel on Climate Change 2018 p. 4). At current emissions rates, global temperatures will increase by 1.5°C between 2030-2052, resulting in increased incidence of severe weather events and loss of ecosystem services (Intergovernmental Panel on Climate Change 2018 pp. 4-5). Average temperatures have already risen across the American bumble bee's range and temperatures have increased more in areas where this bee has declined including the northern great plains, the midwestern, northeastern, and southwestern parts of the country; these areas have seen increases of 1.69 F, 1.26F, 1.43F, and 1.61F, respectively (Vose et al. 2017 p. 3).

Bumble bees have evolved to fly and forage at lower temperatures than other bees and are found at higher latitudes and altitudes (Heinrich 1972 p. 185). However, above 24℃, bumble bees lose the ability to maintain a stable body temperature (Heinrich 1972 p. 186) and they are unable to fly if their thorax temperature exceeds 42-44℃ (Goulson 2010 p. 17). A reduction in the length of time bumble bees can fly results in fewer foraging trips and thus fewer resources to rear large colonies. Consequently, bumble bees have been extirpated from areas with extreme temperatures, independent of land use in some cases (Kerr et al. 2015 p. 179; Soroye et al. 2020 p. 687).

Global climate change's impact on temperature is threatening the American bumble bee's range and plant resources. Increasing temperature and more variable precipitation affects the plant resources the American bumble bee relies on for food and habitat (Cameron and Sadd 2019 p. 19.9). Due to climate change-related temporal shifts in flowering or phenological patterns of these plants, the American bumble bee's phenology may become mismatched with certain plants and lead to gaps in the availability of food resources (Schweiger et al. 2010 p. 779). Climate change can also reduce the quality of nectar resources for bumble bees which can reduce longevity (Hoover *et al.*, 2012 p. 14).

Disruptive range shifts are also possible as a result of climate change at the northern and southern extents of the American bumble bees range (Cameron and Sadd 2019 p. 10.8). For example, the southern portion of North American bumble bee's ranges are shrinking due to rising temperatures (Kerr *et al.*, 2015 p. 178). However, a proportional shift northward to remain within the preferred temperature range is not occurring and is leading to a "range compression" of North American's bumble bees (Kerr *et al.*, 2015 p. 178; Soroye et al. 2020 p. 687). The American bumble bee is a good example of a species experiencing range compression based on populations losses throughout the entire northern part of its range (Figure 8). The American bumble bee is not moving northward to keep up with climate change which means it is more vulnerable to increasing temperature and subsequent adverse effects to floral resources.

2. Loss of Genetic Diversity and the Production of Diploid Males

The American bumble bee has been shown to have lower genetic diversity compared to other bumble bees (Lozier and Cameron 2009 p. 1882) and its population decline puts it at risk of losing more genetic diversity due to small population size which will have serious consequences for the future of the species (Darvill *et al.* 2006 p. 602). Genetic study of American bumble bees in Illinois showed that the American bumble bee has experienced significant genetic change and a consistent decline in genetic diversity (Lozier & Cameron 2009. p. 1882). As a consequence of a declining population American bumble bee, populations have become increasingly isolated over the last four decades in its historical range (Lozier & Cameron 2009 p. 1881). Indeed, bumble bee populations that are in decline exhibit a loss of genetic diversity and gene flow over time, while stable populations are less likely to show such changes (Lozier et al. 2011 p. 4883). As more American bumble bees become further isolated, the less likely it is that the current populations will be able to recover from current threats.

Declining genetic diversity can have the effect of accelerating population decline via the "diploid male extinction vortex" (Grozinger and Zayed 2020 p. 278). Bumble bees are uniquely vulnerable to the loss of genetic diversity because their sex is determined by a genotype at a single loci (Zayed 2009 p. 239). This genetic phenomenon is called haplodiploidy and a single loci sex determination in which haploid males (single set of chromosomes) develop from unfertilized eggs while diploid (two sets of chromosomes) females develop from fertilized eggs (Zayed & Packer 2005 p. 239). This sex determination system in small populations with limited gene flow makes the American bumble bee particularly susceptible to inbreeding depression and is a major threat to population viability (Zayed 2009 p. 244). Small and inbred populations can produce sterile diploid males when females fertilize eggs with sperm that has the same allele at the sex-determination locus (Zayed 2009 p. 239). In addition, females fertilize eggs to produce females and thus waste reproductive effort when males are inadvertently produced, leading to increased male biased sex ratio and further reduced population sizes, creating a positive feedback loop that ultimately leads to extinction (Zayed & Packer 2005 pp. 10744–10745; Zayed 2009 pp. 239, 241). The production of diploid males in haplodiploid bees can increase extinction risk by 50-63%, an order of magnitude higher than extinction risk caused by inbreeding alone, making diploid male production a unique and serious threat to the American bumble bee (Zayed & Packer 2005 pp. 10744–10745).

3. Non-native honey bees and exploitative competition

The honey bee (*Apis mellifera*) harms native bees and the American bumble bee by direct competition and transmitting disease (Mallinger et al. 2017 pp. 24-25). Honey bee competition affects native bees by depleting pollen and nectar (Torne-Noguera et al. 2016 p. 14), reducing fecundity (Paini and Roberts 2005 pp. 107-108), enhancing parasitism (Goodell 2003 p. 13), floral host preemption (Roubik and Villanueva-Gutierrez 2009 p. 156), reducing foraging success (Henry and Rodet 2018 p. 2), and pathogen spillover (Furst et al. 2014 pp. 3-4). As a prime example, the western bumble bee, which has declined by >90% (Graves et al. 2020 p. 7) had lower foraging success and reduced reproductive success when near honey bee hives (Thomson 2004 p. 463-464). Honey bees have a negative competitive effect on bumble bees specifically and result in lowered reproductive success (Thomson 2004 pp. 463–464), changes in bumble bee foraging behavior (Elbgami et al. 2014 p. 508), lowered average bumble bee body size (Goulson & Sparrow 2009 pp. 7–8), and causing pathogen spillover (Furst et al. 2014 pp. 3-4).

Honey bee colonies contain thousands of individuals and are able to outcompete native bees for nectar and pollen resources on the landscape because they are active for longer and have the ability to recruit nest mates to floral resources (Cane and Tepedino 2016 p. 206). A single honey bee colony can consume 44lbs (20kg) of pollen and nectar over the course of a foraging season (June to August) (Cane & Tepedino 2016 p. 206). A small 40 hive commercial apiary removes enough nectar and pollen from an area (June to August) that could provision 4,000,000 native bees (Cane & Tepedino 2016 p. 207).

The upper Midwest, where the American bumble bee has seen a disastrous decline (Table 2), hosts more than 40% of the honey bee hives in the country and is considered by beekeepers to be "America's last beekeeping refuge" because it provides valuable summer pasture with high-quality grasslands and large amounts of conservation areas like Conservation Reserve Program (CRP) lands where pesticides can still be an issue but are not as significant of a problem (USGS 2019 p. 1). North Dakota and South Dakota are the largest honey producing states in the country (USGS 2019 p. 2) and the American bumble bee may be extirpated from North Dakota and there has been a serious decline in South Dakota (Richardson 2020).

The USGS conducted the largest survey of grasslands in the upper Midwest to evaluate forage for honey bees and they found that honey bees far outnumbered native bees on conservation lands (Otto et al. 2020 p. 17). Otto et al. (2020 pp. 15-17) surveyed more than 1300 transects on private lands enrolled in CRP and Environmental Quality Incentives Program (EQIP) in Minnesota, North Dakota, and South Dakota in 2015-2017 and observed 1,740 honey bees, but only 175 native bees including a mere 36 bumble bees. The American bumble bee was not present in North Dakota or South Dakota and made up only one of the observations in Minnesota (Otto et al. 2020 supplemental data). This survey shows that honey bee competition for floral resources depresses the number of native bees in places that are intended to be reserves for wildlife.

Honey bee hives on public land also represent a significant threat to bumble bees and other native bees. The USFS permits apiaries across every forest region in the country, which increases competition for resources, enhances disease spread, and jeopardizes the reproduction of native plants (Grand Canyon Trust et al. 2020 entire). In response to this threat to native bees and plants, the Center and others have recently petitioned the USFS to reexamine the permitting of honey bee hives on public land (Grand Canyon Trust et al. 2020 p. 1-3). Permitting honey bee hives does not represent a minor use for national forest and other public land and should require environmental assessments like other uses. In the Colorado Plateau, permits of honey bees on national forest land could place as many as 56.8 million bees which present major competition for limited floral resources (Grand Canyon Trust et al. 2020 p. 3). Public lands represent a small portion of the American bumble bee’s range, but permitting large numbers of hives on public land reduces resources and increases disease risk for the American bumble bee.

4. Synergistic Threats

The combination of threats from disease, pesticides, habitat loss, and climate change enhance the extinction risk from any single threat for the American bumble bee (Brown et al. 2000 p. 425; Fauser-Misslin et al. 2014 pp. 453–455; Goulson et al. 2015a p. 6). It is highly unlikely that any one threat has acted to precipitate the decline of the American bumble bee, rather a combination of factors creates conditions that amplify impacts. For the American bumble bee, habitat loss reduces nutrition which is necessary to support healthy colonies (Hatfield et al. 2015 p. 5), and a monotonous diet can weaken a bumble bee’s immune system which can make it more susceptible to disease (Brown et al. 2000 p. 425; Castelli et al. 2020 p. 5). Lack of nutrition also compromises bumble bees’ ability to fight off and survive infections and, in turn, infected bumble bees themselves require increased nutrition which takes resources away from colony growth and reproduction (USFWS 2018 p. 66). It is also likely that the American bumble bee’s preferred climate and habitat, may interact with nectar and pollen availability to make the populations at the edge of their distribution more vulnerable to declines (Williams 2005 p. 40). Slight changes from a warming climate and changes in floral availability may make parts of the species range unsuitable.

Environmental toxins also act together with habitat loss to decrease colony growth and promote disease. For example, neonicotinoids are well known to impair a bee’s ability to find floral resources (Goulson et al. 2015 p. 5) greatly increasing the chance of colony failure or limiting reproduction. The fungicide chlorothalnil is also the strongest predictor of *N. bombi* occurrence and total fungicide use was the best predictor of range loss of the American bumble bee (McArt et al. 2017 p. 6).

Thus, the threats of habitat loss, pathogens, and pesticides together require that American bumble bees have access to more, quality habitat to combat these threats and recover. Protecting the American bumble bee from these synergistic threats requires the power of protection under the Endangered Species Act and designation of critical habitat.

E. Existing Regulatory Mechanisms are Inadequate

Existing federal, state, and local regulatory mechanisms are inadequate to protect against the threats the American bumble bee faces, which include habitat destruction and modification, disease, climate change and the use of pesticides. Listing the American bumble bee under the Endangered Species Act is the only adequate regulatory mechanism available to protect the American bumble bee.

The Center submitted a Freedom of Information Act (FOIA) request to the FWS in 2019 (received Jan. 2020) to attain documents relevant to regulations or actions FWS has taken that could benefit the American bumble bee. The documents contained emails, reports, and some survey data relevant to the American bumble bee. Records revealed that FWS had access to substantial observational data and research regarding the status of the American bumble bee, but to date produced no targeted monitoring programs, regulations, or conservation activities with the stated goal of addressing the decline of this species. FWS had access to Dr. Richardson's database of bumble bee observations—the same database that we use in this petition. This data is in addition to bumble bee observations from Midwest refuges from 2012 and 2013. FWS was aware that the American bumble bee had declined in many states and had been named a species of greatest conservation concern in several states and was a covered species under the New England Working Lands for Wildlife Program. Overall, this FOIA response confirmed that there are no existing regulatory mechanisms adequate to protect the American bumble bee from its myriad threats. All documents obtained in this FOIA request will be included in the supplemental files for this petition.

Other grassland insect species are protected under the ESA within the range of the American bumble bee, but they protect only a fraction of the range of the American bumble bee. Other species whose protection may incidentally provide some protection are wide-ranging grassland species of bees and butterflies including: the rusty patched bumble bee (*Bombus affinis*), the Dakota skipper (*Hesperia dakotae*), the Poweshiek skipperling (*Oarisma poweshiek*), and the Karner blue (*Lycaeides melissa samuelis*). The Dakota skipper and Poweshiek skipperling exist only in native prairie remnants which cover very small areas throughout their former range (FWS 2014 p. 63717), so the protections offered by these species protects very little habitat overall for the American bumble bee which is able to survive in agricultural and urban areas in the upper Midwest. The Karner Blue butterfly has a large historic range across the upper Midwest and into the northeast, however the remnant oak savannah and pine barren habitat with its host lupine is highly fragmented and degraded (FWS 2003 p. 1) and represents a very narrow portion of the possible habitat that would be suitable for the American bumble bee. These butterfly listings together would not provide protection across the wide range of the American bumble bee.

The rusty-patched bumble bee is another wide ranging, generalist bumble bee, but its protected status provides inadequate protection across the vast range of the American bumble bee. The rusty-patched bumble bee's historic range does overlap with areas where the American bumble bee is declining in the upper Midwest and northeast. However, the rusty-patched bumble bee has been denied designated critical habitat and has declined to relatively very few populations that are spread sporadically across 41 counties which represents only 11% of historically occupied counties (FWS 2016 p. 35). Therefore, the rusty-patched bumble bee's currently limited, sporadic distribution does not provide significant overlap with the larger range of the American bumble bee. FWS has described areas of high and low habitat potential for the rusty-patched bumble bee (FWS 2020 p. 1) and only 246 (188 low potential and 58 high potential) of the 9,038 recent observations of the American bumble bee are located within rusty-patched bumble bee potential habitat (Clauser 2020). The protections for the rusty-patched bumble bee offer limited habitat protections without critical habitat designation, but they also fail to address other threats. EPA has not consulted with the FWS on pesticide registrations that would harm this bee, and in terms of addressing disease, the current draft recovery plan for the rusty-patched bumble bee states that "…disease epidemic prevention plans…may be used…" but does not describe in any detail the nature of these plans or how they would be implemented (FWS 2019 p. 7). The ESA protections for the rusty-patched bumble bee are therefore nowhere near sufficient to protect the American bumble bee even within the historic range of the rusty-patched bumble bee.

Besides federally-listed species, many states have a state endangered species act that could serve to protect the American bumble bee, yet despite its decline, the American bumble bee is not formally protected by any state endangered species act as a threatened or endangered species. Indeed, several states do not include insects under their state endangered species act. State threatened and endangered species are listed in state wildlife action plans (SWAP) and each state must complete one to qualify for federal funding toward species conservation. SWAPs are non-regulatory documents that provide information on species status and outline the conservation goals of the state. States are not required by law to carry out what is outlined in them and they are generally not detailed enough to provide specific actions that the state will take for a species. Additionally, the status of "species of greatest conservation need" (SGCN) does not have regulatory status like "threatened" or "endangered" status under any state endangered species act. The American bumble bee is regarded as a SGCN by 18 states (Table 2). The American bumble bee is not mentioned in SWAPs for several states where it has dramatically declined (Table 2). State level designations are therefore insufficient to protect the American bumble bee.

As an example, the American bumble bee is currently on the SWAP for both New Jersey and New York where it is a SGCN (NJ DEP 2018 p. 28; NY DEC 2015 p. 4). The SWAPs for New Jersey and New York address habitat destruction of multiple bee species by focusing on acquiring development easements or fee titles to prevent habitat loss, monitoring habitat species loss, and facilitating individual recovery plans for habitat (NJ DEP 2018 p. Appendix 1-5; NY DEC 2015 p. 55). However, neither SWAP has a specific recovery plan for the American bumble bee. Acquisitions of property interests such as covenants do not constitute a regulatory program, and there is currently no way to measure the effectiveness of private property acquisition in the recovery of the species.

It should be noted that any *voluntary* measures taken to promote pollinator habitat throughout the United States are inadequate to address the threats across the range of the American bumble bee. To the extent that any voluntary, i.e. non-regulatory, mechanisms exist to protect the American bumble bee, FWS cannot rely on voluntary measures to deny listing of species. Voluntary and unenforceable conservation efforts are simply *per se* insufficient as "regulatory mechanisms" under 16 U.S.C. 1533(a)(1)(d):

> [T]he Secretary may not rely on plans for future actions to reduce threats and protect a species as a basis for deciding that listing is not currently warranted . . . . For the same reason that the Secretary may not rely on future actions, he should not be able to rely on unenforceable efforts. Absent some method of enforcing compliance, protection of a species can never be assured. Voluntary actions, like those planned in the future, are necessarily speculative . . . . Therefore, voluntary or future conservation efforts by a state should be given no weight in the listing decision (*Oregon Natural Resources Council v. Daley*, 6 F. Supp.2d 1139, 1154-155 (D. Or. 1998).

1. There are no Regulatory Mechanisms to Protect Against Habitat Destruction

Several state and federal regulations have the stated purpose of properly managing and protecting habitat for wildlife, but there are currently none that directly address the American bumble bee or a similar species across the entire range of the American bumble bee.

The most comprehensive database of American bumble bee observations available indicates that the American bumble bee survives almost entirely on privately-held lands that offer no regulatory conservation mechanisms for this bee. Only about 4% of all recent observations (395 out of 9038 observations) of the American bumble bee have been on public land (Clauser 2020). It is clear that the American bumble bee does not rely on the protections offered by public lands. The broad range of the American bumble bee requires broad protections that are provided by the ESA that extend inside and outside federally owned land.

National Forest Management Act

Congress enacted the National Forest Management Act of 1976 ("NFMA") to reform Forest Service management of national forest system lands (16 U.S.C. § 1600 et seq). The NFMA requires that the Forest Service implement a Land and Resource Management Plan ("LRMP") for each national forest. The LRMP must include land allocations, desired conditions, objectives, and standards and guidelines with which site-specific projects must comply. In addition, among NFMA's substantive requirements is the duty to provide for the diversity of plant and animal communities (16 U.S.C. § 1604(g)(3)(B)).

The NFMA regulations require species viability, but do not prohibit the Forest Service from carrying out actions that harm species or their habitat, stating only that "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area" (36 C.F.R. § 219.19). This regulation is inadequate for the conservation of the American bumble bee because it does not require the responsible agency to support the persistence of all species, including invertebrates. The American bumble bee has recently been found in 31 National Forests primarily in the Southern half of the United States with recent observations also in Virginia, Indiana, Colorado, Illinois, and Ohio (Clauser 2020). With National Forest land throughout the American bumble bee's range, the USFS has an opportunity to protect large areas of habitat, but NFMA discounts the importance of this pollinator and provides no protection.

National Environmental Policy Act

The National Environmental Policy Act ("NEPA") is triggered when a Federal action is taken that may have impacts on the human and natural environment. (42 U.S.C. § 4231 et seq). NEPA requires Federal agencies to consider the effects of their actions on the environment through the utilization of environmental assessments and environmental impact statements. These analyses must disclose any adverse impacts to the environment including impacts to sensitive species. However, the law only requires agencies to disclose the impacts of their actions to the public; it does not prohibit agencies from choosing to undertake actions that will cause environmental harm.

Categorical exclusions under NEPA are routinely deployed to facilitate the placement of apiaries on National Forests and Bureau of Land Management (BLM) lands. (For Forest Service, see 36 C.F.R. § 220.6(d)(8)(ii) and 36 C.F.R. § 220.6(e)(3), for BLM, 516 DM 11.9E(19) and 516 DM 11.9E(9)). NEPA does preclude the use of categorical exclusions where there are "extraordinary circumstances," such as presence of an endangered species or designated critical habitat (36 CFR § 220.6). Without the protection of the ESA and concurrent designation of critical habitat, categorical exclusions may continue to be used to place apiaries on federal public lands.

Federal Land Policy and Management Act

The Federal Land Policy and Management Act (FLPMA) regulates the management of public lands administered by the Bureau of Land Management (BLM); specifically the "management, protection, development, and enhancement of public lands" with the intention to "…preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife…" (43 U.S.C. § 102). The American bumble bee has been found on BLM administered land in Arizona, California, New Mexico, Utah, as well as in the Agua Fria National Monument, Kelso Dunes Wilderness, and La Cienega National Conservation Area. Lands administered under FLPMA had <1% of all recent observations of the American bumble bee (Clauser 2020). Additionally, the American bumble bee has not been designated as a "sensitive species" by the BLM. FLMPA does not provide adequate regulatory mechanisms to protect the American bumble bee.

The Wilderness Act

The Wilderness Act of 1964 established the National Wilderness Preservation System and identified four federal agencies responsible for protecting wilderness areas. The Wilderness Act allows for the designation of protected wilderness areas on public land to "…retain its primeval character and influence, without permanent improvements or human habitation…" (16 USC §§ 1131). Wilderness areas offer safe haven for many species, however, they do not provide specific regulatory mechanisms for protecting the American bumble bee. Currently designated wilderness areas do not constitute a significant fraction of the range of the American bumble bee. The American bumble bee has been found in seven National Wilderness Areas in Arizona, California, and Florida (Clauser 2020). The American bumble bee has historically been found in human modified agricultural land throughout the country and the protections offered by designated wilderness offer negligible benefit to this species.

2. There are no Adequate Regulatory Mechanisms to Protect Against Disease Threats

Domesticated bumble bees present a current, significant threat to the American bumble bee where they are currently used in greenhouses and open field settings to provide crop pollination services (see threat section C.1). Greenhouse bumble bees can be contained with adequate screened vents and netted entrances, but few producers employ adequate mitigation measures to contain domesticated bumble bees and there are no nationwide efforts to promote netting of greenhouses (Evans 2017 p. 39). When used outdoors there is no way to mitigate against the risk of pathogen spillover from domesticated bumble bees (Evans 2017 p. 39). Even though domesticated bumble bees are effective pollinators of outdoor crops, the use of domesticated bumble bees for outdoor pollination of crops does not have well documented benefits compared to relying on wild bumble bees (Evans 2017 p. 39).

Once domesticated bumble bees have entered the country, there are effectively no regulations regarding these colonies. The American bumble bee is not protected against disease threats, such as parasites like the varroa mite and *N. bombi*. Currently, regulations do not require that bumble bees transported across state lines or regions be free from diseases like *N. bombi* and other parasites (Xerces Soc'y for Invertebrate Conservation, 2013 p. 18). The Xerces Society et al. petitioned the Animal and Plant Health Inspection Service (APHIS) in 2010 to regulate the transport of commercial bumble bees, but the agency has thus far not taken action to regulate bumble bee transport (Xerces Soc'y for Invertebrate Conservation, 2013 p. 18). Only Oregon restricts the importation of bumble bees to only those native to the state (Oregon Department of Agriculture 2017 p. 1). Thus, the risk from managed bumble bees is not addressed in any substantial way by state or federal regulations throughout the range of the American bumble bee.

The USDA currently regulates the importation of bees from outside the United States and allows two species of bumble bee to be imported from Canada: the common eastern bumble bee (*Bombus impatiens*) and the western bumble bee (*Bombus occidentalis*) (7 C.F.R. § 322.5, 2018). The USDA does not, however, require that these bees be tested for pathogens upon importation; therefore, the threat to the wild populations of the American bumble bee from pathogen spillover remains. Reducing pathogen spread from commercial bumble bees to wild populations through pathogen screening, preventing bumble bees from leaving greenhouses, and restricting the use of commercial bumble bees in open fields are essential to control the effects of pathogens that are negatively impacting the American bumble bee (Szabo *et al.*, 2012 p. 235).

Unfortunately, honey bees are mostly regulated at the state level, but regulations on the transportation and inspection of honey bee hives for disease and other threats are inconsistent across states (Mailander and Grant 2019 p. 36,40). Three states (Arizona, Minnesota, and Kansas) effectively have no laws regulating honey bees (Mailander and Grant 2019 Appendix A). Hive registration is required in only 25 states and three states have exemptions for "hobby" beekeeping—having less than five hives (Mailander and Grant 2019 Appendix A). Hive inspections are an important way to contain the spread of disease, but only two states (Delaware and Florida) require annual hive inspections (Mailander and Grant 2019 Appendix A). Most states require certification that their hives are disease-free to be moved or imported into another state, but 11 states do not require inspection or certification when crossing-state lines (Mailander and Grant 2019 Appendix A).

There are no regulatory mechanisms adequate to protect the American bumble bee from disease threat. Listing the American bumble bee under the ESA is the only way to ensure that it can get the protection it needs to dodge extinction.

3. There are no Regulatory Mechanisms to Protect Against Pesticide Threats

Current regulatory mechanisms to protect bumble bees against pesticide threats are ineffective. The U.S. Environmental Protection Agency (EPA) licenses the sale and use of all pesticides under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA, 7 U.S.C. § 136 et seq). FIFRA directs EPA to register a pesticide only upon determining that "when used in accordance with widespread and commonly recognized practice it will not generally cause unreasonable adverse effects on the environment" (7 U.S.C § 136a(c)(5)(D)). The EPA conducts a cost-benefit analysis in undergoing this assessment and the use of this method has continued to allow numerous bee-toxic pesticides to be used, including on bee attractive crops, throughout the nation. Further, the EPA evaluates the risk of pesticides to bees by using honey bees as a surrogate for all native bees. Bumble bee physiology, behavior, and life cycle characteristics differ from honey bees in ways that are not considered when tests are applied only to honey bees. For example, bumble bee larvae are fed raw pollen and nectar whereas honey bees process nectar and pollen within nurse bees digestive systems before feeding larvae (Fischer & Moriarty 2014 p. 53). Bumble bee larvae are also in direct contact with raw nectar and pollen provisions rather than in individual cells like honey bees and therefore have a different exposure profile (Fischer & Moriarty 2014 p. 53). Further, the persistent residues of pesticides in soil can contaminate bumble bee nests and overwintering sites, but this is not considered by the EPA when assessing risk of pesticides to bumble bees.

The EPA continues to permit neonicotinoid pesticides that are known to kill bumble bees throughout the United States (Hilburn 2013 p. 1; Hopwood et al. 2016 entire). Thus, existing pesticide regulation does not provide an adequate regulatory mechanism for protecting this or any other native pollinator species.

At the state level, Maryland became the first state to ban consumer neonicotinoid use, although this does not apply to agricultural applications (Chow 2016 p. 1). In 2016, New York limited the use of some neonicotinoids (such as dinotefuran) to indoor greenhouses and for bark treatment but allows the use of others (such as thiamethoxam) in most regions of the state. The neonicotinoid imidacloprid is banned in Nassau, Suffolk, Kings, and Queens counties out of concerns over groundwater impacts, but remains unrestricted in the rest of the state (N.Y. Dep't of Envtl. Conservation, 2016). However, these state and local regulations limit neonicotinoid pesticide use on only a small fraction of the American bumble bee's range and are therefore inadequate to protect this species.

In 2014, the Obama administration released a presidential memorandum on creating a federal strategy to promote the health of pollinators which included a number of directives to various federal agencies to undertake actions to assess—and, in some cases, mitigate—threats to pollinator species, including bumble bees (Obama White House, 2014 entire). This directive to federal agencies, however, represents a voluntary directive to agencies which does not adequately protect the American bumble bee.

For these reasons, there are no existing adequate existing regulatory mechanisms for protecting the American bumble bee.

IX. Request for Critical Habitat Designation

We urge the Service to designate critical habitat for the American bumble bee concurrent with its listing. Critical habitat as defined by Section 3 of the ESA is: (i) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) the specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species (16 U.S.C. § 1532(5)).

Congress recognized that the protection of habitat is essential to the recovery and/or survival of listed species, stating that: "classifying a species as endangered or threatened is only the first step in ensuring its survival. Of equal or more importance is the determination of the habitat necessary for that species' continued existence… If the protection of endangered and threatened species depends in large measure on the preservation of the species' habitat, then the ultimate effectiveness of the Endangered Species Act will depend on the designation of critical habitat." H. Rep. No. 94-887 at 3 (1976).

Critical habitat is an effective and important component of the ESA, without which the American bumble bee's chance for survival significantly diminishes. Petitioners thus request that the Service propose critical habitat for the American bumble bee concurrently with its listing.

X. Conclusion

The American bumble bee was once the most common bumble bee species in North America, but without immediate action to protect it under the ESA, it will continue its alarming decline towards extinction. Based on the facts stated in this petition, we request that the U.S. Fish and Wildlife Service act to list the American bumble bees as endangered under the Endangered Species Act.

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