November 17, 2015

Please accept these comments submitted on behalf of the Xerces Society for Invertebrate Conservation and the Natural Resources Defense Council in response to the positive 90-day finding the Service issued for the rusty patched bumble bee (*Bombus affinis*) on September 18, 2018 (FWS-RJ-ES-2015-0112). The Xerces Society submitted a petition for protection of the rusty patched bumble bee on January 31, 2013. We urge the Service to promptly issue a proposed listing to protect the rusty patched bumble bee as endangered under the Endangered Species Act.

Our comments cite recent research and provide additional evidence to support the following factors outlined in our 2013 petition:

I. The Rusty Patched Bumble Bee is Threatened By Disease From Managed Pollinators (Factor C: Disease or Predation);
II. Existing Regulatory Mechanisms Governing Pesticide Use and Managed Pollinators are Inadequate to Protect the Rusty Patched Bumble Bee From Extinction (Factor D: The Inadequacy of Existing Regulatory Mechanisms)
III. Pesticides and Interactions With Honey Bees Threaten the Continued Existence of the Rusty Patched Bumble Bee (Factor E. Other Natural or Manmade Factors Affecting its Continued Existence)

In addition, we provide updated information about this species' current range and conservation status, including a recently published IUCN Red List extinction risk assessment for the rusty patched bumble bee, in which the species was listed as Critically Endangered.

I. The Rusty Patched Bumble Bee is Threatened By Disease From Managed Pollinators (Factor C: Disease or Predation)

As our petition details, emerging infectious diseases pose real and immediate threats to the rusty patched bumble bee (Jepsen et al. 2013, Page 13-17). Here we provide additional evidence and clarification regarding the risk of various diseases to the rusty patched bumblebee. Importantly, we note that all of the diseases that we discuss including *Crithidia bombi, Nosema ceranae* and a host of RNA viruses have been documented within the range of the rusty patched bumble bee and pose threats to its continued existence.

Crithidia bombi

Crithidia bombi is a trypanosome protozoan that can dramatically reduce bumble bee longevity and colony fitness (Brown et al. 2003; Otterstatter & Whidden 2004), interfere with learning among bumble bee foragers (Otterstatter et al. 2005), increase ovary development in workers (Shykoff & Schmid-Hempel 1991), and decrease pollen loads carried by workers (Shykoff and Schmid-Hempel 1991).

Crithidia bombi occurs within the range of the rusty patched bumble bee placing this species at risk of infection by this parasite (Gillespie 2010 pp. 741–742; Cordes et al. 2012 p. 212). Furthermore, several species of bumble bees that are sympatric with the rusty patched bumble bee (including *Bombus impatiens, B. bimaculatus, B. fervidus*, *B. ternarius, B. citrinus, B. perplexus, B. vagans,* and *B. griseocollis*) have been shown to be infected with *Crithidia bombi* (Gillespie 2010 pp. 741–742; Cordes et al. 2012 p. 212). Although *C. bombi* was not detected in a recent study of the rusty patched bumble bee, this may be attributable to the fact that the sample size was extremely small (N=14), due to the scarcity of this species in the landscape (Cordes et al. 2012). The fact that *C. bombi* is found within the range of the rusty patched bumble bee and is known to infect other bumble bee species that occupy the same range suggests that the rusty patched bumble bee is at risk of infection by *C. bombi*.

In addition to direct effects of this pathogen, there may be a synergistic effect between pesticide exposure and disease. A recent laboratory study demonstrated that chronic exposure of bumble bees to low, realistic doses of two neonicotinoid insecticides, when combined with a sublethal infection of *Crithidia bombi*, significantly reduced queen survival (Fauser-Misslin et al. 2013 p. 454). The rusty patched bumble bee occurs in areas where it is exposed to pesticides and within the range of *Crithidia bombi*. It is therefore at risk for increased exposure and subsequent reduced survival by this microparasite.

<u>Pathogen Spillover, RNA viruses and *Nosema ceranae*</u>

Since January of 2013, a body of literature has emerged from research that documents the transmission of diseases from managed bees (both European honey bees and commercial bumble bees) to wild pollinators. These studies have demonstrated the threat that RNA viruses (Fürst et al. 2014; Manley et al. 2015; McMahon et al. 2015) and *Nosema ceranae* (Graystock et al. 2013a, 2015a; Fürst et al. 2014) pose to wild bumble bees. While most of the recent research has been conducted in Europe, these same pathogens exist within the historic and current range of the rusty patched bumble bee and the pathogen spillover poses a significant threat to the continued existence of the rusty patched bumble bee.

RNA viruses that have historically been considered to be specific to honey bees (*Apis mellifera*), including Israeli acute paralysis virus, black queen cell virus, sacbrood virus, deformed wing virus, and Kashmir bee virus, have been recently detected in wild North American bumble bees foraging near apiaries – and within the range of the rusty patched bumble bee (Singh *et al.* 2010). Notably, four species of bumble bee sympatric with the rusty patched bumble bee (the common eastern bumble bee, the tri-colored bumble bee, and the half-black bumble bee) were detected with RNA viruses within the range of the rusty patched bumble bee (Singh et al. 2010). Furthermore, there is a growing body of evidence that RNA viruses can be transmitted between managed bees and wild bees on flowers (Manley et al. 2015 pp. 2–4).

RNA viruses such as deformed wing virus have been shown to be virulent in bumble bees, resulting in malformed wings, non-viable offspring, and reduced longevity (Fürst et al. 2014 p. 364). Deformed wing virus, which is associated with severe winter losses in honey bees (Highfield *et al.* 2009), was also detected in bumble bees in Germany, and the infected bumble bees displayed the same deformities that are typical of infected honey bees (Genersch *et al.* 2006). The rusty patched bumble bee occurs within the range of a variety of RNA viruses making it at risk to infection. Furthermore, current research indicates that these RNA viruses are likely to exert similar lethal and sub-lethal effects on bumble bees as has been documented in honeybees.

Nosema ceranae is a microsporidian, mostly known for its deleterious effects on the European honey bee (*Apis mellifera*). In honey bees it has been shown to cause digestive disorders, decrease lifespan, reduce colony population sizes, and decrease honey production (Chen et al. 2008 p. 186). Recent research has confirmed that *N. ceranae* can infect bumble bees (Graystock et al. 2013a p. 116), and that it is present in wild bumble bees in Europe (Graystock et al. 2013a p. 116; Fürst et al. 2014 p. 364).

Nosema ceranae has been detected in honey bees within the range of the rusty patched bumble bee (Williams et al. 2008 p. 190) and honey bees are both resident and regular migrants throughout the range of the rusty patched bumble bee. Therefore, *N. ceranae* poses a risk to the rusty patched bumble bee.

Commercial bumble bees in the U.S. and abroad are infected with pathogens that threaten the wild bumble bees

A recent review paper that evaluated disease transmission between managed and wild bees (including bumble bees) concluded that the commercial use of pollinators is a key driver of emerging disease in wild pollinators (Manley et al. 2015 p. 5). Disease has been implicated as a potential driving factor behind observed declines in rusty patched bumble bee populations (Cameron et al. 2011a) and commercial bumble bees distributed within the range of the rusty patched bumble bee are known to harbor numerous pathogens (Morkeski & Averill 2010). In 2012, Morkeski and Averill reported results from testing bumble bees from the commercial vendors Koppert and BioBest. They found the commercially reared bumble bees were infected with *N. bombi, C. bombi, Locustacarus buchneri*, and viruses that also affect honey bees, including DWV (Deformed Wing Virus) and BQCV (Black Queen Cell Virus). Averill (unpublished data) also reported that commercial bumble bee colonies have tested positive for SBV (Sacbrood Virus). Singh *et al.* (2010) reported that commercial bumble bee colonies tested positive for IAPV (Israeli Acute Paralysis Virus). Furthermore, a recent study of commercially produced bumble bees (*Bombus impatiens*) in Mexico found that the colonies were infected with numerous pathogens, including: *Apicystis bombi*, *Locstacarus buchneri*, *Nosema bombi*, and numerous viruses (Acute Bee Paralysis Virus, Chronic Bee Paralysis Virus, Deformed Wing Virus, Israeli Acute Paralysis Virus, and Kashmir Bee Virus) (Sachman-Ruiz et al. 2015 pp. 5-9). Since *B. impatiens* is native to the U.S. and Canada but not native to Mexico, and used in commercial bumble bee rearing facilities in both the U.S. and Canada, it is likely that these pathogens originated in rearing facilities in either the U.S. or Canada, and may also occur in managed bumble bee colonies in these two countries. *B. impatiens* is the only species of commercial bumble bee available for distribution in the United States within the range of the rusty patched bumble bee.

In other regions of the world—where the two major North American bumble bee producers also operate—commercial bumble bee colonies have been more widely tested and have routinely been found to be infected with numerous parasites and pathogens, including: *Apicystis bombi, Crithidia bombi*, *Nosema bombi*, *N. ceranae*, Deformed Wing Virus, and three honey bee specific parasites (Graystock *et al.* 2013b pp. 4-6, Meeus *et al.* 2011, Murray *et al.* 2013; Sachman-Ruiz et al. 2015 pp. 5–9). In a 2013 European study, scientists tested commercially produced bees imported into the UK. Although the bees were sold as "disease-free," the scientists found that 77 percent of the colonies tested were infected with at least five parasites and an additional three parasites were present in pollen that was supplied as food for the bumble bee colonies (Graystock *et al.* 2013b). This research indicates that commercial bumble bees are regularly infected with pathogens, and distribution of commercial bumble bees within the range of the rusty patched bumble bee puts that species at risk of infection, and corresponding increase in mortality, thus putting this species at further risk of extinction.

Recent examples from multiple continents demonstrate that pathogens from managed bumble bees can spread to wild bumble bees with catastrophic results. In South America, the commercial bumble bee species *Bombus terrestris* was first introduced into Chile and has since spread to Argentina (Morales *et al.* 2013, Schmid-Hempel *et al.* 2014). There is considerable evidence suggesting that this commercial bumble bee has parasites that are infecting South America's only native bumble bee and have caused its precipitous decline (Schmid-Hempel *et al.* 2014). Indeed, scientists have found that wherever *B. terrestris* invades, the native bumble bee species disappears (Morales *et al.* 2013, Schmid-Hempel *et al.* 2014). In Japan, researchers found that commercially raised bumble bees had a higher infestation rate of the tracheal mite *L. buchneri* than wild bumble bees. Their findings also suggested that a European strain of this mite has likely invaded native Japanese bumble bee populations and may help explain its decline (Goka 2010, Yoneda *et al.* 2008). Significantly *L. buchneri* was recently detected in Mexico (Sachman-Ruiz et al. 2015) indicating that the threat from this pathogen exists close to the range of the rusty patched bumble bee. Together, these examples underscore the potential consequences of continued exposure of the rusty patched bumble bee to commercial bumble bees infected with pathogens.

II. Existing Regulatory Mechanisms Governing Managed Pollinators and Pesticide Use are Inadequate to Protect the Rusty Patched Bumble Bee From Extinction (Factor D: The inadequacy of existing regulatory mechanisms)

The rusty patched bumble bee is in precipitous decline, and no existing federal or local law or regulation has proven itself adequate to slow the bee population's rapid movement towards extinction.

A. A lack of regulatory mechanisms to protect rusty patched bumble bees is compelling evidence of inadequate regulatory mechanisms.

As an initial matter there is a complete lack of regulation at the local and U.S. federal level to directly address rusty patched bumble bee habitat loss, the interstate spread of disease from commercial bees to native wild bumble bees, or the harmful effects of pesticides on bumble bees. In its 90-day finding, the Service stated that showing a mere lack of regulations does not "equate to an inadequate existing regulatory mechanism." (USFWS 2015a, p. 7). This position does not make sense and is inconsistent with previous Factor D findings made by the Service. If there are no regulations they *de facto* are inadequate; or put another way, an absence of regulation can never be the source of protection for a species. The Service has understood this in past listing decisions. As the Service itself has explained, "[r]egulatory mechanisms, if they exist, may preclude listing if such mechanisms are judged to adequately address the threat to the species," however "threats on the landscape are exacerbated when not addressed by existing regulatory mechanisms . . . ." (USFWS 2015b, p. 24292).

For example, in the final rule to list the polar bear as a threatened species, the Service found it significant that there were "no known regulatory mechanisms that are directly and effectively addressing reductions in . . . habitat at this time" (USFWS 2008, p. 28287). In that case, it was the "lack of regulatory mechanisms to address the loss of habitat that ultimately resulted in the conclusion that Factor D weighed in favor of listing" (USFWS 2008, p. 28247), and "we have also determined that there are no known regulatory mechanisms in place, and none that we are aware of that could be put in place, at the national or international level, that directly and effectively address the rangewide loss of sea ice habitat within the foreseeable future (Factor D)" (USFWS 2008, p. 28249); *see also e.g.* 12-Month Finding on a Petition To List the Casey's June Beetle (*Dinacoma caseyi*) as Endangered With Critical Habitat (USFWS 2007, pp. 36635-46) (explaining, in finding Factor D, a factor in favor of listing, that "[t]here are no regulatory mechanisms that specifically or indirectly address the management or conservation of functional Casey's June beetle habitat") (USFWS 1978, p. 35636) (proposal by Service to list 10 North American beetles because, in part, "[t]here currently exist no State or Federal laws protecting this species or its habitat"). Here we have a lack of regulation such that the recognized "threats on the landscape are exacerbated" (USFWS 1978, p. 35636).

B. Factor A habitat loss has continued to threaten the rusty patched bumble bee with extinction in spite of three states' recognition of the rusty patched bee as a Species of Concern and one state's recognition of this species as a state endangered species.

At the local level there are also no laws that directly protect the imperiled bumble bee or its habitat. The rusty patched bumble bee's historic and current range includes 25 of the United States: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Tennessee, Ohio, Kentucky, Indiana, Illinois, Iowa, Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota. In 21 of those 25 states, there is no regulation at the local level that specifically addresses rusty patched bumble bees. Vermont lists the rusty patched bumble bee as a state endangered species, and three states (Wisconsin, Michigan, and Connecticut) list the bee as a Species of Special Concern. However, these states comprise only four of the 25 states in which the bee has been known to live and, therefore, any protection flowing from recognition in those states of the bee's imperiled state would be necessarily limited as it could only impact a small portion of the total range. This limitation aside, the special status of the bee in three of these four states does not protect the bee or its habitat. In Wisconsin, the Special Concern status is a designation meant to "focus attention on certain species," but comes with no concomitant legal or regulatory protection (State of Wisconsin 2015). The bee's nominal Special Concern status in Michigan (State of Michigan 2015) and Connecticut is equally ineffective. In Michigan the status gives the bee no legal protection whatsoever, and in Connecticut it is only endangered and threatened species that the state is required to "conserve" along with "their essential habitats" (State of Connecticut 2015). In Vermont, a state ESA listing does provide protection against take (State of Vermont 2015), although this bee has not been found in Vermont, despite significant effort, since 1999 (McFarland and Richardson 2013). The lack of protection has meant that despite the bee's Special Concern status in three states and endangered status in one state, local regulations have not been effective, or in place, to curb the destruction of the bee's remaining habitat, prevent the spread of disease, or guard the bees from the harmful impacts of pesticides. The lack of protection is not a failure in print only, as the 90-day finding seemed to suggest might be the case. 90-day Finding at p. 6 ("The fact that these 'species of concern' designations do not provide habitat protections does not make any of these designations an inadequate regulatory mechanism."). Where recognized major threats to the bee's survival persists despite the bee's special status—in this case Factors A, C, and E—the local regulations are decisively inadequate.

As the studies cited in our original petition found and the 90-day finding recognized, habitat loss due to agricultural conversion, among other factors, is an established threat to this bee. Local regulatory mechanisms have not prevented continued habitat fragmentation and modification or otherwise been able to address this threat, including in the states where the bee is listed as of Special Concern. In fact, land conversion of grasslands to crops has been on the rise over the past decade, and a study that looked at five Midwestern states found that change to represent a persistent shift in land use (Wright and Wimberly 2013). Data released by the USDA Farm Service Agency confirm that between 2011 and 2012, more than 398,000 acres (620 square miles, or roughly the size of Houston, TX) were plowed, cleared or otherwise converted to cropland (FSA 2015). Of particular importance for purposes of assessing the effectiveness of local regulations is the fact that by the USDA's calculus, more than 20,000 acres were converted to agriculture in Vermont, Wisconsin, Michigan, and Connecticut – all states in which the rusty patched bumble bee has special status – in between the 2011 and 2012 crop year, or during one winter. In a 2013 study, Wright and Wimberly calculated cropland conversion in the Western

Corn Belt. Specifically, they found that 196,000 acres of grassland and wetland were converted to cropland in Minnesota between 2006 and 2011 (Wright & Wimberly 2013). Overall, in this region, the authors discovered that land conversion rates between 2006 and 2011 were greater than in any period since the period directly following the mechanization of agriculture (Wright & Wimberly 2013).

In addition to the failure of state or federal law to ameliorate any Factor A threat of habitat loss, current laws and other regulatory mechanisms fail to protect the rusty patched bumble bee against the Factor C threat of diseases introduced from commercial bumble bees and the Factor E threat of the use of pesticides such as systemic insecticides. Emerging infectious disease is one of the main threats to the rusty patched bumble bee (summarized in Goulson & Hughes 2015 p. 12; Cameron et al. 2011a p. 3; Evans et al. 2008 pp. 24–26; Hatfield et al. 2014b), and pesticides including systemic insecticides have also likely contributed to the rusty patched bumble bee's decline (Whitehorn et al. 2012; Gill & Raine 2014; Pisa et al. 2014; Goulson 2015; Rundlöf et al. 2015). Without regulations to protect the rusty patched bumble bee from 1) the threat of disease from commercial bumble bees, and 2) the threat of pesticides, these two factors will likely cause this species' extinction.

C. Inadequate regulation of commercial bumble bees means that disease (Factor C) remains a significant threat to the rusty patched bee

There are currently no federal laws or regulations governing the interstate movement of commercial bumble bees, and this has likely resulted in the spread of deadly pathogens to the rusty patched bumble bee and a recognized need by the scientific community for better management strategies and policies to protect native bees from such pathogen spillover (Goulson and Hughes 2015, pp. 16-17; Goulson et al. 2015, p. 3,7; Graystock et al. 2015b p. 6; Graystock et al. 2013b pp. 7–8; Manley et al. 2015, p. 8; Sachman-Ruiz et al. 2015 p. 9). At the local level, only two states restrict the importation of commercial bumble bees: Oregon and California. However, these state regulations are inadequate to protect the rusty patched bumble bee from diseases harbored by commercial bumble bees because the rusty patched bumble bee does not occur in Oregon or California. Other states have laws governing honey bee diseases, but they are specific to honey bees, and have proven inadequate to protect the rusty patched bumble bee from the significant threat of disease. For example, the Michigan Apiary Law Act 412 of 1976 was enacted to "provide for the suppression of serious diseases among bees; to prescribe certain powers and duties of the director of the department of agriculture; and to repeal certain acts and parts of acts" (Michigan 1976). However, this law does not directly protect the rusty patched bumble bee because "bees" are defined as "any life stage of the common honey bee, *Apis mellifera* L.".

The failing of current local and federal regulatory mechanisms is evidenced not just in their absence but in the continued decline of native bees across North America, including the rusty patched bumble bee, most likely caused by the spread of such pathogens and diseases (Cameron et al. 2011a p. 664, Goulson & Hughes 2015 p. 12). The emerging body of research linking decline of native bumble bees with the spread of diseases (summarized *above* in Section II) underscores the inadequacy of existing regulatory mechanisms to protect the rusty patched bumble bee from extinction. Disease is a serious "Factor C" threat for this bee, as we explained in our petition, because small, fragmented, and declining populations—like the rusty patched bumble bee—are especially susceptible to infectious disease (Fürst et al. 2014 p. 364).

In addition to a lack of local and federal laws that are directly applicable to the rusty patched bumble bee, the laws that might indirectly help protect the bumble bee—for example those that are meant to safeguard agricultural crops or domestic honey bees—have proven themselves to be ineffective at protecting the rusty patched bumble bee.

i. *The Plant Protection Act*

The Plant Protection Act was passed in 2000 with the stated purpose of preventing the dissemination of plant pests. 7 USC sec. 7711(a). Although the Act was intended to protect agricultural goods, it could potentially directly or indirectly help control the spread of bumble bee diseases and pathogens. However, as we explained in our petition (Xerces Society et al. 2010), it has not done so. Currently, the USDA does not regulate either the disease status or interstate movement of U.S. commercial bumble bees, despite repeated requests to use its authority under the PPA to do so. (Xerces Society et al. 2010; Xerces Society et al. 2013, 2014a, 2014b). This lack of regulation is not merely a "claim" as the 90-day finding suggests, but a fact reflected in the absence of bumble bees, or their pathogens, from the list of pests and diseases regulated by USDA APHIS (USDA 2015). There is no indication that this will change in the near future, and so the Plant Protection Act, which provides for the facilitation of "interstate commerce in agricultural products," remains ineffective at slowing the spread of disease from commercial bumble bees to their native counterparts, including the rusty patched bumble bee, and this inadequacy is reflected in the ongoing spread of disease from commercial to native bumble bees across the United States.

The USDA does regulate the international movement of Canadian bumble bees into the United States. Currently, the USDA allows the common eastern bumble bee (*Bombus impatiens*) and the western bumble bee (*Bombus occidentalis*) to be imported from Canada. 7 CFR § 322.5. The USDA is currently evaluating a request to allow Hunt's bumble bee (*B. huntii*) to also be imported into the U.S. from Canadian bumble bee production facilities (USDA 2014). However, this regulation fails to protect the rusty patched bumble bee for two reasons: 1) Commercial colonies are not tested for pathogens upon importation (7 CFR § 322.5), and any pathogens present in commercial bumble bees could spread to rusty patched bumble bees that visit the same flowers as commercial bumble bees (Graystock et al. 2015b); 2) Commercial bumble bees (*B. impatiens*) are produced both in Canada and the U.S., and colonies produced in the U.S. are also not required to be inspected for any pathogens. The lack of effectiveness of the USDA's program to screen a highly limited subset of international bumble bees is evidenced in the ongoing increase in pathogens and continued spread to native bees (see above Section II).

ii. *The Honey bee Act*

The Honey bee Act (7 USC 281) gives the Secretary of Agriculture the authority to regulate the interstate commerce of honey bees in order to control the spread of bee diseases. However, the Honey bee Act is specific to honey bees, and the USDA has not used it to regulate diseases of managed *bumble* bees. Thus, the Honey bee Act has also failed to protect the rusty patched bumble bee from pathogens harbored by commercial bumble bees that are used throughout the range of the rusty patched bumble bee.

There is clear evidence that honey bees can transmit pathogens to bumble bees (Graystock et al. 2013a, 2013b; Graystock et al. 2015a, 2015b; Fürst et al. 2014; McMahon et al. 2015). However, any indirect protection of the rusty patched bee flowing from regulation of honey bees under the Honey Bee Act is limited in scope. First, pathogens that impact the rusty patched bumble bee may come from multiple sources beyond honey bees; second, the Honey Bee Act does not apply to the movement of pollen for use by the commercial bumble bee trade (the risks of this practice are reviewed in Manley et al. 2015, p. 5); and third, the laws seeking to prevent the spread of disease among honey bees suffer in their lack of uniformity and enforcement. State laws regulating interstate movement of honey bees vary considerably from state to state (Gegner 2003, page 1-2). For example, Massachusetts requires bees imported into the state to be certified disease free within 60 days (State of Massachusetts 2015), while Minnesota does not have any similar requirements, and only offers fee for service apiary inspections (State of Minnesota 2015). In addition, responsibility for disease control remains with the beekeeper, who should routinely examine colonies for disease as a regular part of his or her management program and do what is necessary when disease is found. Yet there are not clear regulations that determine how often hives should be screened, or for which pathogens. Significantly, there are not consistent, effective mitigative actions for beekeepers to employ upon disease discovery (Graystock et al. 2015a).

iv. Regulations Governing Importation and Disease Status of Pollen

Pollen from honey bees is used in the commercial bumble bee and commercial honey bee rearing processes, yet current regulations are ineffective at ensuring that this pollen is free of pathogens prior to importation. Honey bee pollen is frequently fed to both bumble bees and honey bees and research has demonstrated that feeding pollen contaminated with viruses can infect bees (reviewed in Manley et al. 2015, p. 5). Once managed honey bees or bumble bees are infected, pathogens can spill over to wild rusty patched bumble bees when they interact at shared flowers (as in Graystock et al. 2015b). While regulations exist that govern the importation of pollen for bee food into the U.S. and Canada, there is a lack of enforcement preventing the diversion of pollen legally imported for human consumption and diverted to the bee trade. Honey bee pollen that is imported for human consumption is regulated by the Food and Drug Administration, and this agency does not require that honey bee pollen be decontaminated (Cameron et al. 2011b, pp. 9-23).

In a recent review paper on emerging viral diseases and their impacts on pollinators, Manley et al. (2015) stated: "the commercial use of bumblebees needs to be more tightly managed… two recent studies worryingly report that over 70% of 'pathogen free' commercially produced bumblebees were carrying pathogens (Graystock et al. 2013b; Murray et al. 2013). Additionally, Graystock et al. (2013b) found that the pollen supplied to feed these colonies was also carrying pathogens, including [Deformed Wing Virus] DWV. Irradiating pollen prior to use (Singh et al. 2010) and avoiding using honey bee workers to encourage egg laying in captive queens are easy and necessary precautions."

D. Inadequate regulation of pesticides (Factor E) means that this manmade factor continues to be a significant threat to the rusty patched bumble bee's survival

As we explained in our 2013 petition, existing regulations regarding the approval of new pesticides and the use of existing pesticides fail to protect bumble bees from exposure to harmful pesticides. The Environmental Protection Agency regulates the approval of new pesticides, and this agency currently does not require that research be done to evaluate the lethal or sublethal effects of insecticides, herbicides or fungicides on bumble bees before those chemicals are approved for use. Since our petition there has been a new development in the EPA's regulation of pesticides, but because that new study incorrectly equates impacts to honey bees with those on bumble bees, it does not alleviate the serious threat of pesticides to the rusty patched bumble bee.

Currently, acute toxicity to honey bees (*Apis mellifera*) is evaluated in the pesticide approval process, but honey bees are not adequate surrogates for bumble bees in this process. The same problem limits the potential impact of the June 2014 guidelines published by the US EPA: *Guidance for Assessing Pesticide Risks to Bees* (USEPA 2014). The guidelines provide recommendations to assist researchers in designing updated studies to evaluate the risks that pesticides pose to bees. Such studies are in turn used by the EPA to assess risk and determine appropriate regulation. This new guidance document could add new research to the current battery of tests required for pesticides; however, it fails to address concerns specific to bumble bees and other native bees. For example, the guidelines state: "This section summarizes the overall risk assessment process for characterizing the risks of pesticides to honey bees (*Apis mellifera*), which are used as a surrogate species for other Apis and non-*Apis* bees and other insect pollinators." (USEPA 2014 p. 6). But, the differential physiological, biological and behavioral differences of honey bees from other native bees (Vaughan et al. 2014 p. 12) make honey bees poor surrogates for assessing toxicity of pesticides to bumble bees. In particular, the life-history of many non-*Apis* species (including the rusty patched bumble bee) including nest site location, foraging time and distance, food sources, life-cycle, and size may expose the rusty patched bumble bee and other non-*Apis* bee species to alternative exposure routes not considered when tests are only applied to honey bees (Wisk et al. 2014 pp. 49–54). Furthermore, bumble bees – including the rusty patched bumble bee – do not process pollen before feeding it to immature bees, and thus they have different exposure scenarios and may be more vulnerable to pesticides than honey bees (Thompson & Hunt 1999; Fischer & Moriarty 2011; Osborne 2012). Bumble bees appear to be affected by dietary concentrations of the systemic insecticide imidacloprid at levels lower than honey bees, perhaps because, unlike honey bees, bumble bees do not metabolically degrade imidacloprid effectively while continuing to ingest it (Cresswell et al. 2013 p. 3). This range of exposure routes was not considered during the EPA's registration process for neonicotinoids (US EPA 2012).

In summary, the current mechanism that regulates the safety of pesticides to bees fails to take into account attributes specific to bumble bees and is therefore inadequate to protect bumble bees from the threat of pesticides.

The failure of the current federal pesticide regulations to address risks to bumble bees (including the rusty patched bumble bee) is evidenced by the recent, numerous bumble bee kills caused by on-label uses of neonicotinoid insecticides to *Tilia* trees. In most of these cases, large numbers of bumble bees were killed by the legal applications of neonicotinoid insecticides; in one case more than 50,000 bumble bees were killed in a single incident (Hilburn 2013). One such bumble bee kill involved imidacloprid treatment of *Tilia* trees in Delaware, which is within the historic range of the rusty patched bumble bee (DPR 2009). In this incident, investigators concluded that applications of imidacloprid to *Tilia* trees led to bumble bee deaths two years in a row. Furthermore, investigators felt that their investigation supported the conclusion that "imidacloprid and its metabolites reach pollen and nectar at levels high enough to cause mortality to pollinators and that these effects are both long-lasting and potentially additive with each additional application." (DPR 2009). The remaining neonicotinoid-associated bumble bee kills that have been documented have occurred in Oregon. Since June of 2013, there have been seven completed investigations into bumble bee kills that occurred in Oregon (other investigations from the summer of 2015 are still pending). Responding to the risks associated with two of the incidents, US EPA halted foliar use of nitroguanidine neonicotinoids on non-agricultural plants (including *Tilia* trees) <u>while plants are flowering</u> (USEPA 2013). However, because neonicotinoid insecticides can remain in plant tissue for weeks to months to years, this change in regulation remains inadequate to protect bumble bees from nitroguanidine neonicotinoids applied to bumble bee-attractive plants prior to flowering. No action has been taken in response to the risks demonstrated by the other bee-kill incidents caused by non-foliar, systemic applications <u>weeks to months prior to flowering</u>. Of these five incidents, only one was linked with an off-label use. The state of Oregon did respond to this risk by halting all uses of nitroguanidine neonicotinoids to *Tilia* trees within the state of Oregon (ODA 2015). However, the rusty patched bumble bees' range does not extend to Oregon, and therefore is not protected by this state's regulation, and the use of neonicotinoid insecticides outside of Oregon and in the rusty patched bumble bee's range is well documented (See Figures 3-6). Even after the Oregon Department of Agriculture wrote to EPA to point out the inadequacy of the federal regulation, the EPA did not take action to protect bumble bees from long-term residues of systemic insecticides in woody plants such as *Tilia* (ODA 2013, 2014a, 2014b).

An additional failure of the federal regulations to protect the rusty patched bumble bee from the threat of pesticides is that the US EPA's Office of Pesticide Program conducts chemical-specific risk assessments for bees. Yet, research has begun to elucidate threats that pesticide mixtures pose to bees. While the majority of studies have been conducted on honey bees, these studies demonstrate an area of significant uncertainty that could lead to an underestimation of risk to other species of bees – such as the rusty patched bumble bee. For example, there can be different risks between active ingredients and full formulations (Mullin et al. 2015). There are also additive and synergistic effects between chemicals that might be found jointly in tank mixes or in the field. For example, research has raised concern for synergistic effects of the combination of ergosterol biosynthesis inhibiting fungicides and pyrethroids (Vandame et al. 1998). Neonicotinoids are also known to be additively or synergistically toxic when they occur together (Andersch et al. 2010). Zhu et al. (2014) also noted additive and synergistic effects between pesticides as well as other ingredients in pesticide formulations. The findings by Zhu et al. led the researchers to recommend that pesticide mixtures in pollen be evaluated by adding their toxicities together until complete data on interactions can be accumulated. Further, a recent study by Hladik et al. (2015) showed that within a single sample that non-*Apis* bees are exposed to mixtures of several pesticides, including neonicotinoids, pyrethroids, and fungicides. This provides clear evidence that native bees are exposed to multiple pesticides in their foraging bouts, yet, because of a lack of appropriate regulatory mechanisms and testing protocols, the EPA does not understand how exposure to multiple pesticides affects the rusty patched bumble bee – despite evidence that there are significant deleterious effects (See references above).

In summary, current EPA risk assessment regulations for pesticide effects on bees do not consider additive, or synergistic effects of pesticides, and is therefore inadequate to protect bumble bees, and specifically the rusty patched bumble bee, from the threat of pesticides.

E. Canada's protection of the rusty patched bumble bee is limited in its effectiveness because many threats to the bee are land-based, and only a small percentage of the bee's range falls within Canadian borders.

In Canada, the rusty patched bumble bee is listed as endangered under Canada's Species At Risk Act (SARA). As we explained in our petition, this protection applies only to Canadian federal land, which comprises only a small fraction of the bee's total range and therefore, by its own admission, does not protect the bee in the majority of its range. While it is true, as the 90-day finding suggests, that SARA's intended reach was always highly limited that supports, not undermines, a conclusion that it is of limited effectiveness in its protection of the bee population as a whole, which is the relevant inquiry here. A law may be successful at achieving its stated purpose—e.g. protecting the bee in Canada—and yet, fail to adequately protect the species, which is the relevant question under the ESA.

This species is threatened by land-based factors: habitat loss, spread of disease from transient commercial bees, and the application of pesticides and insecticides. In analogous cases, the Service has regularly looked to the geographic scope of a regulatory mechanism in considering its effectiveness. For example, in the high-profile sage grouse listing example, the Service emphasized in its original decision to list the bird the fact that the strong protections afforded in Wyoming "only apply to State lands, which are typically single sections scattered across the State," and so the decision found "the benefit to sage-grouse is limited" (USFWS 2001). By contrast, in the recent decision, which reversed the prior decision and determined that listing of the sage grouse was not warranted, the Service found it significant that the new Federal and State plans "cover 90 percent of the sage-grouse breeding habitat where they provide regulatory mechanisms that reduce potential adverse effects to sage-grouse." 80 FR 59884. Only a small fraction of the rusty patched bee's historic range falls within Canada, and SARA does not apply outside of Canada, so the law is unable to provide protections to the bee in the majority of its range. Finally, irrespective of the breadth of their applicability, the Canadian SARA designation has been in place since 2010 with no documented reduction in the Factor A, C, or E threats to the rusty patched bumble bee.

III. Pesticides and Interactions With Honey Bees Threaten the Continued Existence of the Rusty Patched Bumble Bee (Factor E. Other Natural or Manmade Factors Affecting its Continued Existence)

Pesticides

Herbicides

Globally, loss of habitat is a leading cause of bumble bee decline (Williams et al. 2009). Recent loss of habitat here in the United States has been tied to the development and use of glyphosate resistant crops. Indicative of this decline in habitat is the dramatic decrease in the amount of milkweed found throughout the Midwestern United States (Pleasants and Oberhauser 2013). The rusty patched bumble bee's range overlaps significantly with areas of highest soybean production (Figure 1) and corn production, as well as with areas of high glyphosate use (Figure 2). The loss of flowering weeds from agricultural areas that have become dominated by genetically modified crops during the period from 1996-present has likely deprived the rusty patched bumble bee of significant amounts of nectar and pollen, and the continued loss of these critical resources presents a threat to the future survival of this species. Moreover, recent research within the geographic range of the rusty patched bumble bee has shown that simplification of landscapes through intensive agriculture leads to more pest pressure, and thus increased application of insecticides (Meehan et al. 2011 pp. 1–3). Thus, the conversion of habitat to intensive agriculture throughout the Midwestern United States, the increased use of glyphosate resistant crops, and the subsequent increase in glyphosate use has likely had a compounding negative effect on the rusty patched bumble bee.

The use of the herbicide glyphosate has dramatically increased with the widespread planting of genetically modified glyphosate-tolerant corn and soybeans, which were introduced in 1998 and 1996, respectively (Pleasants & Oberhauser 2013 pp. 5–7). Because glyphosate is a non-selective herbicide that does not distinguish between target and no-target species, its use in agriculture was initially limited because its application would damage crops as well as weeds. With the introduction of genetically modified glyphosate tolerant corn and soy crops, a 20-fold increase in the use of the herbicide glyphosate has occurred on these two crops from 1995-2013 (reviewed in Center for Biological Diversity et al. 2014 pp. 46-52). Increased use of glyphosate in agricultural areas has likely led to the reduced availability of wildflowers in field margins – which otherwise would have been an important resource for the rusty patched bumble bee. Moreover, recent research showed that genetically modified glyphosate-tolerant soybean fields with standard and recommended application rates of glyphosate had lower diversity of flowering weeds than control fields (Scursoni et al. 2006, page 717-718) and other research clearly documents that agricultural lands without native habitat hosts a less diverse pollinator community (Kremen et al. 2002; Winfree et al. 2008; Morandin & Kremen 2013).

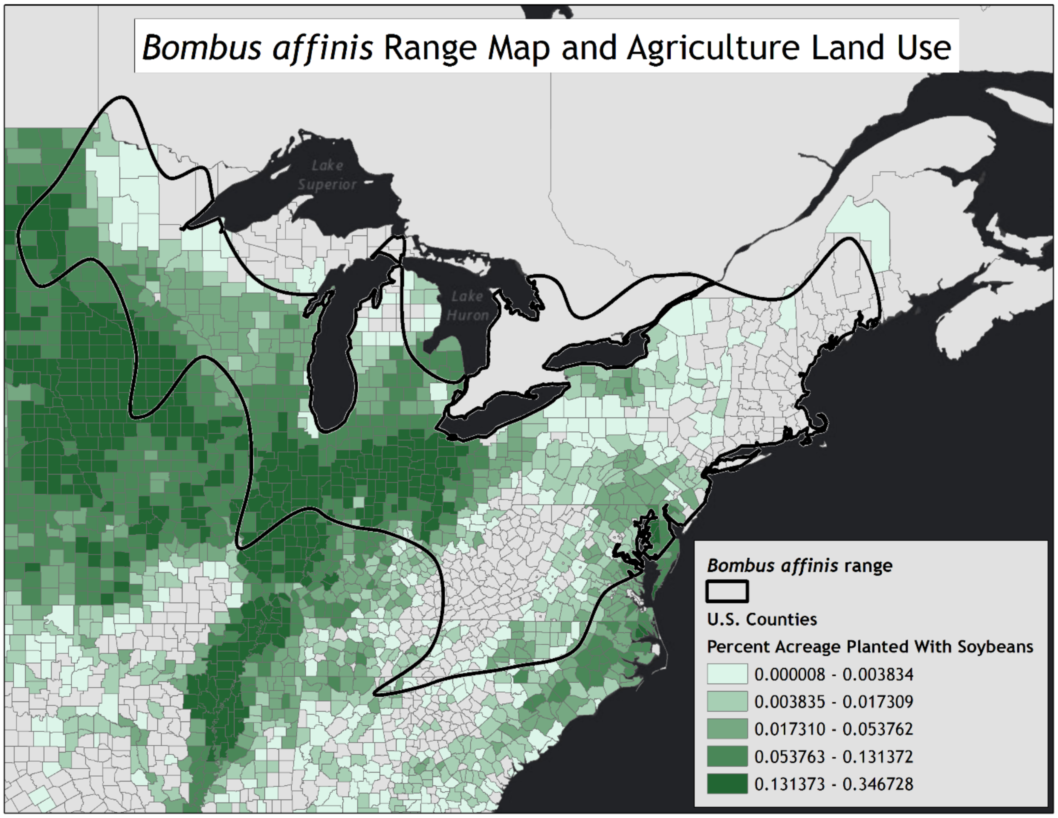

Figure 1: Areas of high soybean density overlap significantly with the range of the rusty patched bumble bee (*Bombus affinis*). Data from USDA/NASS (2012).

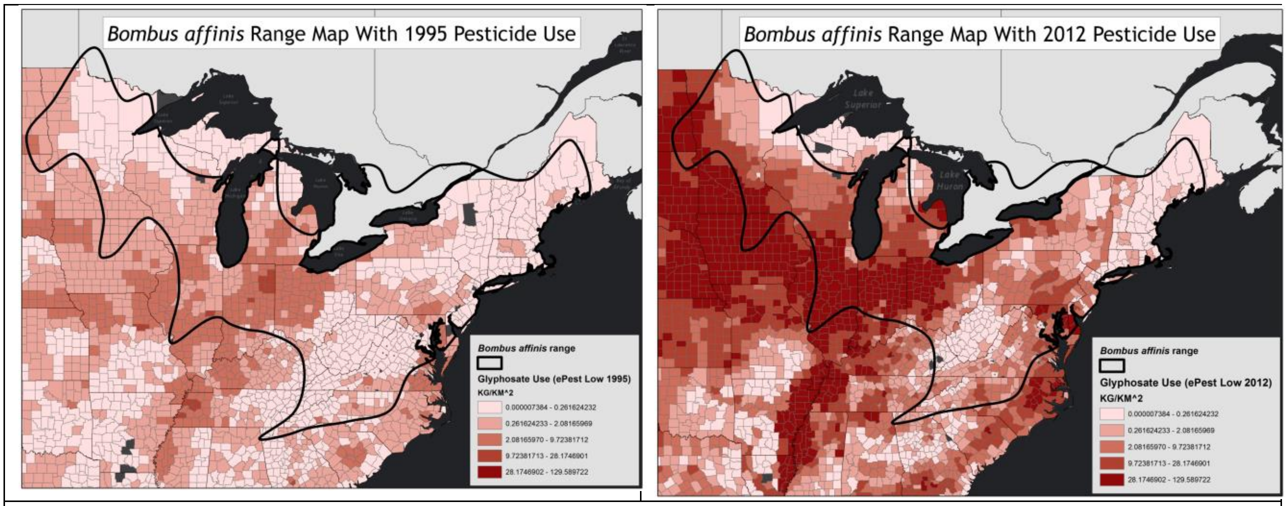

Figure 2: Range of the rusty patched bumble bee with agricultural use of glyphosate in 1995 (left) and 2012 (right). The pesticide data (ePest Low) is from USGS (Thelin & Stone 2013 – left; Baker and Stone 2015 – right) and is displayed in quantiles based on national use of glyphosate in 2012.

2

Rusty patched bumble bee habitat could be further threatened by the introduction of new herbicide resistant crops that are genetically engineered to be resistant to multiple herbicides including 2,4-D and Dicamba, which will be used in addition to glyphosate. The U.S. Department of Agriculture has recently approved a suite of 'next generation' genetically engineered (GE) herbicide resistant corn and soybeans developed by Dow Agrosciences and soy and cotton developed by Monsanto, which will be sold in conjunction with new combinations of herbicides. These GE crops are resistant to the herbicides 2,4-D and glyphosate (Enlist™ by Dow Agrosciences) and dicamba and glyphosate (Roundup Ready Xtend™ by Monsanto). The use of herbicides is expected to increase with the adoption of these 'next generation' GE crops (Mortensen et al. 2012).

Dicamba and 2,4-D are already among the leading herbicides that cause drift-related crop injury because of their volatility (Freese and Crouch 2015 pp. 67-71 and references therein). Because of the greater volatility of dicamba and 2,4-D over glyphosate (which is currently the most widely used herbicide in the U.S.), the increased use of these herbicides is expected to contribute to additional loss of flowering weeds and wildflowers growing within and adjacent to agricultural land within the range of the rusty patched bumble bee.

Given that a significant portion of its current range overlaps with areas of peak genetically modified corn and soybean production, these non-target effects of increasingly potent weed control technology could have a dramatic impact on populations of the rusty patched bumble bee through the escalation of habitat loss.

Beyond impacts to forage, 2,4-D may also be directly toxic to bumble bees. While 2,4-D has been designated by the US EPA as practically non-toxic to bees it is on the cusp of being ranked as moderately toxic. The toxicity ranking that US EPA uses is driven by a pesticide's LD50 (the lethal dose that kills 50% of the test population). If the pesticide's LD50 is 2 ug/bee or less it is considered highly toxic to bees. If the LD50 is greater than 2 ug/bee but less than 11 ug/bee is it moderately toxic. It is considered practically non-toxic if the LD50 is 11 ug/bee or more. The LD50 for 2,4-D is 11.5 ug/bee. This very blunt measure of risk may underestimate the direct impact that 2,4-D could have on the rusty patched bumble bee. The increased use of the herbicide 2,4-D should be considered a threat to the continued survival of the rusty patched bumble bee due to both the anticipated indirect effects (through destruction of floral resources) and direct effects (through direct toxicity).

Agricultural use of herbicides has significantly reduced floral resources throughout much of the rusty patched bumble bee's range (Figures 1 and 2). As floral resources are the only source of food for the rusty patched bumble bee, resource availability is directly connected to the ability to reproduce. Continued widespread use of glyphosate and other herbicides will continue to remove floral resources, and thus continue to threaten the continued existence of the rusty patched bumble bee.

Insecticides

Our petition outlines the significant threat that insecticides pose to the rusty patched bumble bee (Jepsen et al. 2013 p. 20). Since our petition was submitted in early 2013 several new research studies have emerged that further document the threat that neonicotinoid insecticides pose to bumble bees.

The widespread use of neonicotinoids, as well as their longevity, persistence, and toxicity to bees is also a significant threat to the rusty patched bumble bee in agricultural and natural habitats. Significantly, in a study recently completed by Hladik et al.(2015) the authors found that non-*Apis* bees foraging in the landscape were exposed to a suite of 18 pesticides in both agricultural and grassland habitats. Included in the suite of pesticides detected in non-*Apis* bees was thiamethoxam (46% of samples), clothianidin (24% of samples), and imidacloprid (13% of samples) (Hladik et al. 2015), which are all nitroguanidine neonicotinoids and considered to be highly toxic to bees (Hopwood et al. 2012). Below, we compare lethal and sublethal doses with the concentrations detected in the Hladik study. As we did not always have data on bumble bees we, like EPA, sometimes used data on honey bees. The maximum exposure level of thiamethoxam detected in bees in grasslands was 310 ng/g (ppb) (Hladik et al. 2015). The acute lethal dose for honey bees for thiamethoxam is 250 ppb (Syngenta Group 2005). Chronic exposure to thiamethoxam caused lethality at 120 ppb for bumble bees (Mommaerts et al. 2010). The maximum exposure level of clothianidin detected in bees in grasslands was 60 ng/g (Hladik et al. 2015); the Lethal Concentration for honey bees for clothianidin is 81 ng/g (Laurino et al. 2011). The maximum exposure level of imidacloprid detected in bees in grasslands was 82 ng/g (ppb); the lowest chronic lethal dose for bumble bees is 59 ppb (Mommaerts et al. 2010). For acute exposure there is only data for honey bees for which the lowest lethal dose is >185 ppb (Schmuck et al. 2001). These lethal doses are the amounts sufficient to kill 50 percent of the test population. Recognizing that a 50% loss of population is catastrophic for at risk species it is important to factor in that a lower dose can still kill a smaller portion of the test population. Sublethal effects, which can affect population fitness, have been found for bumble bees from chronic exposure to thiamethoxam, clothianidin and imidacloprid at 2 ppb, 17 ppb and 0.2 ppb respectively (Elston et al. 2013; Scholer & Krischik 2014; Laycock & Cresswell 2013;). Acute sublethal effects to bumble bees from exposure to clothianidin were found at 2.1 ppb (Moffat et al. 2015).

While this study was not within the range of the rusty patched bumble bee, and did not identify the non-*Apis* bees to species, the agricultural use of clothianidin, thiamethoxam, and imidacloprid in many counties within the range of the rusty patched bumble bee exceeds that of the study area (Logan County in NE Colorado, Figure 3) suggesting that similar or higher exposures are possible within the range of the rusty patched bumble bee. This study suggests that bees, and specifically rusty patched bumble bees, that are foraging in the landscape may be regularly exposed to toxic insecticides at concentrations capable of causing both lethal and sub-lethal effects.

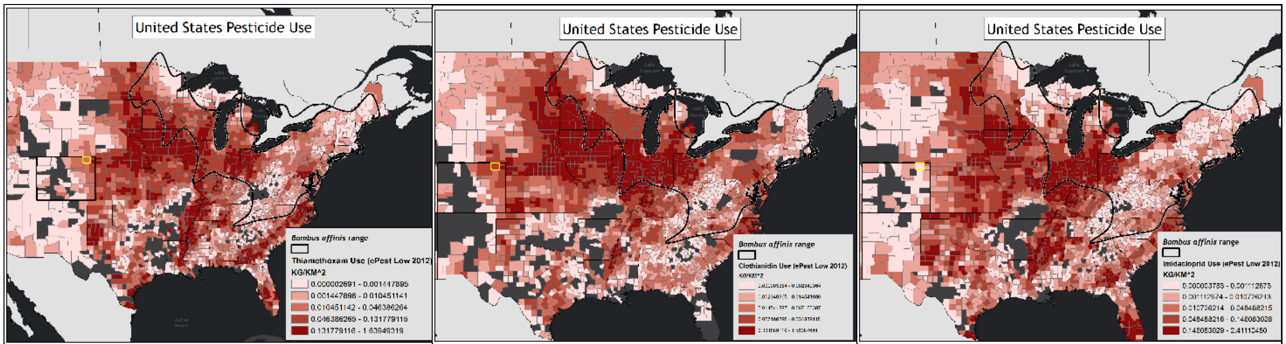

Figure 3: Pesticide use of thiamethoxam (left), clothianidin (center), and imidacloprid (right) within the range of the rusty patched bumble bee and Colorado. Study area from Hladik et al. (2015) is highlighted in yellow.

A number of laboratory studies have found that bumble bees exhibit sublethal effects after chronic exposure to neonicotinoids. This research has shown that bumble bee colonies exposed to neonicotinoids exhibit reduced brood production (Laycock & Cresswell 2013 pp. 3–5; Laycock et al. 2013), reduced queen production (Larson et al. 2013; Feltham et al. 2014; Scholer & Krischik 2014 pp. 5–8), altered behavior, including decreased capacity to forage for pollen and nectar (Laycock et al. 2013 pp. 155–156; Elston et al. 2013; Feltham et al. 2014 pp. 3–4; Gill & Raine 2014; Scholer & Krischik 2014 pp. 5–8), increased worker mortality (Fauser-Misslin et al. 2013; Larson et al. 2013), reduced drone production (Elston et al. 2013), impeded overall colony growth (Fauser-Misslin et al. 2013; Scholer & Krischik 2014; Rundlöf et al. 2015), and colony failure (Bryden et al. 2013).

In addition to the body of work presented above that is directly related to bumble bees, the International Union for the Conservation of Nature (IUCN) conducted a global review of the effects that systemic insecticides are having on global biodiversity (van Lexmond et al. 2014). This study concludes that the wide use of neonicotinoids, along with their water solubility, persistence in the environment, and availability to be taken up by both agricultural and wild plants, lead to pollinator exposure to sub-lethal doses of neonicotinoids for most of the year (van der Sluijs et al. 2013). This finding is corroborated from a recent research study that found high levels of neonicotinoids in wildflowers surrounding treated crop fields (Botías et al. 2015).

The IUCN review (van Lexmond et al. 2014) also concluded that the toxicity of neonicotinoids can be amplified by other agrochemicals, and create synergisms with pathogens such as *Nosema ceranae* that can lead to bee declines and that this practice is unsustainable for the ecosystem service of pollination. This finding is consistent with other studies that have found a synergistic effect between the effects of pesticides and disease. For example, a recent laboratory study demonstrated that chronic exposure to low, realistic doses of two neonicotinoid insecticides, when combined with a sublethal infection of *Crithidia bombi*, significantly reduced queen survival (Fauser-Misslin et al. 2013 p. 454).

There is no doubt that exposure to neonicotinoid pesticides poses numerous risks to the rusty patched bumble bee, from direct lethal effects to sublethal effects including reduced fitness and susceptibility to disease.

<u>Pesticide Use in the Range of Bombus affinis</u>

The United States Geological Survey's Pesticide National Synthesis Project has a website that provides maps of estimated agricultural pesticide use dating back to the mid-1990s. The maps outline the use of more than 420 herbicides, fungicides and insecticides by county. A Xerces Society review of the pesticide use maps found that in 2012 alone approximately 220 pesticides were used within the range of the rusty patched bumble bee (Thelin & Stone 2013, Baker & Stone 2015). These maps do not include non-agricultural use such as that performed by landscapers or backyard gardeners.

In these comments, we provide multiple maps that display pesticide use within the rusty patched bumble bee's range (Figures 2-6). For the active ingredients dinotefuran, clothianidin, imidacloprid, and glyphosate, we generated maps for the first year they were used in the rusty patched bumble bee range as well as the most recent map for 2012 to demonstrate the significant increase in use over that time period.

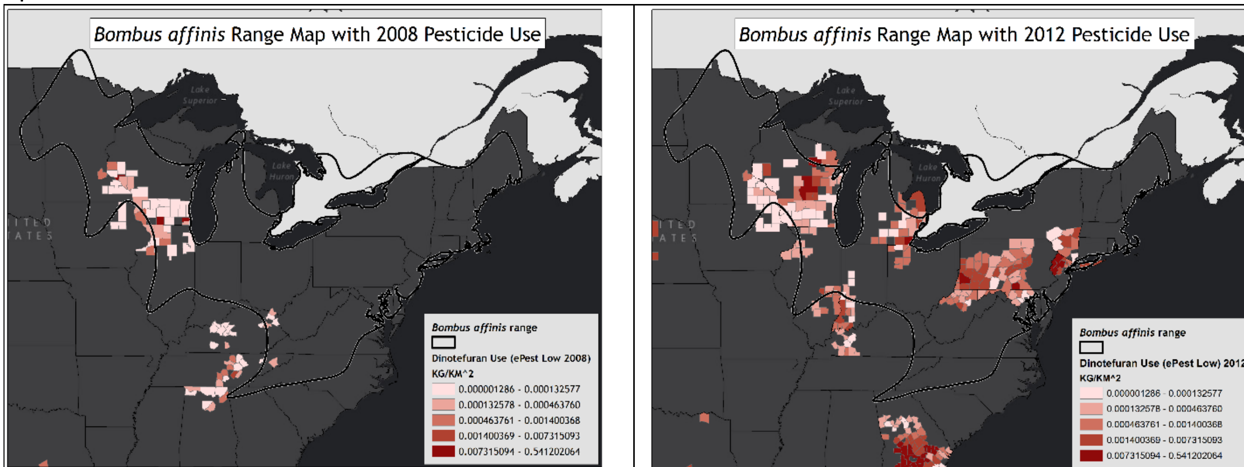

Figure 4: Range of the rusty patched bumble bee with agricultural use of dinotefuran in 2008 on the left, and 2012 on the right. The pesticide data (ePest Low) is from USGS (Thelin & Stone 2013 – left, Baker & Stone 2015 – right) and is displayed in quantiles based on national use of dinotefuran in 2012.

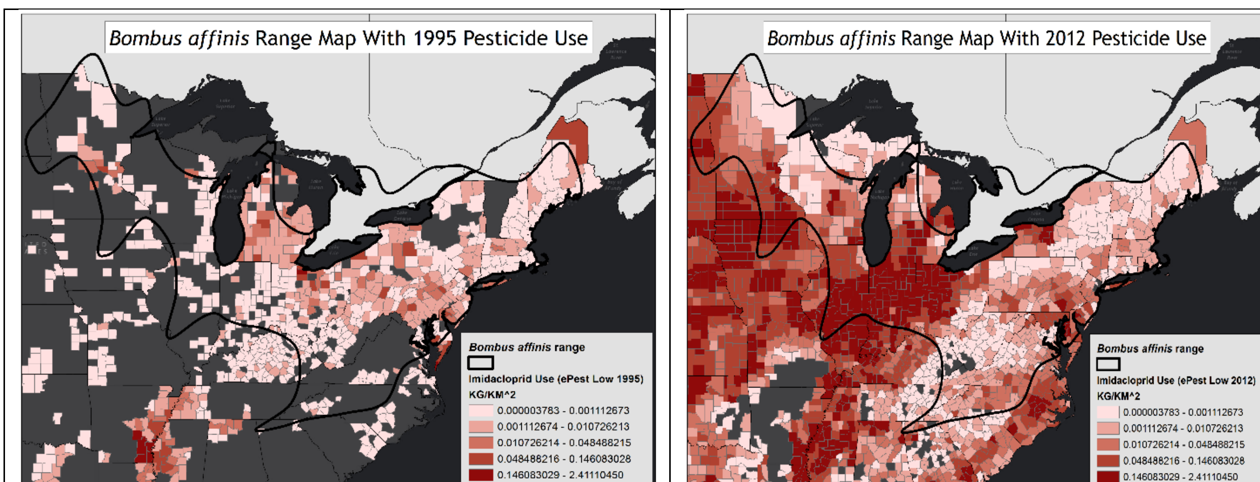

Figure 5: Range of the rusty patched bumble bee with agricultural use of imidacloprid in 1995 on the left, and 2012 on the right. The pesticide data (ePest Low) is from USGS (Thelin & Stone 2013 – left, Baker & Stone 2015 – right) and is displayed in quantiles based on national use of imidacloprid in 2012

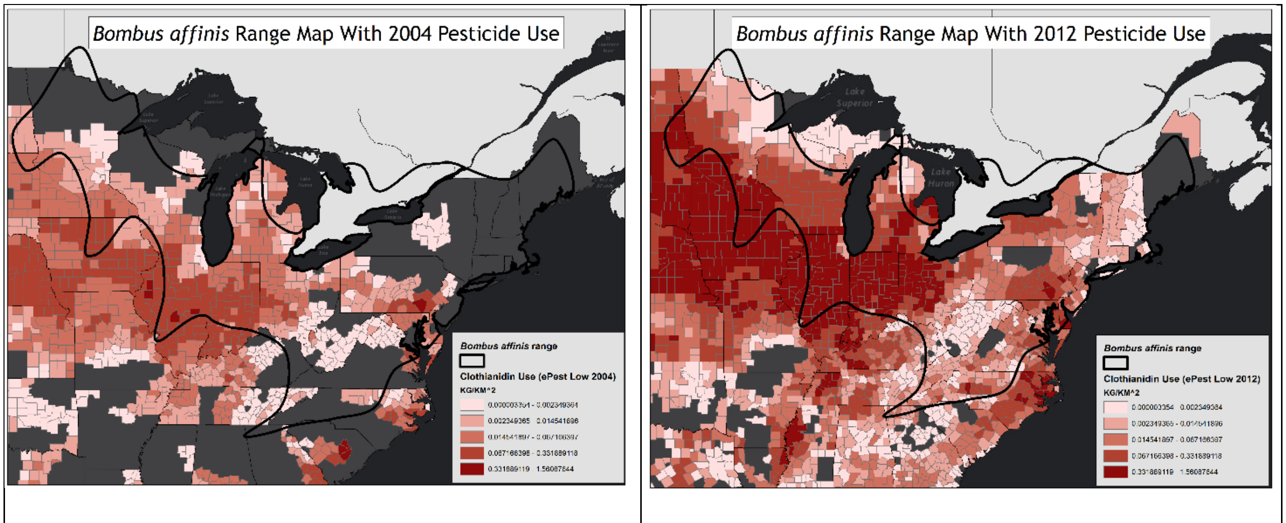

Figure 6: Range of the rusty patched bumble bee with agricultural use of clothianidin in 2004 (left) and 2012 (right). The pesticide data (ePest Low) is from USGS (Thelin & Stone 2013 – left; Baker and Stone 2015 – right) and is displayed in quantiles based on national use of clothianidin in 2012.

<u>Fungicides</u>

Recently published research suggests that fungicides have the potential to negatively impact native bumble bee populations. Bernauer et al. found that bumble bee colonies exposed to field-relevant levels of the fungicide chlorothalonil produced fewer workers, had lower total bee biomass, and had lighter queens than control colonies (2015). The researchers suggested that the use of fungicides during bloom has the potential to severely impact the success of native bumble bee populations foraging in agricultural areas. Since a large proportion of the rusty patched bumble bee's current range is in areas of high agricultural production, it is likely that rusty patched bumble bees are exposed to fungicides on a regular basis.

<u>Interactions with Honey Bees</u>

European honey bees can compete with the rusty patched bumble bee for resources, thus providing an additional threat to the continued existence of the species. A single honey bee colony requires substantial resources to survive. Estimates of single hive consumption vary from 20-130 lbs/year for pollen and 45-330 lbs/year of honey – representing 120-900 lbs/year of nectar (Goulson 2003 and references therein). Depending on the environment and the density of honey bees hives in an area and the time of year, this could represent a substantial proportion of the resources available. This resource competition could have a significant effect on an already imperiled species, like the rusty patched bumble bee – especially during times of year when resources are scarce, yet essential for successful bumble bee reproduction (Goulson 2010; Hatfield et al. 2012).

Additional evidence shows that honey bees are regularly using, and depleting, the most abundant resources in the surrounding environment (Paton 1996; Mallick and Driessen 2009; Shavit et al. 2009), and that upon removal of honey bees, native bees exhibit signs of competitive release by returning to plants that were formerly used by honey bees (Pleasants 1981; Wenner and Thorp 1994; Thorp 1996; Thorp et al. 2000). This resource competition could have significant effects on rusty patched bumble bee populations and threaten the species continued existence.

IV. Recent Research Indicates that the Rusty Patched Bumble Bee is Critically Endangered with Extinction

Since our petition was submitted in January of 2013, additional information about the conservation status of the rusty patched bumble bee has emerged. These reports and findings continue to suggest that the rusty patched bumble bee remains extremely rare throughout its range, is still highly imperiled, and continues to face a number of threats that affect its continued existence.

The most notable update for this species is that the rusty patched bumble bee has been listed on the International Union for the Conservation of Nature (IUCN) Red List as Critically Endangered (Hatfield et al. 2014b). The IUCN assessment provides additional support for the conservation status of this species. In the petition, the authors cited a systematic survey conducted within the historic range by Cameron et al. (2011a) that concluded that the rusty patched bumble bee has disappeared from 87% of its historic range, as well as surveys of historic sites by Colla and Packer (2008) that found that the rusty patched bumble bee was likely extirpated throughout much of its range. The IUCN Bumblebee Specialist Group used a presence-only database of museum records and recent observations of all North American bumble bees to evaluate changes between recent and historic time periods between each species' overall Extent of Occurrence, Persistence, and Relative Abundance (Hatfield et al. 2014a). The IUCN Bumblebee Specialist Group concluded that the rusty patched bumble bee has suffered a greater than 45% decline in Extent of Occurrence (a measure of range loss), a greater than 70% decline in persistence, and a 92.5% decline in relative abundance when compared to historic values (Hatfield et al. 2014). When all three of these metrics are considered together, this species has experienced a nearly 70% decline from its historic values (Hatfield et al. 2014a). Of particular concern is the 92.5% drop in relative abundance. As a result, despite concerted efforts to locate this species, it has dropped from one of the three most common bumble bees throughout its range, to one of the species most difficult to detect (Hatfield et al. 2014b and references therein). The findings of the IUCN Bumblebee Specialist Group provide novel methods of evaluating changes in this species' population size over time, and are consistent with previous findings of Cameron et al. (2011a) and Colla and Packer (2008). Furthermore, a recent survey of the status of bees in the Northeastern United States identified a rapid and recent decline in the rusty patched bumble bee (Bartomeus et al. 2013 p. 4657). Their analysis detected a significant negative decline of this species throughout its range in the northeast, and identified the last collection date from collections they considered as 2001 -- many other species included in their analysis were detected as recently as 2011 (Bartomeus et al. 2013 Table S1).

Recent efforts from citizen scientists have located this species in the Upper Midwest, including observations in Illinois, Wisconsin, Minnesota, and a single observation in Virginia and Iowa (Figure 7). Despite the fact that this species at least remains detectable in parts of the Midwestern United States (IL, WI, MN, and IA), significant survey efforts in the states of Maine and Vermont have not resulted in a single observation of this species to date. In 2012 and 2013 the state of Vermont initiated a statewide bumble bee survey effort ("bumble bee atlas"). In this effort over 10,000 bumble bee specimens were identified, and the rusty patched bumble bee was not detected (McFarland & Richardson 2013). The state of Maine initiated a statewide bumble bee atlas in 2015 and preliminary results from the first year of the study have turned up zero rusty patched bumble bees, although very little of the data have been analyzed (Beth Swartz, Personal Communication with R. Hatfield, October 2015).

Recent concerted efforts to find the rusty patched bumble bee within its historic range have been largely unsuccessful. While there are some remnant populations, particularly in Wisconsin, and parts of

Minnesota this species remains well below its historic relative abundance – and notably absent from much of its range. Conservatively it has disappeared from 45% of its range, and by some estimates nearly 90% of its range. Meanwhile this species has also suffered a greater than 90% decline in relative abundance including zero detections in Vermont and Maine where there have been concerted and systematic efforts to find it. While the rusty patched bumble bee continues to exhibit signs of a species in decline, the threats to the existence of this species continue to mount underscoring the need for protection for this species under the endangered species act.

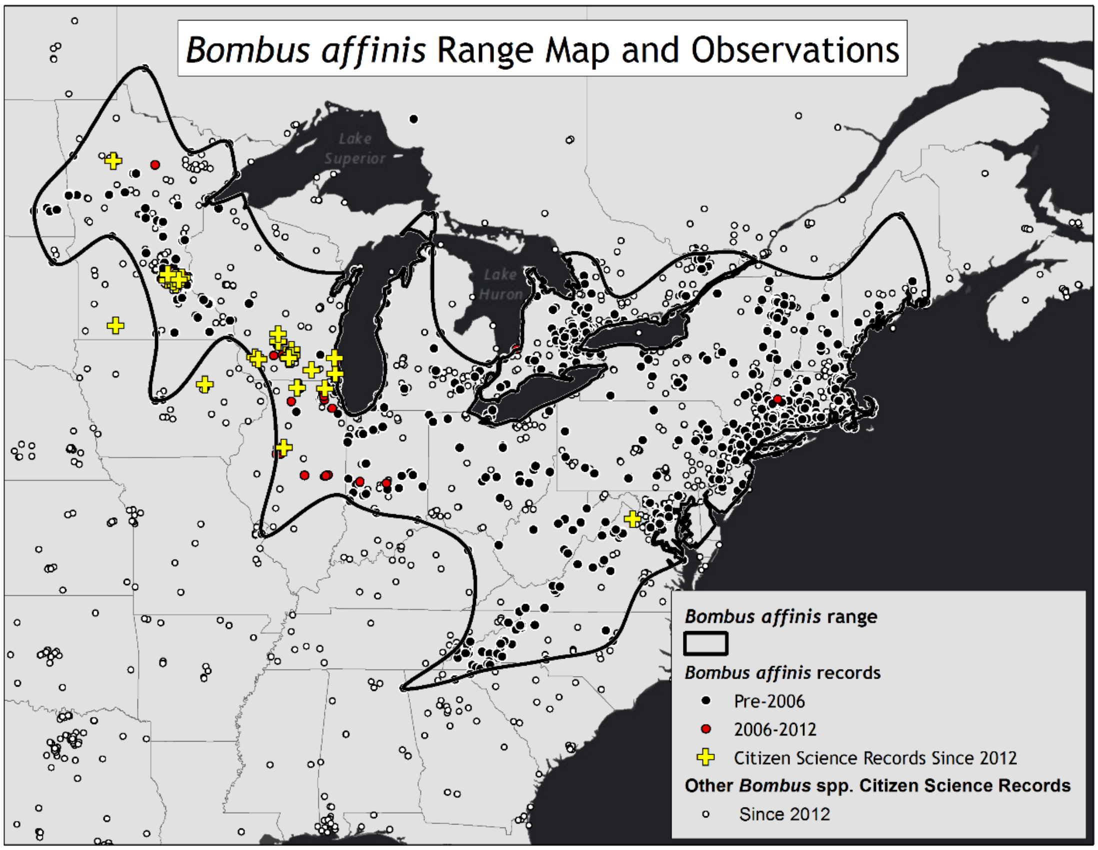

Figure 7: Range of the rusty patched bumble bee with all known records. Records from the last 10 years are displayed in yellow or red (see legend), historic records are in black. Search effort from citizen scientists – displaying areas from which bumble bees (other than the rusty patched bumble bee) have been reported – since 2012 are reported as open circles. This shows that despite significant search effort throughout this species' range, it remains exceedingly rare, particularly in the eastern portion of its range. Data from Hatfield et al. (2014b) and Bumble Bee Watch (2015).

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