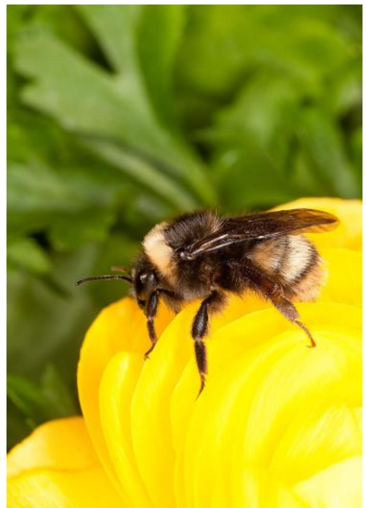
A Petition to list the Western Bumble Bee (*Bombus occidentalis*) as an Endangered, or Alternatively as a Threatened, Species Pursuant to the Endangered Species Act and for the Designation of Critical Habitat for this Species



Bombus occidentalis, Photo courtesy of the Agricultural Research Center, U.S. Department of Agriculture

Submitted to the United States Secretary of the Interior acting through the United States Fish and Wildlife Service

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I. EXECUTIVE SUMMARY

The Western bumble bee (*Bombus occidentalis*) is in danger of extinction. *B. occidentalis* was formerly one of the most common (Goulson, 2008 at 192) and widespread (Thorp, *et al.,* 1983 at 30; Rao & Stephen, 2011 at 64) bumble bees throughout western North America. However, populations of this species have virtually disappeared from the coastal valleys of its range (Rao & Stephen, 2011 at 65–66). *B. occidentalis* went from being one of the common bees in the West to being almost non-existent in large portions of its range in a span of just fifteen years (NatureServe Explorer, at 1; *see also* Rao & Stephen, 2009 at 7). In yearly surveys conducted between 1999 and 2008, researchers collected only 13 *B. occidentalis* in southern Oregon and northern California (Rao & Stephen, 2011 at 66). In 2007, researchers were able to identify *B. occidentalis* in only a quarter of its historic sites in Utah, northeastern California, southern Oregon, and Nevada (Rao & Stephen, 2011 at 66). In Alaska between 2001 and 2008, researchers collected only two *B. occidentalis* specimens (Evans, *et al*., 2008 at 20 (compiled from unpublished data)). Declines in *B. occidentalis* were also reported in Colorado in 2010 (*see* NatureServe Explorer, at 2 (citing Cranshaw, 2010)), and there is evidence of losses in Canada as well. Bumble bee surveys conducted in British Columbia between 2000 and 2001 suggest there has been a decline in *B. occidentalis* over the past 20 years. Once one of the most common bumble bees in British Columbia in 1981, only two *B. occidentalis* individuals were seen during field surveys in 2000 and 2001 (Tommasi, *et al*., 2004 at 865).

There are numerous threats to *B. occidentalis'* continued existence. The major threats are diseases introduced by commercially reared bumble bees (*see* Cordes, *et al.,* 2012 at 213; Durrer & Schmid-Hempel, 1994 at 299, 301; Brown, *et al.,* 2003 at 994, 1000; Otterstatter & Whidden, 2004 at 355) and the use of pesticides (Thompson & Hunt, 1999 at 147; Goulson, *et al.,* 2008 at 194; *see also* Laycock, *et al.,* 2012 at 1937; Kearns, *et al.,* 1998 at 91-92). In addition, *B. occidentalis* faces other threats, which include habitat destruction (Öckinger & Smith, 2007 at 56), degradation, and loss (Hines & Hendrix, 2005 at 1481; Kimoto, 2012b at 12–13; Ahrné, *et al.,* 2009 at 4), changes in population dynamics (Whitehorn, *et al.,* 2009 at 2, 5–6), and climate change (*see* Memmott, *et al.,* 2007 at 6).

Defenders of Wildlife (Defenders) requests that the U.S. Secretary of the Interior, acting through the U.S. Fish and Wildlife Service (Service), list the Western bumble bee (*Bombus occidentalis*) as an endangered, or alternatively as a threatened, species under the Endangered Species Act (ESA), (16 U.S.C. §§ 1531-44), and concurrently designate critical habitat for this species as required by the ESA. *Id.* § 1533(b)(6)(C). Defenders submits this petition pursuant to the ESA, *Id.* § 1533, and the Administrative Procedure Act (APA), 5 U.S.C. § 555(e).

II. ENDANGERED SPECIES ACT AND IMPLEMENTING REGULATIONS

In 1973, Congress enacted the Endangered Species Act to conserve the ecosystems upon which endangered and threatened species depend and to provide a program for the conservation of such species. 16 U.S.C. § 1531(b). These ESA protections apply only to species that have been listed as endangered or threated under the provisions of the Act.

The ESA defines an endangered species as one that is "in danger of extinction throughout all or a significant portion of its range." *Id.*§ 1532(6). A "threatened species" is one that "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." *Id.* § 1532(20). The Service must consider the following five listing factors set forth in 16 U.S.C. § 1533(a)(1) in evaluating whether a species is threatened or endangered:

A. The present or threatened destruction, modification, or curtailment of its habitat or range;

B. Overutilization for commercial, recreational, scientific, or educational purposes;

C. Disease or predation;

D. The inadequacy of existing regulatory mechanisms; or

E. Other natural or manmade factors affecting its continued existence.

A species need only be imperiled by one, or any combination of, the above listing factors to qualify for federal listing as an endangered or threatened species. 50 C.F.R. § 424.11(c).

The Service is required to make a listing determination "solely on the basis of the best scientific and commercial data available to [it] after conducting a review of the status of the species and after taking into account" existing efforts to protect the species. 16 U.S.C. § 1533(b)(1)(A); *see also* 50 C.F.R. §§ 424.11(b), (f).

Upon receipt of a listing petition, the Service is required to determine "whether the petition presents substantial scientific or commercial information indicating that the petitioned action may be warranted" within 90-days. 16 U.S.C. § 1533(b)(3)(A). For purposes of the 90-day finding, the ESA defines "substantial information" as "that amount of information that would lead a reasonable person to believe that the measure proposed in the petition may be warranted." 50 C.F.R. § 424.14(b)(1). If the Service concludes that the listing of a species may be warranted, the Service has twelve months, from the date the petition was received, to institute a status review and determine whether the species will be listed. 16 U.S.C. § 1533(b)(3)(B). If not warranted, the listing process ends. The ESA authorizes judicial review of both the 90-day and 12-month findings. *Id.* § 1533(b)(3)(C)(ii).

III. TAXONOMIC STATUS

All bumble bees belong to the genus *Bombus* within the family *Apidae*. The Western bumble bee (*Bombus occidentalis*) belongs to the subgenus *Bombus sensu stricto*. *Bombus sensu stricto* is well supported as a distinct subgenus (Williams, *et al.,* 2008 at 53, tbl. 1). Dr. Edward Greene was the first to describe *B. occidentalis* (Greene, 1862 at 12). The full taxonomic classification of *B. occidentalis* is shown in Table 1.

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

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

B. occidentalis is recognized as a valid species under the Integrated Taxonomic Information System (ITIS) (ITIS Report). Although *B. occidentalis* and *B. terricola* were considered to be a single species in the past (*see* Thorp, *et al.,* 1983 at 31), this view is generally no longer accepted (NatureServe Explorer, at 1; ITIS Report; Williams, *et al.,* 2012 at 19). More recent scientific studies have concluded that *B. occidentalis* and *B. terricola* should be regarded as distinct, separate species (Williams, *et al.,* 2012 at 19; ITIS Report). Drs. Robin Owen and Troy Whidden demonstrated that the two species (*B. terricola* and *B. occidentalis*) can be distinguished by wing morphometrics as well as RAPD genotypes and that color pattern variation is present only in *B. occidentalis* (Owen & Whidden, 2013 at 328). Dr. Paul Williams has also concluded that *B. occidentalis* and *B. terricola* should be acknowledged as distinct species (Williams, *et al.,* 2012 at 19). Even in 1983, Dr. Robbin Thorp believed *B. occidentalis* was distinct from *B. terricola* (Thorp, *et al.,* 1983 at 32).

IV. SPECIES DESCRIPTION

A. Queens and Workers

B. occidentalis queens and workers have similar coloration. Queens are between 17 and 19 millimeters in length and 9 to 10 millimeters in width. Workers are between 9 and 14 millimeters in length and 5 to 7 millimeters in width. The hair on their heads is black while the hair on the front part of the thorax is yellow. The first to basal section of the fourth abdominal segments are covered with black hair (Greene, 1862 at 170). Whitish hair appears on the apex of the fourth abdominal segment as well as the fifth and sixth segments (Greene, 1862 at 170). Their legs are also covered in black hair.

B. Males

Males are 13 to 17 millimeters in length and 6 to 8 millimeters in width. The hair on the front of their faces is pale yellowish. Pale yellowish hairs appear on the top of the head medially with some black hair appearing laterally. The front of the thorax is pale yellowish. The first to third and basal part of the fourth abdominal segments of the Male is covered with black hair. The remainder of the body, including segments five to seven, is covered with whitish hair (Evans, *et al.,* 2008 at 17).

Within the subgenus *Bombus*, the *B. occidentalis* is the most chromatically variable North American species (Evans, *et al.,* 2008 at 17). In his revision of New World bumble bees, Franklin (1913) describes twelve female and twelve male variants of the *B. occidentalis*. The large number of variants in the appearance of the species led to a variety of names being applied to this species. (Thorp, *et al.,* 1983 at 13). The major color variants of *B. occidentalis* females, are pictured in Figure 1.

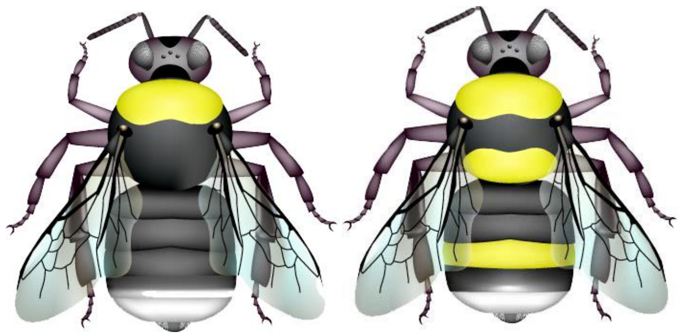

Figure 1: Illustrations by Elaine Evans (Evans, *et al.,* 2008 at 18).

V. BIOLOGY, HABITAT REQUIREMENTS AND POLLINATION ECOLOGY

A. Biology

B. occidentalis colonies are made up of a queen and her offspring, workers, and males. The colony divides labor between these types of bees. The queen is responsible for founding the colony and laying eggs; workers' duties are collecting food, defending the colony, and feeding the young; and the males' only task is mating with the queen (Evans, *et al.,* 2008 at 4-5).

Bumble bee colonies are established on an annual basis (Thorp, *et al.,* 1983 at 1; Elliott, 2009 at 749). A single queen starts the colony in the spring with workers, males, and more queens produced throughout the year (*see* Thorp, *et al.,* 1983 at 1). At the end of the colony cycle, young queens mate with a colony male before entering a type of hibernation called diapause (Thorp, *et al,* 1983 at 2; Elliott, 2009 at 749). The queens come out of hibernation in spring and begin the process anew by selecting a new underground nest site (Elliott, 2009 at 749). In the early stages of the colony, the queen is responsible for collecting all of the colony's food and caring for her young. She gathers nectar and pollen to support egg production and fertilizes her eggs with the sperm she stored from mating before entering diapause the previous fall (*see also* Thorp, *et al.,* 1983 at 1; Elliott, 2009 at 749). As the colony develops, the workers take over food collection, defense, and caring for the young while the queen stays in the nest to lay eggs. Bumble bees, including *B. occidentalis*, generally follow this colony cycle pattern (*see* Thorp, *et al.,* 1983 at 1–2; Elliott, 2009 at 749). *B. occidentalis* has a high output rate for single colony, producing approximately 1,007 workers and males and 146 queens in a single season (Koch & Strange, 2009 at 100). New males and queens are produced in the later stages of the colony's development (*see* Thorp, *et al.,* 1983 at 1–2).

As a generalist forager, *B. occidentalis*, like other bumble bee subspecies*,* requires a continuous supply of flowering plants (*see* Hatfield & Lebuhn, 2007 at 156; *see also* Carvell, 2002 at 33). Pollen availability may impact future bumble bee population levels because a colony's queen production depends on pollen availability (Hatfield & Lebuhn, 2007 at 157). Thus, because only queens are capable of forming new colonies, deficient pollen resources could lead to a reduced number of *B. occidentalis* colonies, and therefore to decreased populations.

The entire *Bombus* subgenus is more susceptible to extinction than most other species due to their haplodiploid method of sex determination (Zayed & Packer, 2005 at 10742). As their populations decrease the species begins to inbreed resulting is a loss of genetic diversity, which in turn increases their production of non-viable diploid male bees (Darvill, *et al.,* 2012 at 3993; Darvill, *et al*., 2006 at 601, 608; Goulson, *et al*., 2008 at 197). This reduces the colonies' reproductive output and can lead to collapse.

B. Habitat Requirements

Bumble bees, including *B. occidentalis,* require habitats rich with floral resources and continuous blooming from spring to fall (Hatfield & Lebuhn, 2007 at 156–57). Bumble bees benefit in terms of species richness and abundance when there is a high abundance of nectar and pollen resources and a continuous availability of nectar throughout the season (Öckinger & Smith, 2007 at 51). Isolated patches of habitat, like those found in urban landscapes, have negative effects on species richness and abundance (Hatfield & Lebuhn, 2007 at 156–57). These landscapes may not be sufficient to fully support *B. occidentalis* populations. Bumble bees, including *B. occidentalis*, benefit from landscapes offering meadow complexes with a variety of habitats with continuous availability of floral resources throughout the year (Hatfield & Lebuhn, 2007 at 156). In particular, the availability of floral resources late in the season may affect species fitness because this is the time in the season that bumble bee communities produce reproductive bees (Hatfield & Lebuhn, 2007 at 157). Additionally, bumble bee populations may be negatively affected when nest sites and nectar and pollen sources are too isolated from one another (Öckinger & Smith, 2007 at 51). This occurs particularly in landscapes that include fragmented habitats. *B. occidentalis* mainly nests underground in abandoned rodent nests just below the surface (Thorp, *et al*., 1983 at 1; *see also* Elliott, 2009 at 749). Therefore, viable nesting sites depend on the habitat's rodent abundance.

C. Pollination Ecology

Although a general forager, *B. occidentalis*, as well as other bumble bee subspecies, is an important pollinator of several wild flowers and agricultural crops (Öckinger & Smith, 2007 at 56-57). Additionally, some populations of wild flowers depend exclusively on bumble bees for pollination (Koch & Strange, 2009 at 97). Bumble bees are better suited and more efficient than commercially reared honey bees in facilitating the fruit-set of important crops such as blueberry, cranberry, greenhouse tomatoes, and greenhouse sweet peppers (*see, e.g.,* Javorek, *et al*., 2002 at 349; Koch & Strange, 2009 at 97). Bumble bees have been recognized as the most effective pollinators of cranberries in America (Ortwine-Boes & Silbernagel, 2003 at 1). *B. occidentalis* has been used to pollinate commercial avocado crops (McNeil & Pidduck, 2001 at 254) and was tested for use in almond pollination in California in 1993, 1995, and 1996 and on caged almond trees in California in 1994 (Evans, *et al.,* 2008 at 18). Thus, without the pollination provided by *B. occidentalis* and other bumble bee species, many insect-pollinated plant populations would be in jeopardy (Koch & Strange, 2009 at 97).

B. occidentalis visits a wide variety of wildflowers including, among others, *Aster* spp. (Thorp, *et al.,* 1983 at 31), *Brassica* spp. (Thorp, *et al.,* 1983 at 31), *Centaurea* spp. (Thorp, *et al.,* 1983 at 31), *Cimicifuga arizonica* (Pellmyr, 1985 at 409-11), *Corydalis caseana* (Maloof, 2001 at 1961), *Chrysothamnus* spp. (Thorp, *et al.,* 1983 at 31), *Cirsium* spp. (Thorp, *et al.,* 1983 at 31), *Cosmos* spp. (Thorp, *et al.,* 1983 at 31), *Dahlia* spp. (Thorp, *et al.,* 1983 at 31), *Delphinium nuttallianum* (Irwin & Maloof, 2002 at 526), *Erythronium grandiflorum* (Thomson, 1986 at 330–33), *Foeniculum* spp. (Thorp, *et al.,* 1983 at 31), *Geranium* spp. (Thorp, *et al.,* 1983 at 31), *Gladiolus* spp. (Thorp, *et al.,* 1983 at 31), *Grindelia* spp. (Thorp, *et al.,* 1983 at 31), *Haplopappus* spp. (Thorp, *et al.,* 1983 at 31), *Hypochoeris* spp. (Thorp, *et al.,* 1983 at 31), *Ipomopsis aggregata* (Irwin & Brody, 1999 at 1704), *Lathyrus* spp. (Thorp, *et al.,* 1983 at 31), *Linaria vulgaris* (Irwin & Maloof, 2002 at 526), *Lotus* spp. (Thorp, *et al.,* 1983 at 31), *Lupinus monticola* (Bauer, 1983 at 141, tbl. 5), *Mentha* spp. (Thorp, *et al.,* 1983 at 31), *Medicago* spp. (Thorp, *et al.,* 1983 at 31), *Melilotus* spp. (Thorp, *et al.,* 1983 at 31), *Mertensia ciliata* (Bauer, 1983 at 141, tbl. 5), *Monardella* spp. (Thorp, *et al.,* 1983 at 31), *Nama* spp. (Thorp, *et al.,* 1983 at 31), *Origanum* spp. (Thorp, *et al.,* 1983 at 31), *Orthocarpus* spp. (Thorp, *et al.,* 1983 at 31), *Pedicularis groenlandica* (Macior, 1968b at 930), *Penstemon procerus* (Bauer, 1983 at 141, tbl. 5), *Phacelia* spp. (Thorp, *et al.,* 1983 at 31), *Prunus* spp. (Thorp, *et al.,* 1983 at 31), *Raphanus* spp. (Thorp, *et al.,* 1983 at 31), *Rhododendron* spp. (Thorp, *et al.,* 1983 at 31), *Salix* spp. (Thorp, *et al.,* 1983 at 31), *Salvia* spp. (Thorp, *et al.,* 1983 at 31), *Solidago* spp. (Thorp, *et al.,* 198 at 31), *Symphoricarpos* spp. (Thorp, *et al.,* 1983 at 31), *Tanacetum* spp. (Thorp, *et al.,* 1983 at 31), *Taraxacum* spp. (Thorp, *et al.,* 1983 at 31), *Trifolium dasyphyllum* (Bauer, 1983 at 141, Tbl. 5), *Trichostema* spp. (Thorp, *et al.,* 1983 at 31), *Trifolium* spp. (Thorp, *et al.,* 1983 at 31), and *Zea* spp. (Thorp, *et al.,* 1983 at 31). This makes theman important species for wildflower pollination as well.

VI. POPULATION STATUS AND DISTRIBUTION

A. Historic Distribution

B. occidentalis was once the most common bumble bee in western North America (Goulson, *et al.*, 2008 at 192) and was the second most common bumble bee in the western United States until the mid-1990s (NatureServe Explorer, 2010). *B. occidentalis'* range spanned from western South Dakota to northern New Mexico and Arizona, east to Alberta, and from Southern Alaska to central California (Thorp, *et al.,* 1983 at 30; Rao & Stephen, 2011 at 64). This range included northern California, Oregon, Washington, Alaska, Idaho, Montana, western Nebraska, western North Dakota, western South Dakota, Wyoming, Utah, Colorado, northern Arizona, and New Mexico (*see* Koch & Strange, 2009 at 99; Rao & Stephen, 2011 at 64; Figure 2, *infra*). Its historic range also included the Canadian provinces of Alberta, British Columbia, Saskatchewan, and the Yukon Territory (Evans, *et al.,* 2008 at 19).

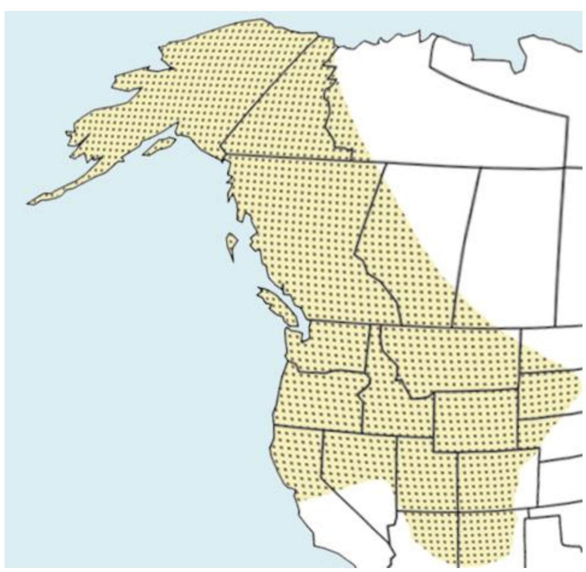

Figure 2. Map of the *B. occidentalis* historic range. (Map by Xerces Society, compiled with data from Milliron 1971, *available at* http://www.xerces.org/western-bumble-bee/).

B. Present Distribution

Declines in *B. occidentalis* populations were first noted in the 1990s, when the species was no longer found in the coastal valleys of its historic range (Rao & Stephen, 2011 at 64; Goulson, *et al.*, 2008 at 192). The subgenus *Bombus sensu stricto*, which includes *B. occidentalis*, is experiencing the most dramatic declines of all bumble bee species (Koch & Strange, 2012 at 212). Since 1998, this decline has been most dramatic across western and central California, western Oregon, western Washington, and British Columbia (Evans, *et al.*, 2008 at 19). In just fifteen years, *B. occidentalis* went from being one of the most common species of bumble bees in North America to being almost non-existent in large portions of its range, and rare in others (NatureServe Explorer; *see also* Rao & Stephen, 2009 at 7; Koch & Strange, 2012 at 212). Currently, *B. occidentalis* has healthy populations in only a few isolated areas, primarily in the Rocky Mountain region (NatureServe Explorer).

Evidence for *B. occidentalis* decline is based on extensive surveys conducted by research entomologists across western North America. Numerous studies show that *B. occidentalis* populations have declined in the coastal valleys of its range (Rao & Stephen, 2011 at 65–66). Between 2004 and 2007, only six *B. occidentalis* specimens were recorded in yearly surveys conducted in western Oregon (Rao & Stephen, 2011 at 65–66; Rao & Stephen, 2009 at 7). In a survey conducted between 2008 and 2009, thousands of different types of bumble bees were collected in areas of western Oregon, but only twelve of the individuals captured were *B. occidentalis* (Rao & Stephen, 2011 at 66). Additionally, in yearly surveys in southern Oregon and northern California from 1999 to 2008, only 13 *B. occidentalis* were observed or collected (Rao & Stephen, 2011 at 66).

Since 2002, Dr. Robbin Thorp has collected or observed more than 12,000 bumble bees in Oregon and California, but has collected only one *B. occidentalis* (Evans, *et al.,* 2008 at 21, 23, tbl. 5 (compiled from unpublished data)). Between 1998 and 2008, Dr. Thorp reported that the relative abundance rate for *B. occidentalis* had declined precipitously (Evans, *et al.,* 2008 at 23, tbl. 5 (compiled from unpublished data)). In 1998, Dr. Thorp reported that *B. occidentalis* made up 12.03% of all bumble bees collected for his surveys. Just one year later, Thorp reported that it had fallen to just 1.53%. By 2003, the relative abundance rate for *B. occidentalis* dropped to zero, and it has not recovered since then (*see* Figure 3; Evans, *et al.,* 2008 at 23, tbl. 5 (citing Thorp 2008)). Declines in *B. occidentalis* abundance have also been reported across its range in Alberta, Canada (Koch & Strange, 2012 at 212).

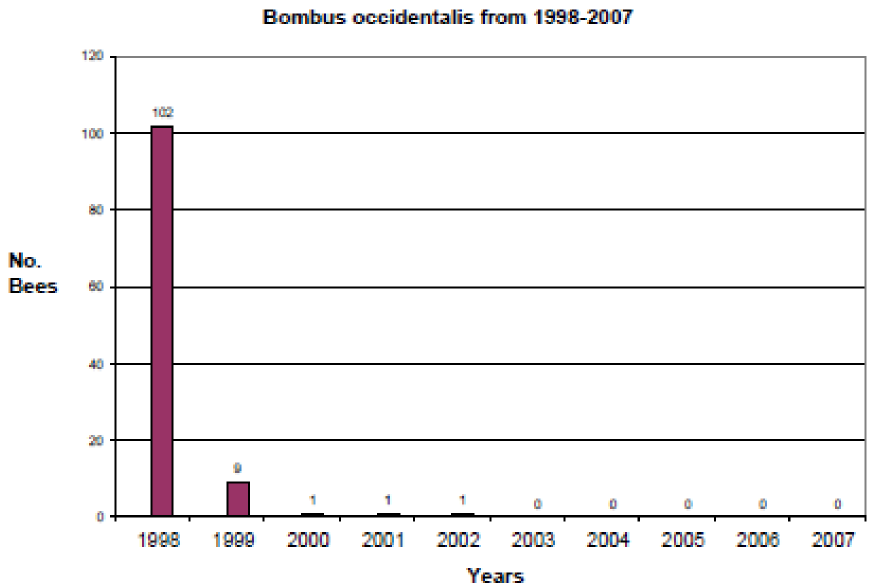

Figure 3. In yearly surveys of southern Oregon and northern California, Thorp observed 15,573 bumble bees. Thorp observed 102 *B. occidentalis* in 1998 and none in 2003 through 2007. (Evans, *et al.,* 2008 at 21, 23, tbl. 5 (compiled from data presented in Thorp, 2008)).

Researchers in Oregon's Willamette Valley did not report a single *B. occidentalis* sighting from 1997 through 2005, leading surveyors to believe that *B. occidentalis* had been extirpated from some parts of its historical range (Rao & Stephen, 2009 at 7). In a 2008 study conducted in Mt. Ashland, Oregon, a single *B. occidentalis* was detected in a survey that included over 2,000 bees (Evans, *et al.,* 2008 at 21 (compiled from unpublished data)). Researchers reported that in studies conducted in eastern Oregon, *B. occidentalis* made up less than half of one percent of the relative abundance rate of all bumble bees collected in 2007 (Evans, *et al.,* 2008 at 21).

In a more widespread survey that Dr. James Strange and his colleagues conducted in 2007, they found *B. occidentalis* in only one-quarter of the historical sites they visited in Utah, northeastern California, southern Oregon, and Nevada (Rao & Stephen, 2011 at 66). In Alaska, only two *B. occidentalis* specimens were collected between 2001 and 2008 (Evans, *et al.*, 2008 at 20 (compiled from unpublished data)). In 2010, Cranshaw reported declines in *B. occidentalis* as far east as Colorado (*see* NatureServe Explorer, at 2). Collections of 3,834 bumble bees in San Francisco in 2003 and 2004 revealed no specimens of *B. occidentalis,* where the species was once commonly collected (McFrederick & LeBuhn, 2006 at 378, tbl. 2). Similar population losses are present throughout Canada where *B. occidentalis* has suffered declines in large portions of southern Canada, leading the Committee on the Status of Endangered Wildlife in Canada to list the bee as "Threatened" In Canada (COSEWIC, 2014 at 1). Surveys of British Columbia bumble bees in 2000 and 2001 likewise suggest a decline in *B. occidentalis* over the past 20 years. *B. occidentalis* was once one of the most abundant wild bees in the a surveyed area in 1981, but only two individuals were observed during the 2000 and 2001 field seasons (Tommasi, *et al.*, 2004 at 865).

B. occidentalis is not currently listed on the International Union for the Conservation of Nature's (IUCN) Red List (IUCN Red List of Threated Species). However, a study in 2009 applied IUCN Red List criteria across the entire range of both *B. occidentalis* and *B. terricola,* and found that they would be listed as endangered if they were assessed (Williams & Osborne, 2009 at 377). This study was conducted before *B. occidentalis* was recognized as a distinct subspecies of bumble bee, and, therefore, it is likely conservative. Additionally, in 2011, NatureServe changed *B. occidentalis'* ranking from G4 to G2/G3 (meaning that the species is now globally imperiled/vulnerable, where it was considered globally apparently secure before), noting the ranking would likely need to be changed to a more severe threat ranking again within five years (NatureServe Explorer). Declines in *B. occidentalis* populations are "on-going and continent-wide." (NatureServe Explorer). NatureServe stated "[i]n a plausible worst case scenario some or all endemic North American species of subgenus Bombus could be extinct within a decade or two. . . ." (NatureServe Explorer).

VII. CURRENT AND POTENTIAL THREATS – SUMMARY OF FACTORS FOR CONSIDERATION

Many factors have contributed to the drastic *B. occidentalis* decline. Habitat alterations that destroy, fragment, degrade, or reduce the bee's food supplies and nest sites all negatively impact *B. occidentalis* (Öckinger & Smith, 2007 at 56; Darvill, *et al.,* 2012 at 3993). Habitat loss is attributable to agricultural intensification (Hines & Hendrix, 2005 at 1481), livestock grazing (Kimoto, 2012b at 12–13), urban development (Ahrné, *et al.,* 2009 at 4; Bhattacharya, *et al.,* 2003 at 44), and fragmentation of landscapes (Öckinger & Smith, 2007 at 56). However, perhaps the most significant factor in the species' decline is the recent introduction of non-native fungal and protozoan parasites, including *Nosema bombi* (Colla, *et al.,* 2006 at 464-65) and *Crithidia bombi* (Brown, *et al.,* 2003 at 994, 1000). In addition, pesticide application threatens the entire species as *B. Occidentalis* has both direct and indirect contact with these chemicals and they have been known to negatively affect bumble bees (Gels, 2002 at 723; Thompson, 2001 at 312). Neonicotinoid pesticides are particularly harmful to bumble bees, with just trace amounts of these pesticides resulting in reduced fecundity (Laycock, *et al.,* 2012 at 1937). Similarly, insecticides have been shown to result in bumble bee deaths, (*see* Thompson & Hunt, 1999 at 163), while herbicides reduce the number of suitable nesting sites and reduce the availability of floral resources (Kearns & Inouye, 1997 at 300). Lastly, global climate change is also a likely contributing factor to *B. occidentalis* population declines (*see* Memmott, *et al.,* 2007 at 6).

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

Destruction, modification and curtailment of habitat is a significant threat to bumble bees, including *B. occidentalis*. Habitat alteration, including intensive agricultural practices (Hines & Hendrix, 2005 at 1481), livestock grazing (Kimoto, 2012b at 12–13), urbanization (Ahrné, *et al.,* 2009 at 4; Bhattacharya, *et al.,* 2003 at 44), and fire suppression (Panzer, 2002 at 1297; Schultz & Crone, 1998 at 244), affect *B. occidentalis* by severely limiting the species' access to floral resources, destroying nesting and hibernation habitat, and contributing to a loss of genetic diversity (Goulson, *et al.*, 2004 at 1; Öckinger & Smith, 2007 at 56). Each of these contributes to decline in *B. occidentalis* populations.

Bumble bee abundance and species richness are affected by habitat fragmentation from different landscape-level disturbances (Hatfield & LeBuhn, 2007 at 155). Habitat fragmentation creates isolated patches of habitat resulting in the creation of small and isolated populations of bumble bees (Darvill, *et al.,* 2006 at 601). Without immigration from other bee populations, these isolated populations may suffer from a lack of genetic diversity (Darvill, *et al.,* 2006 at 601, 607-08).

When floral resources and nesting habitat are isolated from each other, central place foraging bumble bees may be unable to utilize them, negatively affecting their populations (Öckinger & Smith, 2007 at 56). Though bumble bees are generally central-place foragers, some bumble bees fly long distances to forage (Öckinger & Smith, 2007 at 56). These bee species may be able overcome problems with isolated resources. However, *B. occidentalis* is a central foraging bumble bee (*see* Elliott, 2009 at 752; *see also* Hatfield & Lebuhn, 2007 at 151). Consequently, continued habitat fragmentation and isolation of foraging and nesting sites will have a negative effect on *B. occidentalis* populations. The reduction of foraging habitat due to fragmentation has been shown to increase inbreeding, especially in populations limited to less than 15 square kilometers of suitable habitat (Darvill, *et al.,* 2012 at 3993). This habitat fragmentation and resultant isolation thus leads to a loss in genetic diversity (Ellis, *et al.,* 2006 at 4384). A loss of genetic diversity among bumble bee populations could lead to inbreeding depression, making it difficult for the bees to respond to changes in the environment (Darvill, *et al.,* 2006 at 601, 608). Evidence now shows that inbreeding also contributes to declines in both individual bee and overall bee population performance (Darvill, *et al.*, 2006 at 601, 608; *see* Goulson, *et al.*, 2008 at 197).[2]

Loss of plant diversity in agricultural habitats has also been linked to a decline in bee diversity (Le Féon, *et al.,* 2010 at 147). Grasslands have declined significantly in the United States and are considered a critically endangered ecosystem (Noss, *et al.,* 1995 at 7). Specifically, there have been significant losses of native grasslands in *B. occidentalis'* historic range, including a 47 percent loss of native grassland in South Dakota by 1977 with continued significant losses; a 90 percent loss of native grasslands in North Dakota; an 80-90 percent loss of native grasslands in western Montana; a 99 percent loss of native grasslands in California; and a loss of more than 90 percent of native shurp-steppe grassland in Oregon and southwestern Washington (Noss, *et al.,* 1995 at 68-75). This ongoing habitat loss is both a current and future threat to the species.

1. Agricultural Intensification

Intensive agricultural practice is synonymous with the heavy use of pesticides[3] and fertilizers, increased mechanization and farm size, as well as a focus on high productivity (Le Féon, *et al.,* 2010 at 143). These practices directly harm bees, impact the availability of floral and other habitat resources, and likely contribute to declines in species richness, abundance, and diversity. In North America, trends show declines of bumble bee populations in native habitats that have been altered by agricultural practices (Grixti, *et al*., 2009 at 76; Hines & Hendrix, 2005 at 1477). Likewise, studies from Europe show that agricultural intensification, and changes in land-use and farming practices, contribute to declines in bumble bee richness and abundance (Le Féon, *et al.,* 2010 at 143, 148; Carvell, *et al.,* 2006 at 481, 486; Goulson, *et al.,* 2004 at 1; Goulson, *et al*., 2008 at 193).

Intensive agricultural practice fragments and alters native grasslands and reduces the available habitat for bumble bees. Bumble bee diversity and abundance is positively related with the abundance of floral resources and tall grass prairie habitat patches (Hines & Hendrix, 2005 at 1481; *see also* Kimoto, *et al.,* 2012a at 15). Native tall grass habitats are typically abundant in floral resources that bumble bees utilize as food sources and suitable nesting sites (Hines & Hendrix, 2005 at 1477-78). Native grasslands and the marginal grassy areas surrounding them are also common nesting sites

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[2] This is discussed in depth in Section (VII)(D)(5) "Population Dynamics and Structure," *infra*.
[3] The impact of pesticides is discussed in Section (VII)(D)(1) "Pesticides," *infra*.

for bumble bees (Hines & Hendrix, 2005 at 1483; Kimoto, *et al.,* 2012a at 15). The loss of these areas is likely contributing to the decline of bumble bees throughout North America.

In agricultural areas, some mass flowering crops provide nectar and pollen resources for bumble bees that can lead to increased densities of bumble bees and colony growth (Westphal, *et al.,* 2003 at 964). However, the increased planting of genetically modified crops that are tolerant to herbicides leads to increased use of those herbicides, thus reducing the availability of wildflowers in agricultural field margins (Pleasants & Oberhauser, 2013 at 136, 143). The loss of plant diversity close to nesting sites may decrease foraging access, as Drs. John Pleasants and Karen Oberhauser demonstrated with the Monarch butterfly (Pleasants & Oberhauser, 2013 at 136, 143). Likewise, genetically modified crops can create monocultures shown to harm the reproductive success of bumble bees (Westphal, *et al*., 2009 at 191-92; Goulson, *et al*., 2008 at 193). Monocultures typically provide floral resources only for a short period of time, whereas bumble bee colonies need them throughout their colony life cycle from early spring to late fall (Westphal, *et al*., 2009 at 192; *see also* Goulson, *et al*., 2008 at 193). As a result, agricultural intensification poses a serious threat to *B. occidentalis*.

2. Livestock Grazing

Livestock grazing is one of the most common land uses in Western North America (Kimoto, 2010 at 1; *see also* Kimoto, 2012b at 2). *Bombus* as a genus, are sensitive to grazing (Kimoto, 2010 at 85). Studies conducted both in North America and in Asia have shown that unmanaged or excessive grazing negatively impacts the floral and nesting resources of bumble bees, contributing to a decline in overall bee abundance and richness (Kimoto, 2012b at 10, 12–13; Hatfield & Lebuhn, 2007 at 154; Xie, *et al*., 2008 at 700-01). Livestock animals have a disproportionate effect on the ecosystems in which they are introduced (Vazquez & Simberloff, 2003 at 1081). Herbivores like cattle and sheep may have a disproportionately strong impact on the plant-pollinator relationship in that same ecosystem (Vazquez & Simberloff, 2003 at 1081).

Selective defoliation, trampling, and nitrogen deposition from livestock grazing shape plant community structure and diversity (Scohier, *et al.,* 2013 at 287). Low grazing intensity preserves floral resources benefitting bumble bees (Scohier, *et al.,* 2013 at 287, 292). However, in highly grazed areas, the height of floral resources decreases significantly, which can lead to decreases in species richness and abundance (Xie, *et al*., 2008 at 701). The reduction of vegetation height and structure from high intensity grazing in the Pacific Northwest bunchgrass prairies has been linked to declines in bumble bee richness and abundance (Kimoto, 2012b at 12–13).

Because livestock grazing also disturbs the soil, it could negatively impact bee nesting sites. Bumble bees often nest in abandoned rodent burrows (Sugden, 1985 at 300). Bumble bee colonies construct delicate chambers in those burrows close to the surface (Sugden, 1985 at 300). Grazing inherently leads to disturbance of the ground surface, and thus livestock grazing could destroy the colony and potential nesting sites (Sugden, 1985 at 300). As a result, livestock grazing is a threat to *B. occidentalis.*

3. Urban Development

Urban development, like agricultural intensification causes habitat fragmentation that likely contributes to bumble bee population declines. Urban areas consistently contain high levels of impervious surfaces, which have a negative impact on bumble bee diversity (Ahrné, *et al.,* 2009 at 1, 3 (fig. 1), 4). These surfaces include buildings, roads, railroads, industrial areas, and other man-made barriers. Impervious surfaces increase in proportion relative to the decrease in green areas suitable for bumble bee habitat (Ahrné, *et al.,* 2009 at 4, 6). Thus, bumble bee abundance and species composition are affected as the proportion of impervious surface increases relative to the decrease in natural areas (Ahrné, *et al.,* 2009 at 1, 3-4).

Urban areas fragment bumble bee habitat by isolating floral resources, which reduces movement of bumble bees between these patches of habitat (Bhattacharya, *et al.,* 2003 at 44). This may lead to smaller, more isolated populations of bumble bees, and a reduction of gene flow between the fragmented populations of plant species that depend on bumble bee visitation (Bhattacharya, *et al.,* 2003 at 44). This, in turn, can cause a reduction of adequate gene flow between bumble bee colonies reliant on the plant species.

Adequate gene flow in species helps to prevent inbreeding and maintain adaptive genetic variation (Jha & Kremen, 2013 at 2483). Bumble bees require nesting and dispersal across landscapes to maintain this flow (Jha & Kremen, 2013 at 2483). Human altered landscapes such as urbanized areas can fragment the populations of species and reduce native pollinators, including bumble bees (Jha & Kremen, 2013 at 2492). Drs. Shalene Jha and Claire Kremen's 2013 study was the first to demonstrate that "bumble bee gene flow patterns can be limited by impervious land use and appear to be particularly sensitive to recent land use patterns." (Jha & Kremen, 2013 at 2492).

Urban green spaces may provide a safe-haven for bumble bees by preserving floral and nesting resources (Frankie, *et al.,* 2005 at 235; McFrederick & LeBuhn, 2006 at 372) and by providing nesting sites. However, some floral resources are slowly being transformed by anthropogenic disturbances that compact the soil and otherwise facilitate the introduction of invasive plant species that eventually lead to the loss of native plants (McFrederick & LeBuhn, 2006 at 373). With added species competition in these increasingly scarce urban areas, native bumble bee diversity and richness have shown an associated decline (McFrederick & LeBuhn, 2006 at 379).

Urban development functions as the ultimate habitat disruptor by creating areas where bumble bees simply cannot survive. Even if some colonies survive around impervious surfaces, the loss of genetic diversity weakens populations, making them more susceptible to the other threats discussed in this petition.

4. Fire and Fire Suppression

Natural and manmade fire has historically been an important factor in native grasslands. Fires caused by lightning as well as those set by Native Americans were historically used to maintain grasslands (Schultz & Crone, 1998 at 244). Fire suppression can ultimately lead to the loss of grasslands (*see* Panzer, 2002 at 1297; Schultz & Crone, 1998 at 244). Grasslands have dramatically declined since the inception of fire suppression techniques. Fire suppression degrades the native grassland ecosystem by facilitating the invasion of shrubs and trees (Panzer, 2002 at 1297). Invasive weeds and encroachment of forests threaten surviving grasslands (Schultz & Crone, 1998 at 244). In the Pacific-Northwest, forests now cover many areas that were grasslands 200 years ago (Schultz & Crone, 1998 at 244).

Fire suppression also leads to increased fuel loads and tree densities, which can cause severe, high intensity fire (Huntzinger, 2003 at 1). Fire suppression in forested habitats has contributed to rising tree lines in the Rocky Mountain region (Roland & Matter, 2007 at 13702). The rise in tree lines contributes to fragmentation of alpine meadows, leading to forest encroachment and population isolation within these meadows (Roland & Matter, 2007 at 13702). The resulting habitat fragmentation reduces dispersal and foraging opportunities for populations living in these meadows, increasing the likelihood of species extinction (Roland & Matter, 2007 at 13702). Grasslands covered about 42% of the earth's surface historically (Kimoto, 2012a at 2). Grasslands now only cover less than 13% of the surface of the earth (Kimoto, 2012a at 2). The decline in grasslands of the Northwest is particularly concerning for *B. occidentalis* and other native bees because grasslands support rich native bee fauna (Kimoto, 2012a at 15). Fire suppression and the resulting loss of grassland ecosystems is therefore likely having a negative impact on *B. occidentalis* populations.

B. Disease or Predation (Factor C)

A major cause of the decline in *B. occidentalis* can be attributed to pathogens that have been recently introduced into wild bumble bee populations throughout the United States. Specifically, these include the exotic strain of the microsporidium *Nosema bombi,* the protozoan parasite *Crithidia bombi,* the tracheal mite *Locustacarus buchneri,* and the Deformed Wing Virus (Colla, *et al*., 2006 at 462).

These diseases most likely originated in or can be attributed to commercially reared bumble bees used for greenhouse pollination. Commercially reared bumble bees frequently harbor pathogens and their escape from greenhouses can lead to infections in native species (Colla, *et al*., 2006 at 465-66). Once infected, colonies exhibit reduced survival and reproduction rates as well as diminished foraging efficiency (Brown, *et al*., 2003 at 1000; Gegear, *et al*., 2005 at 213; Otterstatter, *et al*., 2005 at 387). According to the National Academy of Sciences National Research Council (NRC) report on the Status of Pollinators in North America, "pathogen spillover" from infected commercially reared bumble bees is responsible for the recent declines in some native bumble bee populations and may also be the most important factor responsible for the likely extinction of *B. franklini* (NRC, 2007 at 8, 87-89). Thus, pathogens present a profound risk to wild bumble bee populations throughout North America.

1. *Nosema bombi*

N. bombi is a microsporidian that infects bumble bees primarily in the malpighian tubules (small excretory or water regulating glands), but also in body fat, nerve cells, and sometimes the tracheae (Otti & Schmid-Hempel, 2007 at 119). *B. occidentalis* and other infected bumble bee colonies can appear to be healthy but still carry the disease and transmit it to other colonies (*see* Koch & Strange, 2012 at 218; *see also* Larson, 2007 at 3). The effect of *N. bombi* on *B. occidentalis* varies from mild to severe (Otti & Schmid-Hempel, 2007 at 118, 119, 123; *see also* Larson, 2007 at 3). Scientists have observed *N. bombi* in wild bumble bees throughout North America including *B. occidentalis* (Colla, *et al.,* 2006 at 465; Koch & Strange, 2012 at 217; Gillespie, *et al.,* 2010 at 738; Kissinger, *et al.,* 2011 at 220, 222; Cordes, *et al.,* 2012 at 212, tbl. 2, 213).

Dr. Robbin Thorp hypothesizes that *N. bombi* is the most probable cause for the decline of *B. occidentalis* (Evans, *et al.,* 2008 at 24). Dysentery is the main symptom found in bumble bees infected with *N. bombi* (Koch & Strange, 2012 at 213). *N. bombi* also detrimentally affects bees by lowering their mating success, ability to survive in the winter, and negatively affecting their ability to establish colonies (Koch & Strange, 2012 at 213; Colla, *et al.,* 2006 at 466; Otti & Schmid-Hempel, 2007 at 123). *N. bombi* reduces the colony's fitness reduces the individual bee's reproduction rate and reduces the individual bee's life span (Colla, *et al.*, 2006 at 462; Otti & Schmid-Hempel, 2007 at 123; van der Steen, 2008 at 273, 278-79, 281; Rutrecht & Brown, 2009 at 946). *N. bombi* was most likely introduced and spread through commercial bumble bee production in the period of time leading up to declines in *B occidentalis* populations. *B. occidentalis* queens collected from the west coast were shipped to commercial rearing facilities in the Midwest and Europe where they interacted with other bumble bee species (Rao & Stephen, 2009 at 7). These *B. occidentalis* colonies were likely infected with *N. bombi* while at these rearing facilities and then returned to the west coast for use in pollination of greenhouse crops (Rao & Stephen, 2009 at 7). Once back on the west coast, the infected *B. occidentalis,* which are highly susceptible to *N. bombi* and other pathogens, infected wild populations of *B. occidentalis* through pathogen spillover, likely resulting in local exactions of *B. occidentalis* populations (Rao & Stephen, 2009 at 7).

Scientists have found higher intensity *N. bombi* infections in *B. occidentalis* than in other species (Cordes, *et. al.,* 2012 at 213). Due to widespread infection rates, APHIS stopped issuing courtesy permits for the interstate transport of *B. occidentalis* in 1998 (Evans, *et al.,* 2008 at 25). Additionally, at least one North American commercial producer has stopped producing *B. occidentalis* because of problems with infections among this species in particular (Velthius & van Doorn, 2006 at 432). However, the disease is still commonly found throughout *B. occidentalis* populations (*see* Colla, *et al.,* 2006 at 465; Evans, *et al.*, 2008 at 25; Koch & Strange, 2012 at 217).

Scientists have shown that *N. bombi* spreads from commercial bumble bees, utilized in greenhouses, to wild bumble bees through shared pollination (Colla, *et al.,* 2006 at 462, 465). Significant evidence suggests that commercially reared bumble bees possess a higher prevalence of various pathogens than their wild counterparts (Colla, *et al.,* 2006 at 462). Commercially reared bumble bees routinely forage outside the greenhouse when alternative food sources are available (Whittington, *et al.*, 2004 at 599, 601). *N. bombi* is likely spread to wild bumble bees when both wild and commercial bees pollinate the same flowers (Colla, *et al.,* 2006 at 462).

Scientists have also transmitted European origin *N. bombi* to two native Japanese bumble bees, thereby showing that the potential hosts for *N. bombi* are wide ranging (Larson, 2007 at 9). Furthermore, University of Illinois at Urbana-Champaign researchers discovered that an *N. bombi* strain found in multiple species of North American bumble bees is genetically very similar to that found in European bumble bees (Cordes, *et al.,* 2012 at 215).

The NRC report on the Status of Pollinators in North America reviewed several studies suggesting that when heavily infected commercial colonies come into contact with wild bumble bee populations, pathogens can be introduced to nearby wild populations (NRC, 2007 at 88-89). The NRC also states that the recent disappearance of *B. occidentalis* from the western part of its range was likely caused by pathogen spillover from infected commercially reared bumble bees (NRC, 2007 at 88). Additionally, the Service has recognized that *N. bombi* poses a threat to all bumble bee populations generally and that it is easily transferred from commercial to wild bumble bees. 76 Fed. Reg. at 56,381, 56,388 (Sept. 13, 2011). Therefore, the available information indicates that *N. bombi* is likely negatively impacting *B. occidentalis*, especially where the species may come into contact with commercially reared bees.

2. *Crithidia bombi*

Crithidia bombi is an internal protozoan parasite that is also likely a cause of the decline of *B. occidentalis*. This parasite adversely impacts the bee's entire lifecycle from the queen's colony founding success, to the fitness of established colonies, as well as the survival and foraging efficiency of worker bumble bees (Brown, *et al.,* 2003 at 994, 1000; Otterstatter, *et al.,* 2005 at 388; Gegear, *et al.*, 2005 at 213; Gegear, *et al.,* 2006 at 1075-76). Particularly high mortality rates from *C. bombi* are present in hosts that are already under stress from other threat factors (Brown, *et al.,* 2000 at 421, 425-26).

Like *N. bombi, C. bombi* is commonly found in bumble bees near greenhouses (Colla, *et al.,* 2006 at 461, 463). One study found infection rates as high as 47% within 30 meters of commercial greenhouses, with infection rates dropping proportionately as the distance from the greenhouse increased (Otterstatter & Thomson, 2008 at 3). Scientists believe the parasite spreads from commercially reared bumble bees to wild species through the shared pollination of flowers (Durrer & Schmid-Hempel, 1994 at 299, 301). More recently, researchers have shown that honey bees may also be a possible vector for *C. bombi*, by carrying and passing the parasite on to various bumble bee species (Ruiz-González & Brown, 2006 at 616, 620-21). Finally, the Service has recognized that *C. bombi* poses a threat to all bumble bee populations generally and that it is easily transferred from commercial to wild bumble bees. 76 Fed. Reg. at 56,388. Therefore, *C. bombi* is also a likely cause of *B. occidentalis'* population declines.

3. *Locustacarus buchneri*

The tracheal mite, *Locustacarus buchneri*, is also prevalent in *B. occidentalis* (Otterstatter & Whidden, 2004 at 355). Like the microparasite *N. bombi, L. buchneri* is much more common in commercially reared European bumble bees. Studies report the infestation rate in certain commercially raised bees at 17 to 20% compared to a 1 to 8% infestation rate in particular wild bees. Scientists believe that mites could spread through drifting workers or pollinating shared flowers (Goka, *et al.,* 2001 at 2098). *L. buchneri* can accumulate in the workers and cause lethargy and a cessation of foraging (Goka, *et al.,* 2001 at 2095).

Further, bumble bees in the sub-genus *Bombus sensu stricto*, such as *B. occidentalis,* appear to be more susceptible to tracheal mite infestation than other bumble bees, exhibiting a higher infestation rate (Otterstatter & Whidden, 2004 at 355). Finally, the Service has recognized that *L. buchneri* poses a threat to all bumble bee populations generally and that it is easily transferred from commercial to wild bumble bees. 76 Fed. Reg. at 56,388. Therefore, *L. buchneri* is likely negatively impacting *B. occidentalis* populations.

4. Deformed Wing Virus

Lastly, Deformed Wing Virus (DWV) may also contribute to the decline of *B. occidentalis*. DWV causes crippled wings, rendering bees unable to fly and forage (*see* Otti & Schmid-Hempel, 2007 at 123; Genersch, *et al.,* 2006 at 61). This ultimately poses a serious threat to bumble bee populations. DWV, originally a disease found only in honey bees, has recently been observed in bumble bee populations (Genersch, *et al.,* 2006 at 61). DWV was first observed in 2004 in bumble bee queens in European commercial operations (Genersch, *et al.,* 2006 at 61). Honey bees are frequently used in breeding facilities to encourage bumble bee queens to initiate nesting behavior

(Genersch, *et al.,* 2006 at 61–62). Consequently, the two species come in close contact in these facilities. DWV was also observed in a wild population of bumble bees found in Germany that had previously been known to rob nectar from nearby honey bee hives (Genersch, *et al.,* 2006 at 62). The strain of DWV found in both of these bumble bee populations was of a higher virulence than its honey bee counterpart (Genersch, *et al.,* 2006 at 63).

Commercial bumble bee rearing operations are likely the source of the spread of DWV from honey bees to bumble bees, but honey bees may also be able to spread the disease to bumble bees in the wild (Evans, *et al.,* 2008 at 32). DWV also causes wing crippling in bumble bees as well as honey bees (Genersch, *et al.,* 2006 at 63). DWV may also show a higher virulence in bumble bees (Genersch, *et al.,* 2006 at 63). Additionally, the Service has recognized that DWV poses a serious threat to bumble bee populations than those observed with the disease thus far. 76 Fed. Reg. at 56,388. Given that infections have occurred in both commercial and wild populations, DWV likely poses a serious threat to *B. occidentalis* populations.

C. The Inadequacy of Existing Regulatory Mechanisms (Factor D)

Congress and regulatory agencies have failed to take action on the collapsing U.S. bumble bee population. While scientific evidence stacks up regarding the likely causes of population declines, little government action has occurred in response. *B. occidentalis* and its habitat are not directly protected under Federal or State law, nor does any law prohibit the taking of this species.

Furthermore, there are no regulations that limit the interstate transport of bumble bees and therefore no regulations that would curb the spread of disease. Currently, U.S. Department of Agriculture regulations promulgated under the Honey Bee Act permit honey bees to be imported from Canada, Australia, and New Zealand. 7 C.F.R. § 322.4. Department of Agriculture regulations also permit the import of two species of bumble bees, *B. occidentalis* and *B. impatiens* from Canada. 7 C.F.R. § 322.5. Only California and Oregon restrict the importation of commercial bumble bees.

Due to the high rates of pathogen infection in commercially reared bumble bees, regulations must address the transport of both foreign and domestic bees to be effective. In addition, there are no regulations that limit the interstate transport of bumble bees and therefore no regulations that would curb the spread of disease.

As discussed above, disease and pesticide use are the greatest threats to bumble bees. The existing regulatory mechanisms are inadequate to protect *B. occidentalis* from these threats.

1. Disease

Measures to reduce the transmission of disease from commercially reared bees to wild *B. occidentalis* populations are scarce regulated in the United States. Although he Animal Plant Health Inspection Service (APHIS) requires an export certificate from the country of origin for honeybees that must identify diseases or parasites of concern, the diseases that threaten *B. occidentalis* are not specifically listed. 7 C.F.R. § 322.6. Furthermore, the regulations do not require that diseases or parasites be listed on export certificates of "bees other than honeybees," which would include all commercially reared *Bombus* species. 7 C.F.R. § 322.6(c). This enables diseases to continue to be spread throughout native populations of *B. occidentalis* by the import of commercially reared bees. Additionally, APHIS does not regulate the movement of bees across State lines once the bees are in the United States (APHIS Petition, 2010 at 13 (stating that "APHIS ceased to regulate the interstate movement of bumble bees in 1998")). The Service has acknowledged that this existing regulatory scheme might be inadequate to protect against the spread of disease among bumble bees in North America. 76 Fed. Reg. at 56,389.

In 2010, the Xerces Society, Defenders of Wildlife, the Natural Resources Defense Council, and Dr. RobbinThorp petitioned the Secretary of Agriculture and APHIS urging the agency to regulate commercial bumble bees (APHIS Petition, 2010). Specifically, the petitioners requested that commercial bumble bees be certified as disease free before crossing state lines within their native ranges and that APHIS prohibit the movement of bumble bees outside of their native ranges. (APHIS Petition, 2010 at 2). APHIS did not respond to the initial petition (DOW Letter to APHIS, 2013 at 1). In October 2013, the petitioners renewed their efforts and asked the Secretary of Agriculture to take action on their petition (DOW Letter to APHIS, 2013). It is unclear if APHIS has taken any action on the petition as there have not been any Federal Register or other public notices of a proposed rulemaking on these issues. Without adequate regulation of commercial bumble bees, diseases may continue to be transmitted to native populations of *B. occidentalis* (*see supra* Part V.C). The current regulations are inadequate to protect *B. occidentalis* against this threat.

2. Pesticides[4]

The detrimental effects of pesticides on bumble bees and other pollinators is becoming increasingly clear as colonies continue to collapse. Pesticide regulations do exist, but none are specific to the protection of bumble bees. State legislatures are attempting to control the use of pesticides in their own capacity and Europe has banned neonicotinoid pesticides for at least two years until more studies can be conducted. The United States is beginning to shift focus to neonicotinoids as well, but to date there are no effective regulations of these pesticides to protect bumble bees in the United States.

The Environmental Protection Agency regulates the use of pesticides in the United States under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA). Pesticides need to be registered (licensed) with the EPA, which must ensure each pesticide on the list continues to meet the "highest level of safety to protect human health and the environment." (EPA: Reevaluation of Pesticides, 2014 at 1). In response to the concern over the status of pollinators, the EPA has accelerated its review of neonicotinoid pesticides and results should be available between 2016-2019 (EPA: Schedule for Review of Neonicotinoid Pesticides, 2014). Since 2011, EPA has conducted pollinator risk assessments for pesticide registrations under FIFRA that determine likelihood of exposure and impact of the pesticide. Due to the heightened awareness of pesticide use and new data, EPA has recently announced that it is not likely to approve any new uses for neonicotinoids (EPA I, 2015). However, EPA has not restricted current uses of neonicotinoids.

In response to scientific studies on the sub-lethal effects of neonicotinoids (EFSA 1-3 2013), the European Union (EU) amended its previous regulations of neonicotinoids and banned the use of three types of neonicotinoids because of their effects on bees (Commission Implementing Regulation (EU) No 485/2013, p. 139/13). However, *B. occidentalis* is not native to Europe, so these

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[4] The impact of pesticides is discussed in Section (VII)(D)(1) "Pesticides," *infra*.

actions will have no effect on the species. Similar legislation has been introduced in Congress, in some states legislatures, and even recently, at the local level.

Representative John Conyers recently reintroduced the Save America's Pollinators Act of 2015 (H.R. 1284). This bill directs the EPA Administrator to suspend the registration of neonicotinoids until a determination can be made that neonicotinoids will not cause unreasonable adverse effects on pollinators based on; (1) the best scientific evidence and (2) a complete comprehensive field study that is completed which meets the criteria of the Administrator (H.R. 1284 (2015), p.7). Currently the bill is co-sponsored by 35 Democratic and one Republican House members (as of May 17, 2015). Given the lack of majority Republican support for the legislation and general anti-regulatory agenda of the governing party, it is unlikely to be enacted into law in the current term. As a result, effective federal protections are lacking and will likely continue to be lacking, at least in the short term.

In some instances, states and local communities have been taking the lead on pesticide regulation. Oregon has issued a temporary emergency rule regulating the use of two types of neonicotinoids. Under this rule, the use of dinotefuran and imidacloprid on Linden trees or other *Tilia* spp. are prohibited from June 26 – December 23, 2014 (State of Oregon, 2014). The rule was passed in response to the death of over 50,000 bumble bees from an improper application of a neonicotinoid pesticide in two separate towns in 2013 (KPTV, 2013). However, this regulation only covers certain applications of two neonicotinoids for part of the year in one state. This rule is also classified as being "temporary," meaning that any protections it may offer could disappear if it were not renewed. As of November 3, 2014, Minnesota is also considering a statewide ban of neonicotinoids (MN. Bill HF 2798). Other states such as New Jersey and Minnesota have bills to regulate or ban neonicotinoids pending in their state legislatures. None of these proposals is currently providing any level of concrete protection. However, Eugene Oregon recently passed a resolution to ban the use of any product containing neonicotinoids on "any city property." (Eugene Res. 2014). While this is a step in the right direction it only addresses city property in one town. This is clearly inadequate for a species facing range-wide threats.

Even though some of the measures mentioned above attempt to protect *B. occidentalis* and other pollinators, the regulation of commercially reared bumble bees across state lines, stricter measures on pesticides at the Federal and State levels, and regulations for the protection of bumble bee habitat to ensure the continued survival of *B. occidentalis* are lacking and do not appear to be coming anytime soon. The currently-existing regulatory mechanisms are simply inadequate to protect the species.

D. Other Natural or Manmade Factors Affecting *B. Occidentalis'* Continued Existence (Factor E)

Bumble bees, including *B. occidentalis,* are threatened by several other natural or manmade factors, including the use of pesticides (Thompson & Hunt, 1999 at 147), population dynamics and structure (Darvill, *et al.,* 2006 at 601), and global climate change. (NRC, 2007 at 100). The multiple threats that these bumble bees face are dangerous independently, but also may interact with one another to create a greater threat to the species than their additive impact alone (Williams & Osborne, 2009 at 371; Laycock, *et al.,* 2012 at 1937).

1. Pesticides

Pesticide application threatens the entire *Bombus sensu stricto* subgenus as well as bumble bees more generally (Evans, *et al.,* 2008 at 29;Thompson & Hunt, 1999 at 147). The NRC Report on the Status of Pollinators notes that pesticides may be having dramatic detrimental effects on honey bee population in North America (NRC, 2007 at 79-80). Additionally, many common pesticides are applied in the late evening or early morning, which overlaps times when bumble bees are foraging (Thompson, 2001 at 305), making it likely that bumble bees will come into direct contact with pesticides. Aerial pesticide sprays can also kill up to 80% of foraging bees near the pesticide's source while drifts can continue to be dangerous for more than a mile from the source (Evans, *et al.,* 2008 at 29 (citing Johnsen & Mayer, 1990)). In addition, bumble bees that forage on pesticide-sprayed fields that have not been irrigated following pesticide application suffer reduced foraging, colony weight, and other negative effects. Finally, the Service has noted that pesticides pose a serious threat to rare invertebrates in general, 76 Fed. Reg. at 56,390, 56,391, which would include *B. occidentalis*.

Numerous studies on the use of pesticides and its effect on bumble bees have found that pesticide use may cause bumble bee population declines. For example, researchers noted that in 1995 there were numerous dead and dying bumble bees in a nearby garden following pesticide use on oil rape seed in full flower (Thompson & Hunt, 1999 at 163). In 1996, another incident linking bumble bee deaths to application of pesticide to field beans in full flower was reported (Thompson & Hunt, 1999 at 163). In a third incident reported in 1997, pesticide was used on full flower oil rape seed, and two days later dead bumble bees were reported (Thompson & Hunt, 1999 at 163). In addition, populations of bumble bees declined in blueberry fields near sprayed forests (Kearns, *et al.,* 1998 at 91). Bumble bee deaths were also reported in the United Kingdom following applications of dimethoate and alphacypermethrin to oilseed rape and following application of cyhalothrin to field beans (Goulson, *et al.*, 2008 at 195).

In addition to pesticide threats in general, the increased uses of persistent neonicotinoid pesticides has been shown to be highly toxic to bees and may be a substantial threat to bumble bees in particular (Colla & Packer, 2008 at 1388). Neonicotinoids are among the most effective and widely used pesticides utilized to control common insect pests such as aphids and whiteflies (Elbert, *et al.,* 2008 at 1099; *see also* Colla & Packer, 2008 at 1388). They are synthetic neurotoxins that lethally disrupt the pest's nervous system (Laycock, *et al.*, 2012 at 1937-38). Neonicotinoids are applied as a seed dressing or sprayed on a plant's leaves and are then taken up by the plant and distributed systemically (Sur & Stork, 2003 at 35-36) to target pest herbivores that consume sap and plant tissues. Studies have shown that honeybees are non-target organisms that ingest dietary residues of neonicotinoids in the nectar and pollen of treated mass-flowering crops (Rortais, *et al.,* 2005 at 77). While these studies focused exclusively on honeybees, neonicotinoids have been shown to be toxic to bumble bees, particularly when applied in violation of labeling, during flowering periods (Larson, 2014 at 257).

When bumble bees are exposed to even trace residues of neonicotinoids, the effects can be severe. A recent study examining neonicotinoid pesticides applied in environmentally realistic doses showed that such applications substantively reduced the fecundity of bumble bees. The study determined that trace dietary amounts of neonicotinoid pesticides can reduce worker fecundity by at least one third (Laycock, *et al.,* 2012 at 1937).

In addition, two recent studies have confirmed theories that neonicotinoids are causing bee declines. First, Dr. Maj Rundlof demonstrated that neonicotinoid coated seeds led to "reduced wild bee density, solitary bee nesting, and bumblebee colony growth and reproduction under field conditions." (Rundlof, *et al.,* 2015 at 77). Dr. Sebastian Kessler showed that instead of bees avoiding neonicotinoids as some had theorized, they actually grew addicted to some neonicotinoid additives and would likely visit those plants more, thus increasing exposure (Kessler, *et al.,* 2015 at 74). Both studies conclude that the contribution of neonicotinoids to bee decline may be underestimated.

As a result, both pesticides in general and neonicotinoids specifically represent a serious threat to *B. occidentalis'* persistence.

2. Insecticides

Direct exposure to insecticides is toxic to bee populations (Gels, 2002 at 723). Bees may also suffer indirect negative effects as a result of indirect exposure to insecticides (Gels, 2002 at 723). Bees are exposed to insecticides in three different ways: through sprays of insecticides on crops and wild flowers, consumption of contaminated nectar, or contact with foliage that is covered in insecticides (Goulson, *et al.*, 2008 at 194). Aerial pesticide sprays can kill up to 80% of foraging bees near the pesticide's source while drifts can continue to be dangerous for more than a mile from the source (Evans, *et al.,* 2008 at 29 (citing Johnsen & Mayer, 1990)). Insecticides used in the spring are especially impactful on bumble bee populations because this is when queens forage and colonies are still small (Goulson, *et al.,* 2008 at 194).

Researchers have also associated the organophosphate insecticides, such as Fenitrothion, with bee poisonings in food crops (Kearns, *et al.,* 1998 at 91). Insecticides used for turf management in golf courses and urban parks also pose a risk to bumble bees (Gels, *et al.*, 2002 at 722).

3. Herbicides

Herbicides reduce the availability of floral resources (Smallidge & Leopold, 1997 at 264), and may negatively affect the ability of bumble bees to forage or return to their nests (Thompson, 2001 at 312). Therefore, herbicides pose yet another threat to bumble bee populations by killing their food plants (Williams & Osborne, 2009 at 373, 374). Herbicides are used in agricultural and other industries for controlling weed species. However, their use indiscriminately removes important nectar resources and causes bumble bee population declines (Kearns, *et al.,* 1998 at 91; Williams & Osborne, 2009 at 374). Dr. Carol Kearns noted that "herbicide use affects pollinators by reducing the availability of nectar plants. In some circumstances, herbicides appear to have a greater effect than insecticides on wild bee populations… Some of these bee populations show massive declines due to the lack of suitable nesting sites and alternative food plants." (Kearns, *et al.,* 1998 at 91-92).

4. Population Dynamics and Structure

Bumble bees are haplodiploid organisms (*see* Zayed & Packer, 2005 at 10742). The sex of offspring is determined by the unique number of alleles at the sex-determining locus (*see* van Wilgenburg, *et al.,* 2006 at 2). Males are haploid and come from unfertilized eggs while females are diploid and come from fertilized eggs (NRC, 2007 at 95). As a result of this sex determination system, bumble bees will have lower population sizes in general compared to diploid organisms (Packer & Owen, 2001 at 8). Lower population size and inbreeding are particularly detrimental to bumble bees (van Wilgenburg, *et al.,* 2006 at 3). When bumble bees engage in sib-mating (where brother and sister bees mate), there is an increased chance that the offspring could be a diploid male, instead of the normal diploid female (van Wilgenburg, *et al.,* 2006 at 3). Many diploid males are sterile (Zayed & Packer, 2005 at 10743; van Wilgenburg, *et al.,* 2006 at 2). When a diploid male is able to mate, they produce sterile triploid offspring that will reduce the proportion of fertile individuals in the population further (Whitehorn, *et al.,* 2009 at 2). Diploid males are produced in place of female workers, which can reduce colony fitness, including lower survival and growth rates, and create colonies that have reduced numbers of offspring (Whitehorn, *et al.,* 2009 at 2; *see also* Darvill, *et al.,* 2006 at 608). This could lead to a loss of genetic diversity (*see* Whitehorn, *et al.,* 2009 at 5–6).

Populations without frequent immigration are also susceptible to the loss of genetic diversity "through bottlenecks and drift." (Darvill, *et al.,* 2006 at 601, 608). This loss of genetic diversity can lead to inbreeding depression within the fragmented population that reduces both "individual and population performance" and overall fitness (Darvill, *et al.,* 2006 at 601, 602, 608).

Inbreeding and reduced genetic diversity can lead to a reduction in adult longevity, larval survival, egg hatching rates (Darvill, *et al.,* 2006 at 601, 608; Packer & Owen, 2001 at 21), and an increased susceptibility to disease and parasites (Whitehorn, *et al.,* 2010 at 1195, 1200). The reduction of genetic diversity in bumble bees and corresponding increase in disease and parasite prevalence may lead to increased susceptibility to environmental pressures, or even extinction (Cameron, *et al.,* 2011 at 665; Whitehorn, *et al.,* 2010 at 1195, 1200). The Service has also recognized that low genetic variability is a threat to rare invertebrate populations. 76 Fed. Reg. at 56,390, 56,391. This therefore represents a threat to *B. occidentalis'* ongoing existence.

5. Climate Change

Climate change will likely threaten *B. occidentalis* by disrupting habitat and altering floral resources (*see* Memmott, *et al.,* 2007 at 1, 4, 5). Changes in temperature and precipitation, increased frequency of temperature and precipitation extremes, early snow melt, late frost events, and increased drought are just a few of the likely causes of these disruptions.

As the climate warms, the distribution of plants that pollinators rely on may change (*see* Forrest, *et al.,* 2010 at 438, 439; Inouye, 2008 at 361). Localized studies in the eastern U.S. have shown that some plants are flowering earlier than they were in the past (Abu-Asab, *et al.,* 2001 at 598; Primack, *et al.,* 2004 at 1261). This can lead to phenological asynchrony between the plants and pollinators (Memmott, *et al.,* 2007 at 4; Thomson, 2010 at 3197), meaning that the bees and the plants that they rely on are out of sync, potentially posing an extreme threat to species, like *B. occidentalis*, that are entirely reliant on these plants for food.

Climate change may also be causing exotic and invasive plant and insect species to thrive in areas not within their native ranges (Willis, 2010 at 1-2). More invasive plants increases competition with native plant species, which in turn will cause a reduction in requisite floral resources for native bumble bees (Morales & Travaset, 2009 at 723. Additionally, bees will become confused by similar appearing non-native floral resources, leading to lower visitation and reproductive success (Morales & Travaset, 2009 at 723). As this invasive plant problem continues to grow it will exert further pressure on *B. occidentalis.*

VIII. CONCLUSION

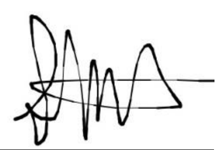
B. occidentalis was formerly common and widespread throughout western North America (Goulson, *et al.*, 2008 at 192; Thorp, *et al.,* 1983 at 30; Rao & Stephen, 2011 at 64). However, populations in the coastal valleys of *B. occidentalis'* historic range have almost disappeared (NatureServe Explorer; *see also* Rao & Stephen, 2009 at 7) with only isolated pockets of healthy populations, primarily around the Rocky Mountains, remaining (NatureServe Explorer). Similar losses in *B. occidentalis* have been observed in Canada. Once the most common bumble bee in British Columbia, *B. occidentalis* has suffered significant declines in this region over the past 20 years (Tommasi, *et al*., 2004 at 865).

The threats facing the *B. occidentalis* are numerous. Pesticides (Gels, 2002 at 723; Thompson, 2001 at 312), such as highly toxic neonicotinoids (Laycock, *et al.,* 2012 at 1937); diseases (*see, e.g.,* Brown, *et al.,* 2003 at 994, 1000), including *N. bombi* (Colla, *et al.,* 2006 at 464-65); and habitat loss and fragmentation (Öckinger & Smith, 2007 at 56) from causes including agricultural intensification (Hines & Hendrix, 2005 at 1481) and urban development (Ahrné, *et al.,* 2009 at 4; Bhattacharya, *et al.,* 2003 at 44) are all contributing to the decline of *B. occidentalis*. *B. occidentalis* are also likely suffering losses due to problems with global climate change (*see* Memmott, *et al.,* 2007 at 6), small population size, and low genetic diversity (Darvill, *et al.,* 2006 at 601, 607-08).

The existing regulatory mechanisms are inadequate to protect *B. occidentalis* its habitat. The Service must list *B. occidentalis* as an endangered, or alternatively as a threatened, species with designated critical habitat under ESA to prevent the global extinction of this once common bumble bee.

Thank you for your time and attention to this Petition. We look forward to hearing from you shortly. If you have any questions or need additional information, please feel free to write or call.

Sincerely,



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