REGION 2 SENSITIVE SPECIES EVALUATION FORM

Species: (Scientific Name/Common Name/National Code for Plants – USDA PLANTS)-- **Western bumble bee – *Bombus occidentalis* (Greene), 1858**

Criteria	Rank	Rationale	Literature Citations
1 Distribution within R2	B	There are 1,008 collection records on 11 Forests within Region 2 (Hatfield, unpublished data). See chart at the bottom of this form for forests in R2 with specimen records. Confidence in Rank **High**	• Hatfield Unpublished Data
2 Distribution outside R2	B	*Bombus occidentalis* was historically broadly distributed from the west coast of North America from Alaska to central California, east through Alberta and western South Dakota, and south to Arizona and New Mexico (Milliron 1973), although it has undergone severe recent declines in distribution and abundance. Cameron *et al.* (2011) found that *B. occidentalis* has declined from 28% of its historic range. Increased levels of parasites (of the microsporidian *Nosema bombi*) and lower genetic diversity are associated with this species, relative to co-occuring stable species (Cameron *et al.* 2011; Lozier *et al.* 2011). The leading hypothesis for this decline, which is currently under investigation at the University of Illinois, suggests that an exotic strain of *Nosema bombi* was introduced from Europe by the commercial bumble bee industry in the early 1990s, and then spread to wild populations of *B. occidentalis*. Although it has not been proven, the hypothesis is supported by the timing, speed and severity of the decline—a crash in laboratory populations of domesticated *B. occidentalis* occurred shortly before researchers noticed *B. occidentalis* and other closely related species disappearing from the wild. (Thorp & Shepherd 2005; Evans et al. 2008a). Confidence in Rank **High**	• Cameron *et al.* 2011 • Evans *et al.* 2008 • Lozier *et al.* 2011 • Milliron 1971 • Thorp & Shepherd 2005

Species: (Scientific Name/Common Name/National Code for Plants – USDA PLANTS)-- **Western bumble bee – *Bombus occidentalis* (Greene), 1858**

Criteria	Rank	Rationale	Literature Citations
3 Dispersal Capability	B	Studies of flight distance show that different species of bumble bees vary in how far they forage from the nest (Knight et al. 2005), with estimates ranging from 275m (Osborne et al. 1999) (900 ft) to 750m (Carvell et al. 2012) (2,460 ft, nearly 1/2 mi.), considerably further than most other native bees. Between species, body size (Greenleaf et al. 2007) and colony size (Goulson 2010) are good predictors of flight distance. There is also recent evidence that bumble bee foraging distances decrease with nearby high quality foraging habitat (Osborne et al. 2008; Carvell et al. 2012). This agrees with optimal foraging theory which suggests that bumble bees should seek to reduce their flight distances; longer flights require more energy expenditure, and thus increased time foraging for nectar, meaning fewer resources for offspring26. Although the foraging behavior of the western bumble bee has not been studied in detail, foraging dispersal distances have been observed for *B. terrestris* in Hertfordshire County, England (Osborne et al. 1999). This species foraged a mean linear distance of 339 (range 96-631) and 201 (70-556) meters during June and August, respectively. Most bees flew over 200 m from the nest to forage on a regular basis. While the above studies do not deal directly with queen dispersal, it is the best information that we have on bumble bee movement. Based upon these studies, it should be appropriate to assume that bumble bees migrating to set up new nests would be able to travel approximately 1 km, or perhaps a bit further if the conditions were right. Confidence in Rank **Medium**	• Knight et al. 2005 • Osborne et al. 1999 • Carvell et al. 2012 • Greenleaf et al. 2007 • Goulson 2010 • Osborne et al. 2008 • Osbourne et al. 1999
4 Abundance in R2	B	Because bumble bees thrive in high latitude and high elevation locations, R2 has a high species richness of bumble bees (Hatfield et al. 2012); There are records from 22 *Bombus* spp. on R2 forests (Hatfield Unpublished Data). Of all of those species, the western bumble bee is the second most abundant species (behind *Bombus bifarius*) in the available database with a relative abundance of 9.4% (1,008 of 10,718 total bumble bee records). However, the relative abundance over the last 10 years of 5.6% (122 of 2,190 total bumble bee records) within R2 is significantly different from its overall relative abundance in the database (Hatfield Unpublished Data). This suggests that populations are becoming increasingly fragmented and overall less abundant in the Rocky Mountain Region. Confidence in Rank **High**	• (Hatfield et al. 2012) • (Hatfield Unpublished Data)

Species: (Scientific Name/Common Name/National Code for Plants – USDA PLANTS)-- **Western bumble bee – *Bombus occidentalis* (Greene), 1858**			
Criteria	Rank	Rationale	Literature Citations
5 Population Trend in R2	A	There is good evidence that the abundance of this species is declining in R2. Prior to 2002 the relative abundance of the western bumble bee was 10.4% (of all bumble bee species records). Since 2002, the relative abundance of the western bumble bee has dropped to 5.6%, a nearly 50% decrease in relative abundance (Hatfield, unpublished data). The population trend outside of R2 is similarly in decline. Cameron et al. (2011) determined that the western bumble bee had experienced a 28% range reduction in recent years and had experienced an even more drastic (~35% down to ~5%) drop in relative abundance across its entire range. Confidence in Rank **High**	• (Hatfield Unpublished Data) • Cameron et al. 2011

Species: (Scientific Name/Common Name/National Code for Plants – USDA PLANTS)-- **Western bumble bee – *Bombus occidentalis* (Greene), 1858**

Criteria	Rank	Rationale	Literature Citations
6 Habitat Trend in R2	A	Bumble bees require flowering resources for the entirety of their flight season. As such, within R2 they are highly dependent on subalpine and montane meadows. Climate change, livestock grazing, logging, and recreation are all historical and current threats to these habitats throughout R2 (Peet et al. 2000; Aldridge et al. 2011). Bumble bees are threatened by many kinds of habitat alterations which may destroy, alter, fragment, degrade or reduce their food supply (flowers that produce the nectar and pollen they require), nest sites (e.g. abandoned rodent burrows and bird nests), and hibernation sites for over-wintering queens. Major threats that alter landscapes and habitat required by bumble bees include agricultural and urban development. Livestock grazing also may pose a threat to bumble bees, as animals remove flowering food sources, alter the vegetation community, and likely disturb nest sites. As bumble bee habitats become increasingly fragmented, the size of each population diminishes and inbreeding becomes more prevalent. Inbred populations of bumble bees show decreased genetic diversity and increased risk of decline (Xerces Society 2012). Insecticide applications on farms poses a direct threat to foraging bumble bees (Xerces Society 2012). Bumble bees are threatened by invasive plants and insects. The invasion and dominance of native grasslands by exotic plants may threaten bumble bees by directly competing with the native nectar and pollen plants that they rely upon. In the absence of fire (primarily due to fire suppression), native conifers encroach upon many meadows, which removes habitat available to bumble bees (Xerces Society 2012). Global climate change also poses a real threat to bumble bees; anecdotal evidence has suggested that some of the bumble bee species adapted to cool temperatures are in decline, whereas warmer adapted species are expanding their ranges. Baseline data and long term monitoring are needed to better understand the true impact of climate change on bumble bees (Xerces Society 2012). Confidence in Rank **Medium**	• Aldridge et al. 2011 • Peet et al. 2000 • Xerces Society 2012

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Criteria	Rank	Rationale	Literature Citations
7 Habitat Vulnerability or Modification	A	*B. occidentalis*, and bumble bees in general, have three basic habitat requirements: nectar and pollen from floral resources available throughout the duration of the colony period (spring, summer and fall), suitable nesting sites for the colony, and suitable overwintering sites for the queens. *B. occidentalis* generally occurs in open meadow habitats and nests underground. Modifications to bumble bee habitat from fire suppression (Panzer 2002, Schultz & Crone 1998, Roland & Matter 2007), fire, livestock grazing (Hatfield & LeBuhn 2007, Kimoto 2010, Xie *et al.* 2008), agricultural intensification (Williams 1986, Carvell *et al.* 2006, Diekotter *et al.* 2006, Fitzpatrick *et al.* 2007, Kosior *et al.* 2007, and Goulson *et al.* 2008), urban development (Jha & Kremen 2012; Bhattacharya *et al.* 2003) and climate change (Memmott *et al.* 2007, Thomson 2010, Cameron *et al.* 2011b) all threaten *B. occidentalis*. Indirect effects of logging, such as increased siltation in runoff, and recreation (such as off road vehicle use) have the potential to alter meadow habitats and disrupt *B. occidentalis* habitat. For more information on how many of these habitat modifications effect bumble bees, please see these review papers: Evans *et al.* 2008, Hatfield *et al.* 2012, and Jepsen *et al. 2013* and references therein. Confidence in Rank **High**	• Williams 1986 • Panzer 2002 • Bhattacharya et al. 2003 • Carvell et al. 2006 • Diekötter et al. 2006 • Kosior et al. 2007 • Memmott et al. 2007 • Roland & Matter 2007 • Fitzpatrick et al. 2007 • Hatfield & LeBuhn 2007 • Schultz & Crone 2008 • Xie et al. 2008 • Evans et al. 2008b • Goulson et al. 2008 • Thomson 2010 • Cameron et al. 2011b • Kimoto 2011 • Hatfield et al. 2012 • Jha & Kremen 2013

Species: (Scientific Name/Common Name/National Code for Plants – USDA PLANTS)-- **Western bumble bee – *Bombus occidentalis* (Greene), 1858**

Criteria	Rank	Rationale	Literature Citations
8 Life History and Demographics	A	*Bombus occidentalis*, and bumble bees in general, are especially vulnerable to extinction because of their unique life history. Since *B. occidentalis* has recently undergone a dramatic decline in range and relative abundance (Cameron *et al.* 2011), genetic factors (including reduced genetic diversity, inbreeding depression, and the method of sex determination utilized by bumble bees) make this species especially vulnerable to extinction (reviewed in Zayed 2009). Recent research indicates that populations of *Bombus occidentalis* have lower genetic diversity compared to populations of co-occurring stable species (Cameron *et al.* 2011a; Lozier *et al.* 2011). Loss of genetic diversity, which is frequently the result of inbreeding or random drift, can pose significant threats to small, isolated populations of bumble bees (Whitehorn *et al.* 2009). A loss of genetic diversity limits the ability of a population to adapt and reproduce when the environment changes and can lead to an increased susceptibility to pathogens (Altizer *et al.* 2003). Bumble bees have a single locus complementary sex determination system, meaning that the gender of an individual bee is determined by the number of unique alleles at the sex-determining locus (van Wilgenburg 2006). Normally this gender determination comes through a haplodiploid genetic structure in which female bees are diploids and are produced from fertilized eggs with two different copies of an allele at the sex-determining locus. Most male bees are haploid, and they are produced from unfertilized eggs (with only a single copy of an allele at the sex-determining locus). However, when closely related bumble bees mate, the offspring can have two copies of the exact same allele (or be homozygous) at the sex-determining locus, which causes a diploid male to be produced instead of a diploid female. These diploid males may have reduced viability or may be sterile (van Wilgenburg 2006). When diploid males are able to mate, they produce sterile triploid offspring, which has been found to be negatively correlated with surrogates of bumble bee population size (Darvill *et al.* 2012). Diploid males are produced at the expense of female workers and new queens, and the production of diploid males can reduce colony fitness (including slower growth rates, lower survival, and colonies that produce fewer offspring) in bumble bees (Whitehorn *et al.* 2009). It has been suggested that diploid male production in inbred populations substantially increases the risk of extinction in bumble bee populations compared to other animal taxa (Zayed & Packer 2005). Inbreeding and loss of genetic diversity can increase parasite prevalence in populations and parasite susceptibility in individuals (Frankham *et al.* 2010 *in* Whitehorn *et al.* 2010). Populations of bumble bees with low genetic diversity have been found to have a higher prevalence of pathogens (Whitehorn *et al.* 2010; Cameron *et al.* 2011), suggesting that as populations lose genetic diversity, the impact of parasitism will increase and threatened populations will become more prone to extinction. Confidence in Rank **High**	• The rationale for criteria 8 is directly from text by the Xerces Society • Altizer et al. 2003 • Zayed & Packer 2005 • Van Wilgenburg et al. 2006 • Whitehorn et al. 2009 • Zayed 2009 • Frankham et al. 2010 • Cameron et al. 2011a • Lozier et al. 2011 • Darvill et al. 2012

Species: (Scientific Name/Common Name/National Code for Plants – USDA PLANTS)-- **Western bumble bee – *Bombus occidentalis* (Greene), 1858**

Criteria	Rank	Rationale	Literature Citations

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Criteria	Rank	Rationale	Literature Citations

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Evaluator(s):	Date:
Ron Torretta, San Carlos Ranger District, San Isabel National Forest, with primary input from **Rich Hatfield** and **Sarina Jepsen**, The Xerces Society for Invertebrate Conservation.	1 February, 2013

ATTACHMENT SS2

National Forests in the Rocky Mountain Region where species is KNOWN (K) or LIKELY (L)[1] to occur:

Species Name:														
Colorado NF/NG	**Known**	**Likely**	**Kansas NF/NG**	**Known**	**Likely**	**Nebraska NF/NG**	**Known**	**Likely**	**South Dakota NF/NG**	**Known**	**Likely**	**Wyoming NF/NG**	**Known**	**Likely**
Arapaho-Roosevelt NF	x		Cimarron NG			Samuel R.McKelvie NF			Black Hills NF	x		Shoshone NF	x	
White River NF	x					Halsey NF			Buffalo Gap NG			Bighorn NF	x	
Routt NF	x					Nebraska NF			Ft. Pierre NG			Black Hills NF	x	
Grand Mesa, Uncompahgre, Gunnison NF	x					Ogalala NG						Medicine Bow NF	x	
San Juan NF	x											Thunder Basin NG		
Rio Grande NF	x													
Pike-San Isabel NF	x													
Comanche NG														
Pawnee NG														

[1] Likely is defined as more likely to occur than not occur on the National Forest or Grassland. This generally can be thought of as having a 50% chance or greater of appearing on NFS lands.