

## THE MONTANE BEE FAUNA OF NORTH CENTRAL WASHINGTON, USA, WITH FLORAL ASSOCIATIONS

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**ABSTRACT.**—The mountains of north central Washington contain a variety of habitat types, from shrubsteppe to high alpine meadows. While native bee surveys of some surrounding areas like the Columbia Basin are fairly complete, little work has been done in the mountains of north central Washington to document the diversity of bees found therein. We conducted a survey of native bees in the Tonasket Ranger District of the Okanogan-Wenatchee National Forest during summer 2004. Collections yielded a diverse bee fauna (140 species in 24 genera) visiting diverse floral elements (57 plant species in 18 families). These preliminary data suggest that a rich bee fauna exists in the Okanogan Basin and surrounding mountains.

*Key words:* pollinators, bees, Apoidea, Pacific Northwest, biodiversity.

Increased awareness of the important role native bees play as pollinators has led to recent collaborative efforts between researchers and land managers to document bee faunas in North America (Griswold et al. 1998, Messinger and Griswold 2002, Gardner and Ascher 2006, Giles and Ascher 2006, Messinger 2006, Brosi et al. 2007, Wilson et al. 2008). Yet the bee fauna of many ecosystems remains largely unknown. Furthermore, the results of many studies documenting native bee faunas are largely inaccessible, as they are often submitted solely as reports to the funding agency. While these reports are not generally off-limits to the public, researchers must first be aware that a report exists and then find the correct contact person before they can access the information.

The apparent lack of published work documenting native bee faunas may be due, in part, to the notion that a study resulting in little more than a species list is not appropriate for peer-reviewed journals. We would argue, however, that species lists, particularly for bees, are invaluable for many reasons. Studies show that native bees are important components of agricultural systems; however, specific bee species need certain requirements in order to be effective pollinators (Kremen et al. 2004, Ratti et al. 2008). Native bees are increasingly being used as pollinators for several agricultural crops (e.g., rapeseed and blueberries), so understanding the resource needs and floral visitation preferences

of native bees can be key to developing sustainable agricultural plans (Wood 1979, Morandin and Winston 2006).

Besides benefiting agricultural crops, native bees perform an essential function in the maintenance of natural ecosystems through their role as pollinators. Because of the vital ecosystem service bees provide, land managers have been increasingly interested in documenting the native bee faunas in their lands. For example, in the past 10 years, Zion National Park, Yosemite National Park, the Grand Staircase National Monument, Pinnacles National Monument, Dugway Proving Grounds, and Ash Meadows National Wildlife Refuge have invested in efforts to document their bee faunas. However, it is difficult for land managers to assess the quality and distinctiveness of their bee faunas without other published reports of species richness and abundance. Additionally, understanding the diversity and floral preferences of native bees can be important in efforts to protect rare or endangered plants (e.g., Pavlik et al. 1993).

Perhaps the most important reason to document native bee faunas is the rapid decline worldwide in native pollinators (e.g., Kerns and Inouye 1997, Biesmeijer et al. 2006). Specialist bees are more vulnerable to decline than are generalist bees (Biesmeijer et al. 2006). Thus it is important to document the distributions, habitat, and floral preferences of specialist bees, in addition to documenting bee species.

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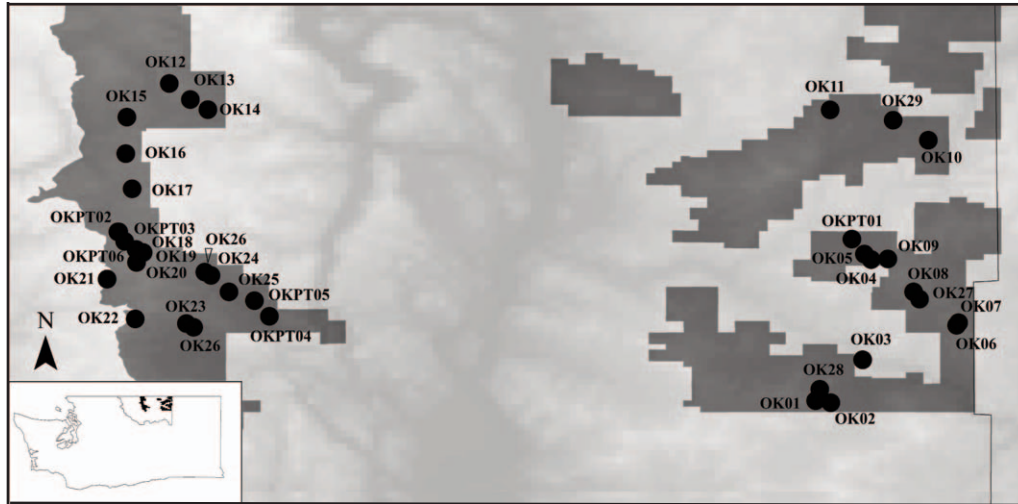


Fig. 1. Map of the Tonasket Ranger District of the Okanogan National Forest with collection locations and ranger district boundaries marked.

Although studies have documented bee faunas in several western desert regions (e.g., Messinger and Griswold 2002, Messinger 2006, Wilson et al. 2008), little work has been done to record the bee fauna of the montane region of north central Washington. Situated in northern Washington between the Rocky Mountains and Cascade ranges, this montane region contains diverse habitats—from shrubsteppe lowlands, to midelevation forests, to alpine lakes and meadows (Lasmanis 1991, Scudder 1992, Ricketts et al. 1999).

The bees of much of the Columbia Basin are well documented (Tepedino and Griswold 1995, Niwa et al. 2001), yet only a handful of records exist from the mountains of north central Washington. One general insect survey reported 78 bee species from the Mount Kobau area of the Okanogan Basin in southern British Columbia, Canada (Blades and Maier 1996). This study is incomplete regarding bee richness, as the majority of bees were only identified to the genus level and designated as morphospecies. Furthermore, the area covered by the study was relatively small.

Reported here are the findings of a study done during the summer of 2004 in the Tonasket Ranger District of the Okanogan-Wenatchee National Forest, Okanogan County, in northern Washington. The goal of this study was to provide a preliminary estimate of bee diversity across the Tonasket Ranger District. We focused

on areas of concern, such as areas targeted for conservation and areas containing high floral abundance. While comparisons of bee faunas across regions are worthwhile and interesting, due to the preliminary nature of this study, we do not attempt to make such comparisons.

#### METHODS

In order to collect from the spring as well as the summer bee fauna, 2 surveys were conducted in 2004: one from 28 June to 9 July and another from 9 August to 14 August. Efforts have been made to standardize collection methods among bee researchers (LeBuhn et al. 2003); however, our goal was to gain a preliminary understanding of bee diversity, so our methods were designed to maximize the number of species collected. Two trained collectors made collections in 35 locations across the ranger district (Fig. 1). Each of the 35 sites was collected in late June as well as early August. The majority of collection sites were in mountainous regions ranging in elevation from 785 m to 2502 m (Table 1). Collection events consisted of 2 researchers sampling from all flowering plants in a given area (no more than 1 ha in size) for 30 minutes. Collecting was primarily done by net (29 locations). When logistically possible, net collecting was augmented by use of pan traps near net collections. Pan-trap collections consisted of 30 colored plastic bowls (10 fluorescent

TABLE 1. Site descriptions for all 35 collection locations. Location names correspond to those found in Figure 1. Location names beginning with OKPT represent locations where pan traps were deployed. Locations from OK01 through OK29 were sampled using nets only.

Location name	Location description	Elevation (m)	Latitude	Longitude
OK01	1.5 mi E Bailey Mountain	1260	48.49443423	-119.0715511
OK02	Cox Meadow	1117	48.49199923	-119.0523257
OK03	1.5 mi NNE Lyman Lake	785	48.54629216	-119.011878
OK04	Turner Lake	1273	48.67374532	-119.0008927
OK05	1 mi NW Turner Lake	1329	48.68069163	-119.0096187
OK06	0.3 mi E Cornell Butte	1526	48.5937285	-118.8897009
OK07	0.4 mi S Cornell Butte	1449	48.59034901	-118.892233
OK08	0.5 mi W Corner Butte	1349	48.63288002	-118.9470178
OK09	2 mi W Corner Butte	1342	48.67475761	-118.9798357
OK10	Virginia Lilly Trailhead	1262	48.82551614	-118.9284066
OK11	1 mi N Lost Lake	1115	48.86401249	-119.0532095
OK12	0.3 mi S Hodges Horse Pasture	2045	48.89751079	-119.8921573
OK13	3 mi SE Hodges Horse Pasture	1670	48.8768845	-119.8657726
OK14	2.4 mi W Duncan Ridge	1465	48.8643688	-119.8433467
OK15	Long Swamp	1660	48.85481852	-119.9462933
OK16	1.5 mi SSW Corral Butte	1796	48.80844473	-119.9477278
OK17	0.4 mi SW Thunder Mountain	1966	48.7637014	-119.9396076
OK18	Tiffany Lake	2010	48.68658891	-119.9344606
OK19	0.8 mi W Tiffany Lake	2221	48.68286902	-119.9254527
OK20	Tiffany Mountain	2502	48.66998316	-119.9339573
OK21	Roger Lake	1802	48.64905108	-119.9711436
OK22	1 mi E Baldy Pass	1884	48.59832214	-119.935499
OK23	1.5 mi SSW Muckamuck Hill	1400	48.59263243	-119.8705777
OK24	Salmon Meadows	1351	48.65355557	-119.8394758
OK25	1.5 mi NNE Sophys Meadows	1114	48.63272623	-119.8164779
OK26	2 mi NW Salmon Meadows	1315	48.58774896	-119.8614852
OK27	0.8 mi S Corner Butte	1290	48.6234261	-118.9394614
OK28	1.3 mi NNW Cox Meadow	1349	48.50910242	-119.0663945
OK29	Beaver Lake	825	48.85079554	-118.9730419
OKPT01	1.3 mi W Suttons Meadow	1245	48.69976692	-119.0253969
OKPT02	Quarry at Three Buttes	2096	48.7089972	-119.956375
OKPT03	Parachute Meadow	2086	48.70896746	-119.9575289
OKPT04	1 mi E Muckamuck Hill	1213	48.60161159	-119.7651077
OKPT05	0.7 mi SW Middle Mountain	1183	48.62161169	-119.7841423
OKPT06	1 mi NNW Tiffany Lake	1990	48.69681491	-119.9490144

yellow, 10 fluorescent blue, and 10 white) filled with soapy water and set at 1-m intervals along a single transect line. Pan traps were deployed at a total of 6 sites (Table 1). All collecting localities were georeferenced with a Garmin GPS unit.

Bee identifications were made by Terry Griswold, Harold Ikerd, Olivia Messinger, and Joseph Wilson using the U.S. National Pollinating Insects Collection, Logan, Utah. Where possible, specimens were identified to species. Where species could not be assigned to a published name, as in some unrevised genera, they were given alphanumeric names to distinguish them as morphospecies (e.g., *Andrena* sp. 1). Some difficult groups of specimens, often males, were labeled "spp.," denoting that the group was composed of multiple species that could not reliably be separated or associated with one of the morphospecies. All bees were labeled

with GPS coordinates for the site at which they were collected, along with a location reference, the flower on which they were collected, the date, and the collector's name. All specimens are deposited in the U.S. National Pollinating Insects Collection.

Floral identifications were made by Larry Loftis. The plant specimens were identified using 3 floras, Douglas et al. (1998–2001), Hitchcock et al. (1955–1969), and Hitchcock and Cronquist (1973).

#### RESULTS AND DISCUSSION

A total of 1975 bees representing 140 species in 24 genera (Appendix 1) were collected from the Tonasket Ranger District of the Okanogan-Wenatchee National Forest. This collection demonstrates that the mountains of north central Washington support significantly

higher bee diversities than were previously known (Blades and Maier 1996). The increased diversity found in this study compared to the earlier work is likely not only a product of the broad range of environments that were sampled but also a result of collecting techniques focused on bees.

Bees were collected from 57 plant species in 18 families (Appendix 2). Asteraceae predominated with 32% of the plant species visited and with 4 of the 7 most visited plants: *Erigeron speciosus* var. *speciosus* (42 bee species), *Achillea millefolium* and *Taraxacum officinale* (24 species each), and *Anaphalis margaritacea* (23 species). Other well-visited plants included *Phacelia leptosepala* (Hydrophyllaceae, 24 bee species), *Potentilla gracilis* (Rosaceae, 23 species), and *Penstemon washingtonensis* (Scrophulariaceae, 22 species).

This survey revealed a surprisingly high diversity in 4 bee genera: *Osmia* (26 species), *Andrena* (17 species), *Bombus* (bumblebees, 14 species), and *Hylaeus* (7 species, including 2 possibly new species). In addition to the 2 potentially new species of *Hylaeus*, *Dufourea maura* represents a northwestern range extension for the species, and *Dufourea trochantera* is a new state record.

Many bees are known to be floral specialists, visiting a single group of closely related plants. Of the bees collected in the Tonasket Ranger District of the Okanogan-Wenatchee National Forest, several are known specialists (Hurd 1979, T. Griswold unpublished data). Asteraceae supports 17 specialist species collected in the 2004 study (*Andrena evoluta*, *Ashmeadiella cubiceps*, *Colletes fulgidus*, *Dianthidium heterulkei*, *D. subparvum*, *D. ulkei*, *Heriades cressoni*, *Megachile fidelis*, *M. perihirta*, *Osmia californica*, *O. coloradensis*, *O. marginipennis*, *O. montana*, and *O. subaustralis*). *Phacelia* supports 6 specialist bees (*Colletes consors*, *Dufourea trochantera*, *Anthidium mormonum*, *A. tenuiflorae*, *Atoposmia copelandica*, and *Chelostoma minutum*). Many other bees collected in this study are known specialists: *Atoposmia elongata*, *Osmia brevis*, and *O. penstemonis*, on *Penstemon*; *Megachile melanophaea*, *Osmia albolateralis*, and *O. odontogaster* on Fabaceae; *Colletes consors* on *Potentilla*; *Dufourea maura* on *Campanula*; *Osmia longula* on *Astragalus*; *O. pikei* on *Ribes*; and *O. sculleni* on *Hackelia*.

Because many bee species have short, highly seasonal lives and exhibit patchy distributions on

the landscape, this study must be viewed as preliminary. This study presents a partial baseline of comparison for future faunistic studies, and we expect that numerous additional species will be detected with further sampling at other stages in the flowering phenology, at different sites, and on additional floral elements.

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APPENDIX 1. List of bee species collected in the Okanogan region of north central Washington with abundances.

Family and species	n
ANDRENIDAE	
<i>Andrena astragali</i>	1
<i>Andrena ceanothifloris cretata</i>	1
<i>Andrena columbiana</i>	1
<i>Andrena evoluta</i>	19
<i>Andrena knuthiana</i>	1
<i>Andrena miranda</i>	2
<i>Andrena nivalis</i>	1
<i>Andrena prunorum prunorum</i>	2
<i>Andrena quintiliformis</i>	3
<i>Andrena ribblei</i>	13
<i>Andrena rufosignata</i>	9
<i>Andrena salifloris</i>	2
<i>Andrena scutellinites</i>	6

APPENDIX 1. Continued.

Family and species	n
<i>Andrena</i> sp. 13	1
<i>Andrena</i> sp. 5	1
<i>Andrena topazana</i>	5
<i>Andrena vicinoides</i>	2
APIIDAE	
<i>Anthophora urbana</i>	1
<i>Anthophora ursina</i>	2
<i>Bombus appositus</i>	5
<i>Bombus bifarius</i>	176
<i>Bombus californicus</i>	2
<i>Bombus centralis</i>	20
<i>Bombus fernaldae</i>	3
<i>Bombus fervidus</i>	5
<i>Bombus flavifrons</i>	29
<i>Bombus insularis</i>	53
<i>Bombus melanopygus</i>	28

APPENDIX 1. Continued.		APPENDIX 1. Continued.	
Family and species	<i>n</i>	Family and species	<i>n</i>
<i>Bombus mixtus</i>	64	<i>Sphecodes</i> sp. 5	8
<i>Bombus morrisoni</i>	1	<i>Sphecodes</i> sp. 6	1
<i>Bombus occidentalis</i>	2	MEGACHILDAE	
<i>Bombus rufocinctus</i>	1	<i>Anthidium mormonum</i>	4
<i>Bombus sitkensis</i> ?	3	<i>Anthidium tenuiflorae</i>	5
<i>Bombus</i> sp.	5	<i>Ashmeadiella cactorum</i>	2
<i>Bombus vandykei</i> ?	4	<i>Ashmeadiella cubiceps</i>	2
<i>Melecta pacifica</i>	1	<i>Atoposmia copelandica</i>	1
<i>Melissodes microsticta</i>	17	<i>Atoposmia elongata</i>	3
<i>Melissodes pallidesignata</i>	29	<i>Chelostoma minutum</i>	2
<i>Nomada</i> sp. 1	2	<i>Coelioxys moesta</i>	2
<i>Nomada</i> sp. 2	1	<i>Coelioxys sodalis</i>	1
<i>Nomada</i> sp. 3	1	<i>Dianthidium heterulkei</i>	1
<i>Nomada</i> sp. 4	1	<i>Dianthidium subparvum</i>	4
<i>Nomada</i> sp. 5	1	<i>Dianthidium ulkei</i>	1
<i>Triepeolus paenopectoralis</i>	2	<i>Heriades cressoni</i>	1
COLLETIDAE		<i>Hoplitis albifrons argentifrons</i>	56
<i>Colletes consors</i>	1	<i>Hoplitis fulgida fulgida</i>	40
<i>Colletes fulgidus fulgidus</i>	8	<i>Hoplitis grimmelli</i>	1
<i>Colletes nigrifrons</i>	31	<i>Hoplitis producta</i>	1
<i>Hylaeus aff. coloradensis</i> sp. 1	16	<i>Hoplitis robusta</i>	1
<i>Hylaeus aff. coloradensis</i> sp. 2	13	<i>Megachile centuncularis</i>	1
<i>Hylaeus annulatus</i>	19	<i>Megachile fidelis</i>	1
<i>Hylaeus basalis</i>	7	<i>Megachile frigida</i>	1
<i>Hylaeus modestus citrinifrons</i>	12	<i>Megachile gemula</i>	4
<i>Hylaeus rudbeckiae</i>	3	<i>Megachile melanophaea</i>	13
<i>Hylaeus (Paraprosopis)</i> sp. 1	1	<i>Megachile montivaga</i>	1
HALICTIDAE		<i>Megachile perihirta</i>	3
<i>Agapostemon femoratus</i>	12	<i>Megachile pugnata</i>	7
<i>Agapostemon texanus</i>	1	<i>Megachile relativa</i>	22
<i>Agapostemon virescens</i>	1	<i>Osmia albolateralis</i>	8
<i>Dufourea maura</i>	4	<i>Osmia atrocyanea</i>	2
<i>Dufourea trochantera</i>	1	<i>Osmia bella</i> ?	1
<i>Halictus farinosus</i>	25	<i>Osmia brevis</i>	12
<i>Halictus ligatus</i>	1	<i>Osmia bucephala</i>	2
<i>Halictus rubicundus</i>	12	<i>Osmia californica</i>	4
<i>Halictus tripartitus</i>	5	<i>Osmia coloradensis</i>	53
<i>Lasioglossum anhyppops</i>	40	<i>Osmia exigua</i>	1
<i>Lasioglossum athabascense</i>	1	<i>Osmia juxta</i>	24
<i>Lasioglossum egregium</i>	6	<i>Osmia longula</i>	3
<i>Lasioglossum sisymbrii</i>	8	<i>Osmia marginipennis</i>	1
<i>Lasioglossum (Dialictus)</i> sp.	9	<i>Osmia montana montana</i>	13
<i>Lasioglossum sedi</i>	157	<i>Osmia nigricentris</i>	2
<i>Lasioglossum nevadense</i>	33	<i>Osmia odontogaster</i>	9
<i>Lasioglossum pacatum</i>	3	<i>Osmia paradisiaca</i>	88
<i>Lasioglossum marinense</i>	14	<i>Osmia penstemonis</i>	18
<i>Lasioglossum ruidosense</i>	8	<i>Osmia pikei</i>	1
<i>Lasioglossum sandhousiellum</i>	16	<i>Osmia proxima</i>	1
<i>Lasioglossum prasinogaster</i>	1	<i>Osmia pusilla</i>	41
<i>Lasioglossum punctatocentre</i>	12	<i>Osmia sculleni</i>	1
<i>Lasioglossum tenax</i>	25	<i>Osmia (Melanosmia)</i> sp. 1	2
<i>Lasioglossum cooleyi</i>	2	<i>Osmia (Melanosmia)</i> sp. 2	3
<i>Lasioglossum (Evylaeus)</i> spp.	30	<i>Osmia subaustralis</i>	22
<i>Lasioglossum (Evylaeus)</i> sp. 2	296	<i>Osmia tanneri</i>	7
<i>Sphecodes</i> spp.	12	<i>Osmia trevoris</i>	5
<i>Sphecodes</i> sp. 1	1	<i>Osmia tristella</i>	68
<i>Sphecodes</i> sp. 2	1	<i>Stelis montana</i>	4
<i>Sphecodes</i> sp. 3	1	<i>Stelis subcaerulea</i>	1
<i>Sphecodes</i> sp. 4	6	<i>Stelis submarginata</i>	2

APPENDIX 2. List of bee-visited flowers with bees collected from them ( $n$  = number of individuals).

Plant family / Flower binomial / Bee binomial	$n$
ASTERACEAE	
<i>Achillea millefolium</i> (24 spp.)	
<i>Andrena scutellinitens</i>	1
<i>Andrena topazana</i>	1
<i>Bombus bifarius</i>	5
<i>Bombus insularis</i>	1
<i>Bombus melanopygus</i>	1
<i>Bombus mixtus</i>	1
<i>Colletes fulgidus</i>	3
<i>Colletes nigrifrons</i>	1
<i>Dufourea maura</i>	1
<i>Halictus farinosus</i>	14
<i>Halictus rubicundus</i>	1
<i>Hoplitis fulgida</i>	1
<i>Hoplitis producta</i>	1
<i>Hylaeus aff. coloradensis</i> sp. 1	3
<i>Hylaeus aff. coloradensis</i> sp. 2	1
<i>Lasioglossum anhypops</i>	1
<i>Lasioglossum sandhousiellum</i>	5
<i>Lasioglossum tenax</i>	3
<i>Megachile perihirta</i>	1
<i>Megachile relativa</i>	1
<i>Melissodes pallidisignata</i>	1
<i>Nomada</i> sp. 5	1
<i>Osmia coloradensis</i>	5
<i>Sphecodes</i> sp.	1
<i>Agoseris glauca</i> var. <i>dasycephala</i> (10 spp.)	
<i>Bombus bifarius</i>	3
<i>Bombus insularis</i>	1
<i>Bombus</i> sp.	1
<i>Coelioxys sodalis</i>	1
<i>Halictus farinosus</i>	1
<i>Hylaeus annulatus</i>	1
<i>Lasioglossum (Evylaeus)</i> sp. 2	2
<i>Osmia brevis</i>	1
<i>Osmia coloradensis</i>	1
<i>Osmia tristella</i>	1
<i>Anaphalis margaritacea</i> (23 spp.)	
<i>Andrena prunorum</i>	1
<i>Andrena columbiana</i>	1
<i>Andrena scutellinitens</i>	1
<i>Bombus bifarius</i>	2
<i>Bombus insularis</i>	3
<i>Bombus melanopygus</i>	1
<i>Colletes fulgidus</i>	1
<i>Halictus farinosus</i>	2
<i>Halictus ligatus</i>	1
<i>Hylaeus aff. coloradensis</i> sp. 1	6
<i>Hylaeus aff. coloradensis</i> sp. 2	6
<i>Hylaeus annulatus</i>	1
<i>Hylaeus modestus</i>	1
<i>Lasioglossum anhypops</i>	1
<i>Lasioglossum (Evylaeus)</i> spp.	3
<i>Lasioglossum (Evylaeus)</i> sp. 2	2
<i>Melissodes microsticta</i>	1
<i>Osmia paradisisca</i>	1
<i>Osmia pusilla</i>	1
<i>Sphecodes</i> sp.	2
<i>Sphecodes</i> sp. 2	1
<i>Sphecodes</i> sp. 4	1
<i>Stelis subemarginata</i>	1

APPENDIX 2. Continued.

Plant family / Flower binomial / Bee binomial	$n$
<i>Arnica cordifolia</i> (10 spp.)	
<i>Agapostemon femoratus</i>	2
<i>Andrena</i> sp. 5	1
<i>Bombus bifarius</i>	5
<i>Bombus mixtus</i>	2
<i>Bombus occidentalis</i>	1
<i>Halictus farinosus</i>	1
<i>Osmia juxta</i>	1
<i>Osmia sculleni</i>	1
<i>Osmia subaustralis</i>	1
<i>Osmia tristella</i>	1
<i>Arnica fulgens</i> var. <i>sororia</i> (7 spp.)	
<i>Andrena evoluta</i>	1
<i>Bombus bifarius</i>	2
<i>Hoplitis albifrons</i>	1
<i>Hylaeus basalis</i>	1
<i>Osmia californica</i>	1
<i>Osmia coloradensis</i>	1
<i>Osmia montana montana</i>	1
<i>Cirsium hookerianum</i> (1 sp.)	
<i>Bombus insularis</i>	1
<i>Cirsium vulgare</i> (4 spp.)	
<i>Bombus insularis</i>	1
<i>Lasioglossum tenax</i>	1
<i>Megachile montivaga</i>	1
<i>Osmia coloradensis</i>	8
<i>Crepis atrabarba</i> (3 spp.)	
<i>Andrena evoluta</i>	2
<i>Hoplitis fulgida</i>	1
<i>Osmia montana</i>	1
<i>Erigeron acris</i> var. <i>debilis</i> (3 spp.)	
<i>Anthidium mormonum</i>	1
<i>Nomada (Nomada)</i> sp. 4	1
<i>Osmia odontogaster</i>	1
<i>Erigeron corymbosus</i> (2 spp.)	
<i>Osmia trevoris</i>	1
<i>Stelis subemarginata</i>	1
<i>Erigeron speciosus</i> var. <i>speciosus</i> (42 spp.)	
<i>Agapostemon femoratus</i>	1
<i>Andrena scutellinitens</i>	3
<i>Ashmeadiella cubiceps</i>	1
<i>Bombus bifarius</i>	23
<i>Bombus centralis</i>	1
<i>Bombus flavifrons</i>	3
<i>Bombus insularis</i>	11
<i>Bombus melanopygus</i>	3
<i>Bombus mixtus</i>	6
<i>Bombus occidentalis</i>	1
<i>Bombus rufocinctus</i>	1
<i>Bombus</i> sp.	1
<i>Coelioxys moesta</i>	2
<i>Colletes fulgidus</i>	1
<i>Dianthidium heterulkei</i>	1
<i>Halictus farinosus</i>	1
<i>Halictus rubicundus</i>	1
<i>Heriades cressoni</i>	1
<i>Hoplitis albifrons</i>	3
<i>Hylaeus aff. coloradensis</i> sp. 1	1
<i>Hylaeus aff. coloradensis</i> sp. 2	2
<i>Lasioglossum (Dialictus)</i> sp.	1
<i>Lasioglossum sedi</i>	1
<i>Lasioglossum (Evylaeus)</i> sp. 2	1

APPENDIX 2. Continued.		APPENDIX 2. Continued.	
Plant family / Flower binomial / Bee binomial	<i>n</i>	Plant family / Flower binomial / Bee binomial	<i>n</i>
<i>Megachile centuncularis</i>	1	<i>Bombus melanopygus</i>	3
<i>Megachile perihirta</i>	1	<i>Bombus mixtus</i>	2
<i>Megachile relativa</i>	16	<i>Bombus sp.</i>	2
<i>Melissodes microsticta</i>	8	<i>Hoplitis albifrons</i>	1
<i>Melissodes pallidesignata</i>	17	<i>Hoplitis fulgida</i>	5
<i>Nomada (Nomada) sp. 3</i>	1	<i>Hylaeus annulatus</i>	1
<i>Osmia brevis</i>	1	<i>Hylaeus modestus</i>	2
<i>Osmia coloradensis</i>	6	<i>Lasioglossum (Ecvylaeus) sp. 2</i>	11
<i>Osmia juxta</i>	4	<i>Lasioglossum marinense</i>	3
<i>Osmia montana</i>	2	<i>Lasioglossum ruidosense</i>	1
<i>Osmia paradisiaca</i>	2	<i>Lasioglossum sandhousiellum</i>	1
<i>Osmia penstemonis</i>	4	<i>Megachile perihirta</i>	2
<i>Osmia pusilla</i>	1	<i>Megachile relativa</i>	2
<i>Osmia subaustralis</i>	9	<i>Osmia albolateralis</i>	2
<i>Osmia trevoris</i>	2	<i>Osmia coloradensis</i>	19
<i>Osmia tristella</i>	3	<i>Osmia juxta</i>	6
<i>Stelis montana</i>	2	<i>Osmia montana</i>	2
<i>Triepeolus sp.</i>	2	<i>Osmia penstemonis</i>	1
<i>Hieracium scouleri</i> (1 sp.)		<i>Osmia pusilla</i>	4
<i>Ashmeadiella cubiceps</i>	1	<i>Osmia subaustralis</i>	1
<i>Microseris nutans</i> (7 spp.)		<i>Osmia tristella</i>	13
<i>Bombus bifarius</i>	3		
<i>Bombus flavifrons</i>	2	BORAGINACEAE	
<i>Bombus insularis</i>	3	<i>Myosotis laxa</i> (6 spp.)	
<i>Bombus melanopygus</i>	2	<i>Andrena rufosignata</i>	1
<i>Lasioglossum (Ecvylaeus) sp.</i>	2	<i>Bombus appositus</i>	1
<i>Lasioglossum (Ecvylaeus) sp. 2</i>	2	<i>Bombus melanopygus</i>	6
<i>Osmia juxta</i>	1	<i>Hoplitis fulgida</i>	1
<i>Senecio sp.</i> (1 sp.)		<i>Osmia albolateralis</i>	1
<i>Osmia subaustralis</i>	1	<i>Osmia pusilla</i>	1
<i>Senecio hydrophiloides</i> (5 spp.)		BRASSICACEAE	
<i>Lasioglossum (Ecvylaeus) sp. 2</i>	3	<i>Sisymbrium altissimum</i> (7 spp.)	
<i>Osmia californica</i>	2	<i>Agapostemon virescens</i>	1
<i>Osmia coloradensis</i>	3	<i>Bombus bifarius</i>	5
<i>Osmia montana</i>	1	<i>Halictus rubicundus</i>	1
<i>Osmia odontogaster</i>	1	<i>Lasioglossum sisymbrii</i>	1
<i>Senecio integerrimus</i> (5 spp.)		<i>Lasioglossum (Ecvylaeus) sp. 2</i>	2
<i>Bombus bifarius</i>	1	<i>Megachile fidelis</i>	1
<i>Bombus melanopygus</i>	2	<i>Melissodes pallidesignata</i>	1
<i>Lasioglossum (Ecvylaeus) sp. 2</i>	1	<i>Smelowskia calycina</i> (5 spp.)	
<i>Osmia paradisiaca</i>	1	<i>Andrena ribblei</i>	2
<i>Osmia subaustralis</i>	1	<i>Bombus fernaldae</i>	3
<i>Senecio triangularis</i> (15 spp.)		<i>Bombus insularis</i>	6
<i>Agapostemon femoratus</i>	1	<i>Lasioglossum (Ecvylaeus) sp. 2</i>	1
<i>Bombus bifarius</i>	11	<i>Megachile relativa</i>	1
<i>Bombus insularis</i>	1		
<i>Bombus mixtus</i>	1	CAMPANULACEAE	
<i>Bombus sp.</i>	1	<i>Campanula rotundifolia</i> (5 spp.)	
<i>Halictus farinosus</i>	1	<i>Halictus rubicundus</i>	1
<i>Halictus rubicundus</i>	1	<i>Lasioglossum sedi</i>	1
<i>Hoplitis albifrons</i>	3	<i>Lasioglossum (Ecvylaeus) sp. 2</i>	4
<i>Megachile perihirta</i>	1	<i>Megachile gemula</i>	1
<i>Melissodes pallidesignata</i>	2	<i>Megachile melanophaea</i>	1
<i>Osmia coloradensis</i>	5		
<i>Osmia montana</i>	1	CAPRIFOLICAEAE	
<i>Osmia penstemonis</i>	4	<i>Lonicera involucrata</i> (1 sp.)	
<i>Osmia subaustralis</i>	2	<i>Bombus mixtus</i>	3
<i>Osmia tristella</i>	4	<i>Symphoricarpos albus</i> (2 spp.)	
<i>Taraxacum officinale</i> (24 spp.)		<i>Bombus bifarius</i>	2
<i>Ashmeadiella cactorum</i>	1	<i>Bombus flavifrons</i>	1
<i>Bombus bifarius</i>	15		
<i>Bombus insularis</i>	7	CARYOPHYLLACEAE	
		<i>Arenaria capillaris</i> (1 sp.)	
		<i>Bombus melanopygus</i>	1



APPENDIX 2. Continued.		APPENDIX 2. Continued.	
Plant family / Flower binomial / Bee binomial	<i>n</i>	Plant family / Flower binomial / Bee binomial	<i>n</i>
CRASSULACEAE		CRASSULACEAE	
<i>Sedum lanceolatum</i> (11 spp.)		<i>Bombus californicus</i>	1
<i>Anthidium tenuiflorae</i>	1	<i>Bombus flavifrons</i>	2
<i>Bombus insularis</i>	1	<i>Bombus melanopygus</i>	1
<i>Chelostoma minutum</i>	1	<i>Hoplitis albifrons</i>	1
<i>Colletes nigrifrons</i>	2	<i>Hylaeus annulatus</i>	1
<i>Halictus rubicundus</i>	1	<i>Megachile melanophaea</i>	1
<i>Hylaeus aff. coloradensis</i> sp.1	1	<i>Osmia atrocyanea</i>	1
<i>Lasioglossum sedi</i>	1	<i>Osmia exigua</i>	1
<i>Lasioglossum (Evylaeus)</i> sp. 2	1	<i>Osmia juxta</i>	1
<i>Osmia paradisiaca</i>	1	<i>Osmia odontogaster</i>	4
<i>Osmia</i> sp. 1	1	<i>Osmia penstemonis</i>	1
<i>Stelis subcaerulea</i>	1	<i>Osmia pusilla</i>	6
		<i>Osmia tristella</i>	1
ERICACEAE		GERANIACEAE	
<i>Ledum glandulosum</i> (1 sp.)		<i>Geranium viscosissimum</i> var. <i>viscosissimum</i> (2 spp.)	
<i>Andrena ceanothifloris</i>	1	<i>Bombus bifarius</i>	5
<i>Phyllococe empetriformis</i> (3 spp.)		<i>Hylaeus annulatus</i>	11
<i>Andrena rufosignata</i>	3	HYDROPHYLLACEAE	
<i>Bombus mixtus</i>	4	<i>Phacelia leptosepala</i> (24 spp.)	
<i>Lasioglossum (Evylaeus)</i> sp. 2	1	<i>Anthidium mormonum</i>	3
FABACEAE		<i>Anthidium tenuiflorae</i>	2
<i>Astragalus miser</i> var. <i>miser</i> (2 spp.)		<i>Ashmeadiella cactorum</i>	1
<i>Osmia albolateralis</i>	1	<i>Atoposmia copelandica</i>	1
<i>Osmia longula</i>	1	<i>Bombus bifarius</i>	18
<i>Astragalus miser</i> var. <i>serotinus</i> (3 spp.)		<i>Bombus centralis</i>	10
<i>Bombus bifarius</i>	3	<i>Bombus fervidus</i>	1
<i>Bombus flavifrons</i>	3	<i>Bombus flavifrons</i>	8
<i>Bombus mixtus</i>	2	<i>Bombus melanopygus</i>	1
<i>Lupinus sericeus</i> (10 spp.)		<i>Bombus mixtus</i>	1
<i>Andrena vicinoides</i>	1	<i>Bombus sitkensis</i>	1
<i>Bombus bifarius</i>	6	<i>Bombus vandykei</i>	3
<i>Bombus centralis</i>	1	<i>Colletes consors</i>	1
<i>Halictus rubicundus</i>	1	<i>Dufourea trochantera</i>	1
<i>Lasioglossum anhypops</i>	1	<i>Hoplitis albifrons</i>	7
<i>Lasioglossum (Evylaeus)</i> sp. 2	2	<i>Hoplitis fulgida</i>	9
<i>Megachile perhirta</i>	1	<i>Hylaeus aff. coloradensis</i> sp. 1	3
<i>Osmia californica</i>	1	<i>Hylaeus annulatus</i>	1
<i>Osmia pusilla</i>	2	<i>Hylaeus basalis</i>	1
<i>Stelis montana</i>	1	<i>Lasioglossum (Evylaeus)</i> sp.	2
<i>Lupinus</i> sp. (8 spp.)		<i>Megachile gemula</i>	1
<i>Bombus bifarius</i>	9	<i>Osmia juxta</i>	2
<i>Bombus mixtus</i>	2	<i>Osmia pusilla</i>	2
<i>Bombus vandykei</i>	1	<i>Osmia tristella</i>	4
<i>Hoplitis albifrons</i>	1	LILIACEAE	
<i>Lasioglossum (Evylaeus)</i> sp.	1	<i>Calochortus lyallii</i> (1 sp.)	
<i>Megachile gemula</i>	1	<i>Andrena evoluta</i>	1
<i>Osmia paradisiaca</i>	11	ONAGRACEAE	
<i>Osmia tristella</i>	4	<i>Epilobium angustifolium</i> (3 spp.)	
<i>Melilotus alba</i> (2 spp.)		<i>Bombus bifarius</i>	3
<i>Bombus bifarius</i>	2	<i>Lasioglossum (Evylaeus)</i> sp. 2	1
<i>Bombus insularis</i>	2	<i>Megachile relativa</i>	1
<i>Oxytropis campestris</i> var. <i>cusickii</i> (1 sp.)		<i>Gayophytum diffusum</i> ssp. <i>parviflorum</i> (3 spp.)	
<i>Osmia tanneri</i>	1	<i>Lasioglossum (Evylaeus)</i> sp. 2	3
<i>Trifolium pratense</i> (5 spp.)		<i>Osmia penstemonis</i>	1
<i>Bombus bifarius</i>	3	<i>Osmia tristella</i>	6
<i>Halictus rubicundus</i>	1	POLEMONIACEAE	
<i>Hoplitis albifrons</i>	2	<i>Gilia aggregata</i> (1 sp.)	
<i>Osmia odontogaster</i>	1	<i>Lasioglossum sandhousiellum</i>	2
<i>Osmia tristella</i>	2	<i>Polemonium pulcherrimum</i> (10 spp.)	
<i>Trifolium repens</i> (14 spp.)		<i>Andrena ribblei</i>	7
<i>Bombus bifarius</i>	2	<i>Bombus bifarius</i>	1

APPENDIX 2. Continued.		APPENDIX 2. Continued.	
Plant family / Flower binomial / Bee binomial	<i>n</i>	Plant family / Flower binomial / Bee binomial	<i>n</i>
<i>Hoplitis fulgida</i>	4	<i>Rubus</i> sp. (2 spp.)	
<i>Osmia albolateralis</i>	1	<i>Bombus melanopygus</i>	1
<i>Osmia coloradensis</i>	2	<i>Bombus mixtus</i>	2
<i>Osmia montana</i>	1	SAXIFRAGACEAE	
<i>Osmia paradisisca</i>	1	<i>Parnassia fimbriata</i> (2 spp.)	
<i>Osmia pusilla</i>	2	<i>Colletes nigrifrons</i>	15
<i>Osmia tanneri</i>	1	<i>Lasioglossum sedi</i>	1
<i>Osmia tristella</i>	6	SCROPHULARIACEAE	
RANUNCULACEAE		<i>Castilleja miniata</i> (4 spp.)	
<i>Delphinium nuttallianum</i> (2 spp.)		<i>Bombus fervidus</i>	1
<i>Bombus flavifrons</i>	3	<i>Bombus flavifrons</i>	2
<i>Bombus mixtus</i>	2	<i>Bombus melanopygus</i>	1
ROSACEAE		<i>Osmia tristella</i>	2
<i>Dryas octopetala</i> var. <i>hookeriana</i> (1 sp.)		<i>Orthocarpus tenuifolius</i> (3 spp.)	
<i>Osmia tanneri</i>	1	<i>Bombus appositus</i>	1
<i>Fragaria virginiana</i> var. <i>platypetala</i> (4 spp.)		<i>Bombus bifarius</i>	7
<i>Osmia penstemonis</i>	1	<i>Bombus centralis</i>	1
<i>Osmia pusilla</i>	3	<i>Pedicularis bracteosa</i> var. <i>latifolia</i> (2 spp.)	
<i>Osmia subaustralis</i>	1	<i>Andrena rufosignata</i>	1
<i>Osmia tristella</i>	2	<i>Bombus mixtus</i>	2
<i>Potentilla gracilis</i> (23 spp.)		<i>Penstemon confertus</i> (15 spp.)	
<i>Andrena quintiliformis</i>	2	<i>Bombus appositus</i>	1
<i>Andrena ribblei</i>	1	<i>Bombus bifarius</i>	3
<i>Andrena miranda</i>	1	<i>Bombus centralis</i>	1
<i>Andrena topazana</i>		<i>Bombus flavifrons</i>	1
<i>Andrena vicinoides</i>	1	<i>Bombus insularis</i>	5
<i>Bombus bifarius</i>	1	<i>Bombus melanopygus</i>	2
<i>Colletes nigrifrons</i>	9	<i>Bombus mixtus</i>	1
<i>Halictus tripartitus</i>	1	<i>Hoplitis albifrons</i>	2
<i>Hoplitis albifrons</i>	2	<i>Hylaeus modestus</i>	2
<i>Hoplitis fulgida</i>	6	<i>Osmia albolateralis</i>	2
<i>Hylaeus annulatus</i>	5	<i>Osmia atrocyanea</i>	1
<i>Hylaeus modestus</i>	2	<i>Osmia brevis</i>	1
<i>Lasioglossum athabascense</i>	1	<i>Osmia juxta</i>	3
<i>Lasioglossum (Evylaeus) sp. 1</i>	1	<i>Osmia pusilla</i>	1
<i>Lasioglossum (Evylaeus) sp. 2</i>	5	<i>Osmia tristella</i>	2
<i>Lasioglossum punctatovenstre</i>	1	<i>Penstemon davidsonii</i> var. <i>davidsonii</i> (1 sp.)	
<i>Osmia marginipennis</i>	1	<i>Lasioglossum sedi</i>	1
<i>Osmia montana</i>	1	<i>Penstemon washingtonensis</i> (22 spp.)	
<i>Osmia odontogaster</i>	1	<i>Agapostemon femoratus</i>	1
<i>Osmia paradisisca</i>	1	<i>Anthophora urbana</i>	1
<i>Osmia pusilla</i>	1	<i>Bombus appositus</i>	1
<i>Osmia tristella</i>	1	<i>Bombus bifarius</i>	12
<i>Sphecodes</i> sp. 5	1	<i>Bombus californicus</i>	1
<i>Rosa nutkana</i> var. <i>nutkana</i> (12 spp.)		<i>Bombus centralis</i>	1
<i>Andrena nivalis</i>	1	<i>Bombus fervidus</i>	1
<i>Andrena salicifloris</i>	1	<i>Bombus flavifrons</i>	3
<i>Andrena topazana</i>	3	<i>Bombus insularis</i>	4
<i>Anthophora ursina</i>	1	<i>Bombus mixtus</i>	1
<i>Bombus centralis</i>	1	<i>Bombus morrisoni</i>	1
<i>Bombus mixtus</i>	1	<i>Colletes fulgidus</i>	1
<i>Hoplitis albifrons</i>	5	<i>Colletes nigrifrons</i>	1
<i>Hylaeus annulatus</i>	4	<i>Hylaeus aff. coloradensis</i> sp. 1	1
<i>Hylaeus basalis</i>	1	<i>Lasioglossum (Evylaeus) sp. 2</i>	1
<i>Lasioglossum sedi</i>		<i>Megachile melanophaea</i>	2
<i>Lasioglossum (Evylaeus) sp. 2</i>	3	<i>Osmia brevis</i>	4
<i>Rubus parviflorus</i> var. <i>parviflorus</i> (3 spp.)		<i>Osmia longula</i>	1
<i>Andrena miranda</i>	1	<i>Osmia paradisisca</i>	30
<i>Bombus bifarius</i>	3	<i>Osmia penstemonis</i>	1
<i>Bombus mixtus</i>	1	<i>Osmia</i> sp. 1	1
		<i>Osmia tanneri</i>	1