WASHINGTON NATURAL HERITAGE PROGRAM

Pollinators of Federally Listed Plant Species in Washington

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Prepared by

John Fleckenstein

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Introduction

This is the final report to the U.S. Fish and Wildlife Service (USFWS) on a traditional Endangered Species Act Section 6 grant (F12AP00784). The project included literature review and field surveys for pollinators of the ten federally listed plant species in Washington State.

Recovery and delisting of these plant species requires an understanding of their reproductive biology. Pollination biology is part of this. Previous to this project, there had been no systematic effort to compile information from previous surveys of pollinators into a single report. There had also been no systematic field survey in Washington for pollinators of federally listed plant species.

This project is designed to improve the quality, quantity, and accessibility of information on pollinators in Washington. Natural Heritage Program (NHP) staff consulted with botanists and entomologists to prioritize information gaps on pollinators and pollination of the plant species in question. It was clear following these discussions that the two highest priority projects were to: (1) gather available information from the published and gray literature and from experts in the field into a single document and (2) to visit sites of listed plants and collect information on potential pollinators and the local insect community.

Methods

A literature search was conducted for each of the listed plant species. Information was collected on the mating system and pollination biology of each species. Lists of known and suspected pollinators were gathered from the literature and from knowledgeable individuals.

Information on population locations and flowering phenology was collected for each of the listed species. The main source was element occurrence records from the Washington Natural Heritage Program (WNHP). Additional information came from Joe Arnett, WNHP botanist, Camp and Gamon (2010), the scientific literature, and consultation with local experts. Based on this information, visits were scheduled to plant sites to conduct surveys for pollinators.

An attempt was made to conduct surveys when conditions were appropriate for insect activity. Ideal conditions are comprised of temperatures above 10°C, sunlight strong enough to cast a shadow, and wind speed less than16 kilometers per hour. Some surveys, especially at remote locations, were not performed under ideal conditions.

Time was limited for these surveys, and little background information is available on insects present on the sites or on potential pollinators of target plant species. The goal of the field project was, therefore, to collect a sample of insects present on each site that might act as pollinators. Bees, flies, butterflies, and moths were emphasized. Field methods were designed to maximize diversity of potential pollinator species collected rather than to create a quantitative, repeatable study. The information collected is intended to provide a basis for more detailed study.

Field time was divided between direct observation of the target plants species and survey of the entire site for potential pollinators. Direct observation consisted of observing the target plant species and collecting floral visitors. In most cases, an individual plant or group of plants that were in full bloom was observed for up to one hour. Remaining time was spent walking over the site and collecting insects that might serve as pollinators. Where possible, the entire site was covered, using a series of informal transects that came within a few meters of all points on the site. Time spent on site visits ranged from about an hour to several hours.

Results and Discussion

The level of knowledge about pollinators of listed plant species varies considerably. Extensive research has been done on pollinators of *Sidalcea oregana* var. *calva* and *Spiranthes diluvialis*. Little information has been collected on *Hackelia venusta* and *Physaria douglasii* ssp. *tuplashensis*. In some cases, notably *Hackelia venusta*, floral structure of closely related species is similar, and pollinators of the related species have been studied. This information was used where appropriate. Relevant information is summarized in the species accounts that follow.

Information from previous studies on potential pollinators and floral visitors is listed in Table 1. The numbers of species recorded in the literature as potential pollinators of differs greatly among target plant species. Variability may reflect true differences in the number of pollinators, or it may reflect different levels of survey intensity.

Surveys for potential pollinators of nine listed plant species were conducted in the field. Due to scheduling problems no pollinator surveys were conducted at *Physaria douglasii* ssp. *tuplashensis*. Seventeen sites were surveyed. Only potential pollinators represented by a collected specimen are included in this report. Three hundred twenty six specimens were collected (Table 2). Sixty eight specimens were collected on the flowers of listed plants. Two hundred fifty six specimens were collected on the site of a listed plant but not on the plant itself.

Identifications were done by taxon experts. *Bombus* specimens were identified to species by Jamie Strange, a bee expert at the U.S. Department of Agriculture lab in Logan, Utah. Most other bees and wasps were identified to genus by Chris Looney, entomologist with the Washington Department of Agriculture. Most other specimens were identified to family by Chris Looney or by Eric LaGasa also an entomologist with the Washington Department of Agriculture. A group of 50 specimens was lost in shipping before they were identified to species. All were identified as Apoidea (bee family) before shipping and are recorded as such in Table 2. None were *Bombus,* and at least a few were *Lasioglossum* species. Another 49 specimens are not yet identified. These are recorded as “unidentified” in Table 2. None are significant pollinators and most probably do no pollination (C. Looney pers. comm. 2014)

As potential pollinators were collected, it was noted whether they were on the site (“near” in Table 2) or actually on the target plant species (“on” in Table 2). The sampling period on each site was brief enough that significant pollinators were probably missed. Some of the insects collected on the site but not on the target species are probably among them. On the other hand, insects that visit a flower do not necessarily collect pollen and those that do, do not necessarily act as efficient pollinators (Zych et al. 2013). Recording all potential pollinators on the site probably gives a more representative list than recording only those seen on the target plant species.

Insect specimens were not examined for the presence of pollen from the target plant species.

All survey work was done in daylight, so nocturnal pollinators including most moths and some Diptera were not seen or collected. No hummingbirds or butterflies were noted as floral visitors.

The Literature Cited section contains most references to the mating systems and pollination processes of the federally listed plants in Washington. It also contains some general references to pollinators and the pollination process. As such, it is a useful resource on which to build additional surveys.

The Appendix to this report contains some general information about pollination biology. This includes a summary of the range of pollination systems and a listing of many of the threats faced by pollinators and pollination processes. The information and threats listed in the Appendix apply generally to each of the listed species but were not summarized in each species account. Where a particular aspect of this general information or a particular threat has special bearing on one of the target plant species, it is noted in the species account.

Castilleja levisecta (golden paintbrush)

Mating System and Pollination

Golden paintbrush appears to rely largely on out-crossing for successful seed set. According to Kaye and Lawrence (2003), plants have very low self-fertility. Outcrossing resulted in much higher reproductive success. Wentworth (1994) found that excluding pollinators resulted in very limited seed set. Structural and genetic barriers seem to make the *Castilleja levisecta* almost entirely dependent on insect pollinators (Caplow 2004). It is assumed; therefore, that significant seed set means that successful insect pollination is occurring.

Joe Arnett (pers. comm. 2014) and Mark Fessler (pers. comm. 2014) each state that *Castilleja levisecta* has set seed in significant amounts on the sites that they have surveyed. It appears that these populations of *Castilleja levisecta* are not pollinator limited at present.

Pollinators

Little work has been done on the pollinators of golden paintbrush. Several possible pollinators have been reported as floral visitors but none have been documented as removing pollen from one flower and depositing it on another.

- *Bombus* visit *Castilleja* flowers and may act as pollinators. Evans et al. (1984) reported *Bombus californicus* as a visitor to golden paintbrush flowers. Adler (2003) found *Bombus pennsylvanicus* to be a common floral visitor to *Castilleja indivisa* in Texas. Mark Fessler (pers. comm. 2014) thought that *Bombus* and some other possible pollinators were generalists on Fort Casey, visiting other plant species in addition to *Castilleja.*
- Two large species of *Megachile* (leaf cutter bees) have been recorded at *Castilleja aquariensis* and *C. christii*, two other western species of paintbrush (Tepedino (pers. comm. 2001 in Caplow 2004)). Species of this genus may also visit and pollinate golden paintbrush.
- Two Halictine bees warrant particular study as possible constant pollinators of golden paintbrush. *Lasioglossum dialictus* and *L. sphecodogastra* have been documented visiting only golden paintbrush flowers at Fort Casey (Mark Fessler pers. comm. 2011). The bees spent four to five seconds inside a flower and appeared to be covered with pollen when leaving (Mark Fessler pers. comm. 2014). Fessler has not identified the species of pollen on the *Lasioglossum* as *Castilleja* but stated that the bees groom their antennae before entering the next flower, suggesting that the pollen was recently acquired. He also noted that these *Lasioglossum* are present early in the flowering season and that the early flowers, lower on the inflorescence are frequently produce more seed than flowers higher on the inflorescence that open after the *Lasioglossum* end their flight period.

During the current study, 23 specimens identified as possible pollinators, representing 13 unique taxa were captured at *Castilleja* sites (Table 2). As stated above, specimens noted as Apoidea were lost. This group includes several individuals tentatively identified as *Lasioglossum* species, similar to those noted by Fessler (pers. comm. 2014).

Conservation Concerns

As stated above, several populations of golden paintbrush have been recorded as producing significant amounts of seed. Good seed set does not occur without sufficient pollination by insects. Few insect species have been recorded visiting golden paintbrush. It may be that *Castilleja* is easily pollinated by the few pollinators seen or that significant numbers of pollinators are yet to be recorded.

Golden paintbrush occurs in a highly fragmented, highly disturbed landscape throughout its range. A number of paintbrush populations are separated by a distance of greater than 3 miles, the maximum recommended in the species recovery plan (USFWS (2010) to allow movement of pollinators among populations. Establishment of stepping stone populations of paintbrush could support movement of pollinators among the surviving populations. This would help protect against loss of genetic diversity in paintbrush populations.

Research Questions

Additional surveys to identify pollinators of golden paintbrush were identified as a priority 3 action in the species recovery plan (USFWS 2010). Watching for *Lasioglossum* should be of high priority. Identification of other floral visitors and identification of pollen that they carry are also of high priority.

The possibility of pollination limitation due to isolation of paintbrush populations or other factors should be reviewed. Habitat management and establishment of stepping-stone *Castilleja* populations may be needed to support adequate pollinator communities.

***Eriogonum codium* (Umtanum desert buckwheat)**

Mating System and Pollination

E. codium appears to rely largely on out-crossing for successful seed set. Beck (1999) found limited self-pollination ability and much greater seed set in outcrossed flowers.

Tepedino et al. (2011) studied *Eriogonum pelinophilum* (clay-loving wild buckwheat), a closely related species of similar floral structure. They found flowers to be self-incompatible.

Pollinators

*Eriogonum i*nflorescences are composed of many small flowers that appear to be available to a broad range of generalist floral visitors.

- Tepedino et al. (2011) found that *Eriogonum pelinophilum* (clay-loving wild buckwheat) is visited by as many as 50 potential pollinator species, representing a wide range of insect taxa. The community of floral visitors changes significantly from site to site, but diversity of the community remained high (Tepedino et al. 2011). These authors investigated possible differences in pollinator value based on both abundance at flowers and body size. They found that abundance at flowers did not correlate with the amount of pollen carried, but that body size did. Larger floral visitors carried more pollen and may, therefore have been more effective pollinators. The authors did not address the possibility that smaller floral visitors may still provide sufficient pollination service. They do state that the plant may not be pollinator-limited. *E. pelinophilum* is similar in floral structure to *E. codium* suggesting that *E. codium* may attract a similar diverse group of pollinators.
- TNC/USFWS (1998) reported a wide variety of insect pollinators visiting Umtanum desert buckwheat (Table 1).
- Dunwiddie et al. (2000) report that a single *E. codium* plant could produce over 205,000 flowers between late May and early September. This large number of flowers and the long bloom period means that a diverse group of potential pollinators would have access to the plant.
- Ensor (1995) reported *Strymon melinus* (gray hairstreak) visiting flowers. The plant may be the larval host for this butterfly, and the adult butterfly may act as a pollinator.
- Jane Able is rearing *E. codium* in a garden situation for transplant into the wild. These plants are in a suburban area, several miles from the native population. These plants are producing seed, (Able pers. comm. 2014), meaning that pollinators have found them.

One floral visitor, *Bombus centralis* was recorded during the present study (Table 2). Conditions were, however, very windy, and a number of species eluded capture. A number of other possible pollinators were recorded elsewhere on the site (Table 2).

Conservation Concerns

The open structure of the inflorescence of Umtanum desert buckwheat suggests that it is a generalist flower, attractive to a large group of pollinators. The bloom period is very long, enabling exposure to many species potential pollinators. *E. pelinophilum* is similar in structure and attracts a large group of floral visitors (Tepedino et al. 2011).

Research Questions

Analysis of the effectiveness of floral visitors in removing pollen from anthers and depositing it on stigma would be useful in assessing the reproductive security of Umtanum desert buckwheat.

A survey of floral visitors during calm wind conditions would reveal which species might be effective pollinators. More work in windy conditions would reveal possible limitations imposed on pollination.

A comparison of pollinators at the native site, at the rearing site, and at the out-planting site would produce some information on the diversity of floral visitors to the plant.

***Hackelia venusta* (showy stickseed)**

Mating System and Pollination

Showy stickseed relies largely on out-crossing for seed set. Flowers are hermaphroditic but protandrous, so autogamy is discouraged. Flowers may, however, self-pollinate toward the end of anthesis (Taylor 2008). Geitonogamous and xenogamous pollination are probably more common, but seed set results from self-pollination or outcrossing.

Seed production is highly variable from year to year. In some years, much of the seed crop aborts (USFWS 2007).

Pollinators

Little information has been collected on floral visitors of showy stickseed.

- Taylor (2008) recorded four insect species visiting showy stickseed (Table 1). The two bees and the *Eulonchus* fly are likely pollinators. *Eulonchus* may be less effective because their tongues are long enough to extract nectar without entering the flower. Taylor saw *Andrena* bees put their head and thorax into the largely enclosed lower part of the flower, where the anthers and stigma are located. This suggested that they act as pollinators. The *Protosmia* bee was not seen on *Hackelia,* but individuals were seen carrying pollen of unknown source. The *Nicocles* fly is a predatory species that was probably hunting floral visitors and not acting as a pollinator. Taylor noted abundant thrips in the flowers in 2004. She found none in 2005. Thrips have been noted as pollinators in some plant species (Kirk 1996). Taylor thought thrips might be secondary pollinators of *Hackelia*.
- Harrod (1999) noted solitary bees and hover flies visiting flowers.
- USFWS (2007) noted that the flowers have short corollas, making them attractive to short-tongued pollinators.

No likely pollinators were found on *Hackelia* during this study. Several possible pollinators were collected on the site (Table 2), including six *Eulonchus* flies. Adult *Eulonchus* flies have distinctive long mouth parts. *Eulonchus sapphirinus* has been studied as a pollinator of *Geranium robertianum* (Borkent and Schlinger 2008a). In an area with a relatively diverse plant community, most individual flies expressed floral constancy to *G. robertianum* while other pollinators are not constant. The flies apparently learned that the plant is a reliable source of high quality nectar. In another study, the same authors found *Eulonchus tristris* to be constant to *Brodiaea elegans* (Borkent and Schlinger 2008b). The fly carried a large load of pollen and appears to be an effective pollinator of the plant. *Eulonchus spp.* appear to be sparsely distributed but can be common and conspicuous where present (Cady et al. 1993). The larvae are parasitic on spiders, and many species are host specific (Cady et al. 1993). Survival of the fly requires, therefore, presence of the host spider species and sufficient nectar sources to support the adult flies.

The *Andrena* and *Protosmia* bees provision their nests with pollen. After collecting pollen from a flower, they groom it onto their hind legs, where it may not be available to pollinate another flower.

Conservation Concerns

The showy stickseed population is probably too small to support a pollinator community by itself. Sufficient other nectar and pollen sources must be present in the area to support the necessary stickseed pollinators.

Research Questions

The USFWS Recovery Plan for showy stickseed (2007) states a Priority 1 goal of identifying breeding system and pollinators. This will require more surveys of floral visitors.

If *Eulonchus* flies are significant floral visitors, it would be significant to know the degree to which they express floral constancy. If they are not constant to *Hackelia* the degree to which they visit other plants will determine their effectiveness as pollinators.

During the current survey, no pollinators were found on stickseed. In particular, I did not look for thrips. It would be instructive to note their distribution on the site.

Lomatium bradshawii **(Bradshaw's lomatium)**

Mating System and Pollination

L. bradshawii appears to depend completely on out-crossing. Kagan (1980) described successful self-pollination in a pollinator exclusion experiment. But Kaye and Kirkland (1994) found very limited self-pollination, apparently regulated by floral phenology. This conflict is probably due to differences in experimental design and execution of exclosures (James Kagan, pers comm. 2014; Tom Kaye, pers comm. 2014). Kaye and Kirkland (1994) state that cross-pollination is probably the dominant behavior.

The plant produces male and hermaphroditic flowers. On a single plant, male flowers appear before hermaphroditic flowers and have wilted before hermaphroditic flowers bloom. Bisexual flowers are protogynous, stigmas become receptive before anthers shed pollen. A receptive stigma and mature pollen are unlikely to be present on the same flower at the same time. Insect pollinators are more likely to carry pollen from one plant to a stigma on another plant rather than pollinating the plant that produced the pollen.

Lomatium bradshawii does not reproduce without fertilization, and seed does not survive in the seed bank (Kaye and Kirkland 1994). Populations are, therefore, dependent on pollination by insects.

Pollinators

Lomatium flowers appear to be attractive to a diversity of pollinators.

- In two years of surveys, Kagan (1980) found very few pollinators (Table 1). He thought most pollination was self-pollination.
- Kaye (1992) Kaye and Kirkland (1994) recorded 38 species of insects on flowers; 26 of which were carrying pollen and appeared likely to pollinate the plant (Table 1). Bees and flies were the dominant groups. The ratio of bees to flies varied among sites and among years. As described in the Appendix, flies are more active in cool, wet conditions (Ssymank et al. 2008) such as are common in spring, during the flowering period of Bradshaw's lomatium.

During the present study, 25 possible pollinators were collected on lomatium and in the surrounding habitat (Table 2). Unfortunately, a number of specimens were lost before being identified. Among those that were identified, a diverse group of seven taxa is represented.

Umbels bearing small flowers like those of *Lomatium bradshawii* do not require pollinators to be physically specialized. Any of a large group of floral visitors can act as pollinators. Some pollinators have, however, been documented as constant to species of Apiaceae (Lindsay and Bell 1985). Floral constancy could be important for *L. bradshawii* since populations are located in a fragmented landscape, among many completing floral resources.

Conservation Concerns

This plant occurs in a highly fragmented, highly disturbed landscape throughout its range in Washington and Oregon. The Washington site is in an area undergoing rapid conversion to residential development. Identification of potential specialist pollinators is needed. Following that, an understanding of the habitat needs of the pollinators of Bradshaw's lomatium will be necessary to ensure the stability of the pollination process on the site.

The Washington site contains a population of 800,000 *Lomatium* plants (USFWS 2010). This population size may reduce the significance of pollinator constancy. Pollinators are much more likely to encounter another *Lomatium* plant than to encounter another species on which pollen might be deposited. But the question of constancy should be addressed along with the potential problem of supporting important pollinators whose flight period extends outside of the bloom period of *L. bradshawii.*

Research Questions

Flies are a significant part of the pollinator community at Bradshaw's lomatium sites in Oregon. A comparison with the Washington pollinator community would be useful. A multi-year study of pollinators is needed to consider fluctuations in populations, and if possible, to identify constant pollinators of *Lomatium*.

USFWS (2010) lists pollinator identification and determination of habitat needs as a priority 3 recovery action. A review of habitat requirements might reveal limiting factors that could be managed.

***Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine)**

Mating System and Pollination

L. sulphureus ssp*. kincaidii* depends almost completely on out-crossing for seed production. Kaye (1999) found that pollination was necessary for more than minimal seed set. Structure and flowering order of lupine flowers inhibit autogamy and encourage out-crossing pollination by insects. Flowers mature from bottom to top of inflorescence. Individual flowers are protandrous, with anthers appearing first. Bumble bees tend to forage from the bottom to the top of the inflorescence, contacting older, female flowers first, and then contacting younger, male flowers. They therefore collect pollen from flowers near the top of the inflorescence and deposit it on female flowers, near the bottom of the next inflorescence (Kaye 1999).

Erhart (2000, in Wilson et al. 2003) also found little self-pollination in bagged flowers. Severns (2003) found that seed set doubled in flowers hand-pollinated from xenogamous populations versus open pollination or geitogamous hand pollination. Seed viability was 25% lower with open pollination or geitogamous pollination vs. xenogamous pollination. Small populations of plants, representing lower levels of diversity, were more susceptible to this effect than larger populations. This suggests the possibility of inbreeding depression caused by current isolation of Kincaid's lupine populations.

Most flowers produce no nectar but do produce pollen that is gathered by insects. Schultz and Dulgosch (1999) found a small quantity of nectar in some flowers.

Pollinators

Kincaid's lupine is not open to pollination by all floral visitors. Pollinators must be able to force their way into the keel or have a tongue long enough to reach the pollen from outside the flower.

- Wilson et al. (2003) recorded several floral visitors on Kincaid's lupine in Oregon (Table 1). Most perched outside the flower and probed for pollen and nectar. Effectiveness of these visitors as pollinators relies on their being able to reach pollen. Koch et al. (2011) record *B. mixtus* as having a medium length tongue and *B. californicus* as having a long tongue. Tongue length of the other visitors is unknown. Nor is it known what length tongue is needed to enable pollination of *L. sulphureus* ssp. *kincaidii.* The small *Dialictus* entered the corolla and rolled vigorously, covering their bodies with pollen. This species clearly picks up pollen but whether it deposits it effectively is not known.

During the current study several insects were recorded as floral visitors (Table 2). The list includes three species of *Bombus*. *B. flavifrons* has a long tongue*. B. mixtus* and *B. vosnesenski* each have medium tongues (Koch et al. 2011). Several other potential pollinators were noted on the sites. A number of specimens, including several potential pollinators are missing.

Kincaid's lupine is the principal larval host for Fender's blue butterfly (Schultz et al. 2003). Larvae feed on leaves, flowers, seed pods, and seeds. They do not cause substantial damage to the plant (Kaye and Kuykendall 1993).

Conservation Concerns

The effectiveness as pollinators of various floral visitors is unknown. Lupine pollen can frequently be identified on the body of a pollinator. A study of floral visitors could be designed to explore which species may be effective pollinators and which are simply floral visitors.

This plant occurs in a highly fragmented, highly disturbed landscape throughout its range in Washington and Oregon. Lupine populations throughout the range are small, and most are widely separated. Strong-flying pollinators such as *Bombus* may be important, and establishment of stepping stone populations of lupine may be helpful to decrease inbreeding (Severns 2003).

Wilson et al (2003) suggest that Kincaid's lupine reproduction may be limited by number of pollinators early in the season, causing relatively low seed set, and limited by resources later in the season, especially at sites where water availability may be limited at that time. Mid-season flowers may be the most successful at seed production. This coordination of pollinators, resources, and flowers may be disturbed if climate change affects insect emergence, water availability, and flowering phenology.

Research Questions

The current study and previous studies recorded a number of potential pollinators on Kincaid's lupine. The plant may not be limited by pollination. Monitoring of seed production could confirm this.

Isolation of Washington populations may, however, be sufficient to cause inbreeding depression. This possibility should be explored.

***Physaria douglasii* ssp. *tuplashensis* (White Bluffs bladderpod)**

Mating System and Pollination

The mating system of *Physaria douglasii* ssp. *tuplashensis* has not been studied. Other members of the genus such as *P. obcordata* (Tepedino et al 2012, Clark 2013) and *P. didymocarpa* (Heidel and Hadley 2004) have a similar size and floral structure. These species self-pollinate to a very limited extent but usually reproduce by outcrossing. This requires insect pollination.

Pollinators

The plant has a dense inflorescence of many small flowers. This may be attractive to a large number of generalist pollinators.

- Beck and Caplow (1998) report a wide variety of floral visitors on White Bluffs bladderpod (Table 1). No Andrenidae or Halictidae, common pollinators of other *Physaria*, (see below) were recorded.
- Minckley (2006) reports nine floral visitors for *P. fendleri* and about 80 species visiting *Physaria gordonii*. Fifty eight of these were members of the Andrenidae, Halictidae, and Megachilidae.
- Heidel and Handley (2004) report that *P. didymocarpa* is a generalist flower, attracting a range of pollinators.
- Tepedino et al. (2012) report that *P. obcordata* attracted 27 species of Andrenidae and Megachilidae bees. They found *P. odcordata* pollen on 18 of these species. The remaining species were apparently gathering only nectar. They also found a variety of flies, wasps, and ants visiting *P. cordata* but found pollen only on one fly. This *Gonia* spp. was commonly found and is a likely pollinator.
- Clark (2013) found *P. obcordata* pollen on a more diverse group of 35 species of bees including members of the families Andrenidae, Anthophoridae, Apidae, Colletidae, Halictidae, and Megachilidae. The average pollen loads of 24 of these species were over 50% *P. cordata* and eight of these species carried more than 80% *P. obcordata* pollen. The sample size is small, but this supports that generalization that many smaller bees are pollen oligolects (Cane 2008)

No survey was conducted of floral visitors of White Bluffs bladderpod.

Conservation Concerns

Many of the floral visitors to other species of *Physaria* are members of the Andrenidae, Halictidae, and Megachilidae families. Some of these species appear to be specialists on *Physaria* when it is in bloom. Some Andrenid species are active for only short periods in the spring that may coincide with the bloom of *P. douglasii* ssp. *tuplashensis.* Other species, especially the Halictids, have a longer activity period and need to have additional nectar and pollen sources later in the season.

Nesting requirements of these species are diverse and in many cases, quite specific. Their survival as pollinators requires that these requirements be met within a suitable flight distance of the plant populations.

These questions require more study of the pollinators of *P. douglasii* ssp. *tuplashensis* and their relationship with other plants in the area and with possible nesting habitat.

Research Questions

The diverse group of pollinators that may visit White Bluffs bladderpod probably has a diverse set of requirements for nesting habitat and other nectar and pollen sources. Pollinators that use this plant may link to many of the other plants and many of the nesting habitat types within several miles of the *P. douglasii* ssp. *tuplashensis* population.

Sidalcea nelsoniana (Nelson's checker-mallow)

Mating System and Pollination

S. nelsoniana appears to depend largely on cross-pollination for successful seed set. Gisler and Meinke (1998) report two types of flowers. Some plants produce only female flowers. These plants can only outcross. Other plants produce hermaphroditic flowers. These flowers are protandrous, with anthers and pollen maturing before the stigma is receptive. As the flower ages, the pollen has usually been removed before the stigma becomes receptive. Younger flowers, with pollen, are near the top of the inflorescence and older flowers, with receptive stigma are lower on the inflorescence. Most pollinators forage from bottom to top of an inflorescence, so they move pollen from the top to a stigma at the base of the next inflorescence that they visit (USFWS 2010). Geitonogamy may occur, but self-pollination is rare.

Pollinators

Nelson's checker-mallow appears to attract a number of pollinators.

- Gisler (2003) recorded 24 species of insects visiting Nelson's checker-mallow flowers (Table 1). He stated that all are likely pollinators because he only collected species that contacted floral reproductive parts directly. Some non-hairy insects, such as wasps, may not be effective because pollen will not stick to their bodies. Others may extract nectar in a manner that does not bring them into contact with anthers or stigma. Others may not be constant to *Sidalcea*, thereby depositing pollen on the flowers of other species.
- One of Gisler's collections was *Diadasia nigrafrons*. Sipes and Tepedino (2005) and Moldenke (pers. comm. in Gisler 2003) report this species as a specialist on *Sidalcea* and other Malvaceae. It may be more constant than other floral visitors to *Sidalcea*.
- Dimling (1992) found greater seed production on hand pollinated inflorescences than on open-pollinated inflorescences. This suggested the possibility of pollinator limitation, at least in his study.

The current study found several potential pollinators on Nelson's checker-mallow, including four species of *Bombus* (Table 2). Unidentified possible pollinators are among the specimens that were lost.

Conservation Concerns

Gisler's (2003) collections were part of a study of hybridization of four *Sidalcea* species that have various levels of overlap in range, flower phenology, and pollinators. A few species of pollinators were unique to each of the *Sidalcea* species, but many visited all four species. The common floral visitors included several bumble bees. These are strong fliers, able to travel up to several kilometers (NatureServe 2012). This ability to carry pollen for a distance is usually seen as an advantage. In this case, it may threaten the Nelson's checker-mallow, by increasing the chances of hybridization.

Nelson's checker-mallow occurs in a highly fragmented, highly disturbed landscape throughout its range in Washington and Oregon. Its pollinator community appears to be large and diverse. The plant may not be vulnerable to pollination limitation, but hybridization caused by cross-pollination may be a problem.

Research Questions

Gisler (2003) reported a large number of pollinators on *Sidalcea* in Oregon. An apparently diverse community of floral visitors was recorded by this project in Washington, as well. Information on the relative effectiveness of these species as pollinators would be useful. It would also be useful to survey

Washington sites for *Diadasia nigrafrons*. *D. nigrafrons* was not recorded during this study but may have been among the specimens that were lost. It nests in open ground. Usable patch size of nesting habitat is not known. Little open ground is apparent in the area around *S. nelsoniana* populations. If the bee present, a survey for nesting habitat should be done. Nesting habitat management may be necessary.

In Washington, other species of *Sidalcea* are present in the area around *Sidalcea nelsoniana.* The hybridization problem described by Gisler (2003) may be an issue in Washington. Investigation of pollinators and their constancy would help address this question.

***Sidalcea oregana* var. *calva* (Wenatchee Mountain checker-mallow)**

Mating System and Pollination

S. oregana var. *calva* is dependent out-crossing. Its pollination biology is similar to that of Nelson's checker-mallow (Arnett pers. comm. 2012). Some plants produce only female flowers. These plants can only outcross. Other plants produce hermaphroditic flowers. On these flowers, anthers and pollen mature first, before the stigma is receptive. As the flower ages, the pollen is usually removed before the stigma becomes receptive. Younger flowers, with pollen, are near the top of the inflorescence and older flowers, with receptive stigma are lower on the inflorescence. Most pollinators forage from bottom to top of an inflorescence, so they move pollen from the top to a stigma at the base of the next inflorescence that they visit (USFWS 2010). Geitonogamy may occur, but self-pollination is rare.

Pollinators

Wenatchee Mountain checker-mallow appears to attract a number of pollinators.

- Zimmerman and Reichard (2005) collected nine species of insects visiting the flowers. These collections were opportunistic and probably represent a fraction of the pollinator diversity.
- One of their collections was *Diadasia nigrafrons.* Moldenke (pers. comm. in Gisler 2003) reported this species as a specialist on *Sidalcea* and other Malvaceae.
- Tepedino recorded *D. nigrafrons* at the Camas Meadows Preserve. He found a nesting colony on a patch of bare ground (Tepedino, 2003).

During the current project, a number of visitors were found on checker-mallow flowers (Table 2), including some species in common with earlier work and possibly some additional species. Four *Bombus* have been identified, and other potential pollinators have been identified to genus.

Conservation Concerns

Bumble bees are common floral visitors and may be significant pollinators of this species. They are strong fliers, able to travel several kilometers (NatureServe 2012). This ability to carry pollen for a distance increases the possibility of gene flow, probably strengthening the populations. Most of the extant populations are within two kilometers of another population. Some sites are, however, separated by potential barriers such as forest and roads. A survey of the effect of these barriers would be useful in management of the checker-mallow.

Several populations of checker-mallow are more than two kilometers from another population. Establishment of stepping stone populations of checker-mallow might increase the genetic diversity of these populations.

Cross-pollination leading to hybridization is a concern in the Puget Trough where several species of *Sidalcea* co-occur (Gisler 2003). This may not be an issue in the area around the populations of Wenatchee Mountain checker-mallow because no other species of checker-mallow are known within pollination range (J. Arnett pers. comm.2014). This should, however, be confirmed.

Research Questions

The diversity of pollinators of Wenatchee Mountains checker-mallow is not known. Additional surveys of possible pollinators on various sites would be useful. Thrips are common in the flowers (J. Fleckenstein pers. obs.) and may serve as pollinators of some plant species (Kirk 1996).

Diadasia nigrafrons has been found at one *S. oregana* var. *calva* site*.* The remaining sites should be surveyed for the distinctive ground nests of this species. Additional information on nesting habitat would enable better protection of the pollinator.

Silene spaldingii (Spalding's silene)

Mating System and Pollination

S. spaldingii is largely dependent on out-crossing*.* Lesica (1993) found total of 99% reduction in fitness of plants where insect pollination was prohibited. This was through reduced seed production, seed germination, and seeding survival. Protandry in the flower encourages cross-pollination over self-pollination (Lesica 1993). There is, however, some overlap between pollen availability and stigma receptivity, making self-pollination possible late in the floral cycle.

Pollinators

Few floral visitors have been recorded.

- Lesica and Heidel (1996) found that at five sites, *Bombus fervidus* made 83% of pollinator visits to *Silene* flowers (Table 1). (Lesica (1993) report of *B. nevadensis* was a misidentification (Lesica and Heidel 1996).) Three Halictine bees also visited flowers but were probably less efficient pollinators. They are too small to contact reproductive parts efficiently. They are also less hairy and so, unlikely to carry as much pollen (Lesica and Heidel 1996).
- Lesica and Heidel (1996) found that at sites where *Hypericum perfoliatum* flowers were abundant, *B. fervidus* often switched from silene as a nectar and pollen source. This competition for pollinators may reduce effective visitation rates and therefore, reproduction.
- Lesica and Heidel (1996) recorded noctuid moths making four visits to *Silene* flowers. Hill and Gray (2004) note that noctuids are important pollinators of other species of *Silene.* Kephart et al. (2005) described the relationship of moths of the genera *Hadena* and *Perizoma* with *Silene*. The moths are important pollinators of other species of *Silene* but have not been documented on *S. spaldingii.* Several species of *Hadena* have been documented in eastern Washington (PNW Moths 2014).

During the current study *B. fervidus* and B *californicus* were found visiting the *S. spaldingii* (Table 2). The silene sites studied by Lesica and Heidel (1996) are within the range of *B. californicus,* but it is unknown if this *Bombus* occurs on the sites. Numerous other species including five additional *Bombus* were collected on silene sites. Two non-*Bombus* insects were collected while visiting silene flowers. These specimens were lost. Many other potential pollinators were collected on silene sites, but none of them were seen visiting silene.

Stickiness of the plant may deter most insect visitors. Insects seen visiting silene flowers during this study landed directly on a flower, rather than landing elsewhere on the plant and walking to the flower. One *Bombus* landed with one foot outside of the flower on a sepal. It struggled for more than one minute to free itself.

Conservation Concerns

The flight period of *B. fervidus* extends from late spring to early fall (Koch et al. 2011). Spalding's silene flowers in mid to late summer (Camp and Gamon 2010). Early in the season, the bee is dependent for floral resources on other species of plants. In addition, where populations of silene are small, insufficient to support a population of bees, other pollen and nectar sources must be present during the silene flowering period, as well. On the other hand, an over-abundance of other blooming plants during the bloom period for silene may cause pollinators to abandon silene.

Bumble bees, including *B. fervidus* are strong fliers, able to travel several kilometers (NatureServe 2012). This ability to carry pollen for a distance increases the possibility of gene flow, strengthening the populations. Some populations of Spalding's silene are within this distance, but others are more than 2 kilometers from another population. Establishment of stepping stone populations of silene could strengthen the genetic diversity of these populations.

Research Questions

Several species of *Bombus* were recorded on or around silene during this study. The relative importance of these species should be studied.

Moths may be important pollinators of silene. Nocturnal pollination studies should be done, and sites should be surveyed for *Hadena* and *Perizoma* moths.

Further research on reproductive biology and pollinators is a Priority 3 in the Recovery Plan (USFWS 2007).

***Spiranthes diluvialis* (Ute ladies' tresses)**

Mating System and Pollination

S. diluvialis will reproduce by autogamy, but out-crossing is more common. According to Sipes and Tepedino (1995) *S. diluvialis* will self-pollinate, but cross-pollination is encouraged by protandry. Anthers and pollinia are present when the flower opens, but the stigma has not developed. After several days, the stigma becomes receptive. By this time, a pollinator may have removed the pollinia. If it has not been removed, self-pollination may occur when a pollinator deposits the pollinia within the same flower. Flowering sequence is acropetalous, moving from the base of the inflorescence to the top, so older flowers with receptive stigma are present lower on the stem, and younger flowers with pollinia are present higher in the inflorescence. When collecting nectar, most bees move up inflorescence, from older to younger flowers. They are less likely to encounter pollinia until after encountering a stigma, increasing the chance of outcrossing, but continued presence of pollinia increases the chances of self-fertilization if pollinator visits are rare.

Spiranthes diluvialis pollen is packaged in pollinia and is not usable by pollinators as food. The flower provides only nectar as food (Sipes and Tepedino 1995).

Pollinators

The genus *Spiranthes* may have fewer pollinators than other orchids because of the level of pollinator specialization required (Tremblay 1992 in Sipes and Tepedino 1995).

- Information on the insects that may pollinate *S. diluvialis* is conflicting. According to Sipes and Tepedino (1995) nectar of Ute ladies' tresses is more available to long-tongued pollinators. They recorded long-tongued bees such as *Bombus morissoni, B. fervidus* and *Anthophora terminalis* on the plants and carrying pollinia (Table 1). They state that smaller bees may steal nectar without encountering pollinia. Pierson *et al*. (2000) recorded a more diverse group of bees carrying pollinia (Table 1). Their list included long- and short-tongued species. All *Bombus* encountered by each study were carrying pollinia.
- Sipes and Tepedino (1995) and Pierson et al. (2000) found that pollinator studies were difficult because pollinator visits were rare enough that a systematic survey was not feasible. Each study made only opportunistic observations.
- Pierson *et al*. (2000) found that *Bombus griseocollis* was the most likely to collect pollinia and the most likely to visit a number of ladies' tresses flowers in sequence. Other *Bombus* and especially the honey bee (*Apis mellifera*) were more likely to visit other plant species between ladies' tresses visits.
- Floral diversity is necessary to support the pollinator community. The *Bombus* and *Anthophora* species recorded as possible pollinators by other studies and as present on *S. diluvialis* sites by this study are active from early spring through late fall. A diversity of nectar and pollen sources is necessary on an orchid site to support pollinators until ladies' tresses flowers. Pierson *et al*. (2000) list other species of pollen found on species carrying ladies' tresses pollen. Asteraceae most common. On the other hand, Pierson *et al.* (2000) advise that if many other pollen and nectar sources are available when the orchid is in flower, orchid pollination may not be thorough.
- Gibble (W. Gibble pers. comm. 2014) reports, however, that in 2008, seed was collected from two *S. diluvialis* sites, meaning that some pollination had occurred.

No potential pollinators were seen visiting *S. diluvialis* during this study.

B. fevidus, *B. griseocollis*, *B. huntii*, *B. mixtus*, and *B. rufocinctus* were found on sites with *S. diluvialis* (Table 2). The first is a long-tongued species, the next three are medium-tongued species, and the last is short-tongued. *B. huntii* and *mixtus* were not recorded by previous studies. Each of the other *Bombus* species are recorded as possible pollinators by Sipes and Tepedino (1995) or Pierson *et al* (2000). In this study, no data were collected on presence of pollinia on possible pollinators

Several specimens, including some small bees collected during this study have been lost. *Anthophora* may have been among them.

Conservation Concerns

All *Spiranthes diluvialis* sites in Washington are adjacent to the Columbia River and on its floodplain. Some of the bees believed to be pollinators nest underground and others nest on the surface. If nest locations are saturated by flooding during the late spring, these species might not survive on the site.

Research Questions

Ute ladies' tresses appear to have a small number of pollinators. Habitat requirements are known for a number of them and could be integrated into site management plans.

Ute ladies' tresses flowers late in the season. Presence of an adequate pollinator community depends on presence of floral resources throughout the season of pollinator activity. A survey of the range of possible floral resources and their adequacy would establish the strength or weakness of this community.

Continued surveys for floral visitors are important. Orchid pollinia are conspicuous on insects, and it is relatively easy to watch possible pollinators for their presence (Pierson *et al.* 2000). Given the rarity of floral visits, continued surveys of ladies' tresses sites for insects carrying pollinia and for pollinators known from other studies is also important. A survey for seed set would also be instructive. If a substantial number of plants set seed that suggests that pollinators are present. If few plants set seed, it may be that pollinators are scarce or that plants are self-pollinating.

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Appendix – Summary of pollination processes and threats to pollinators

The range of pollination processes used by federally listed plant species in Washington is quite broad. Their various pollinators also have a diverse ecological range. These processes and species face a number of significant threats. Following is an outline of some aspects of pollination processes, pollinator biology, and threats. Each applies to some degree to each of the plant species in this report. When there is a special application to a particular plant, it is discussed in the species account.

Diversity of pollination processes

Some plant species are wind pollinated. Most others have a degree of self-fertility, although reproductive output is generally increased when animals act as pollinators. Ollerton et al. (2011) report that reproduction of 85-90% of plant species is aided by pollination by animal species. Among these, many plants have relatively unspecialized flowers that can be pollinated by a wide range of animals. Self-incompatible plants and those with specialized flowers may be dependent on a small number of pollinator species. Continued pollination of a plant population depends on the predictable, continued presence of its pollinators.

Timing of bloom and the availability of pollen and nectar within a population and on a single plant can regulate pollinator activity and timing. Some important floral characteristics are described here.

- Acropetal - development of flowers in sequence, upward from the base of the inflorescence.
- Anthesis - the flowering period.
- Autogamy - self-fertilization of a flower.
- Geitonogamy - fertilization by pollen of another flower from same (or genetically identical) plant.
- Hermaphroditic - male and females parts both present and functional.
- Protandry - development (within a single flower of an inflorescence) of anthers and pollen before stigma thus inhibiting self-fertilization, common in mints, legumes, and composites.
- Protogyny - development (within a single flower of an inflorescence) of the stigma before anthers and pollen thus inhibiting self-fertilization.
- Xenogamy - fertilization by pollen from a genetically different plant, usually some distance away**.**

Diversity of pollinators

A large number of animals can act as pollinators. Among the mammals, rodents and bats are the most common. Mammals have not been reported as pollinators or potential pollinators of any federally listed species in Washington. Hummingbirds are the dominant avian pollinator in North America. Hummingbirds are often significant pollinators of tubular flowers and are often associated with red flowers. Hummingbird pollination was not recorded during this project and does not appear to be significant for these species.

Most pollination of federally listed plants in Washington is accomplished by insects. Bees are the most common pollinator group. Flies are frequent pollinators and may be especially important in cool conditions; early or late in the year or early or late in the day (Ssymank et al. 2008). Other groups, such as beetles, butterflies, and moths serve at times as pollinators of some plants.

Floral visitation versus pollination

Animals may visit a flower without pollinating it. Body size, morphology, or behavior of a floral visitor may prevent contact with pollen or stigma. Appropriate body size and shape, behavior, and timing are necessary for a floral visitor to be a pollinator.

Pollinator specialization

Pollinators have different levels of specialization. Some collect resources from a wide range of plant species while others depend on a small group of plant species. Survival of specialist pollinators depends on continued presence of their plants. Many pollinators will visit a wide range of plant species for nectar collection but a small number of species, or only a single species for pollen.

Pollinators express differing degrees of loyalty to plant species. Loyalty is described with the following terminology.

- Floral constancy - Degree to which an individual floral visitor will visit one species of plant for pollen, nectar, or other resources. This is a temporary loyalty that may change from day to day or individual to individual.
- Monolecty - Permanently fixed specialization of a bee species on pollen of a single plant species. May take nectar from multiple species.
- Oligolecty - Permanently fixed specialization of a bee species on pollen of a few plant species. May take nectar from multiple species.
- Polylecty - Pollen generalist.

Other habitat requirements

Nesting habitat needs differ among pollinator species. Those that nest in the soil require a particular soil composition and moisture level. Species that nest at ground level or above the ground may require a particular set of structural features. Either group may use building materials such as wood scrapings of leaf cuttings or locations such as abandoned rodent nests. Loss of any of these habitat features can cause decline or extirpation of a species.

Invasive plant and animal species

Invasive species may affect pollinators in many ways. Invasive plants may complete with preferred pollen and nectar species, reducing resources on a site. Alternately, invasive plants may be more attractive to a pollinator than native species, reducing pollination services to the native plant species.

Invasive bees such as the honey bee (*Apis mellifera*) may compete with native bees for food resources. Diseases carried by invasive bees or introduced by other means may directly attack native pollinators.

Habitat loss

Effective pollinator populations may survive in relatively small blocks of habitat. Field edges and fence rows can support sufficient pollinators for agricultural crops if habitat needs are met. But practices such as pesticide use and agricultural burning may reduce or extirpate pollinators if improperly applied. Alternate food sources needed to support a pollinator community often needed and as are nesting needs such as the range of soil types on a site. Land management practices must be carefully planned.

Table 1. Pollinators Recorded by Other Studies

Element Code / Floral Visitor	Scientific Name / Pollinator or visitor *	Common Name / Group, common name	Reference
PDSCR0D1S0	**Castilleja levisecta**	**golden paintbrush**	
Bombus californicus	p	Apidae, bumble bee	Evans et al. 1984
Lasioglossum dialictus	p	Halictidae, sweat bee	Mark Fessler, pers comm.
Lasioglossum sphecodogastra	p	Halictidae, sweat bee	Mark Fessler, pers comm.
PDPGN086Y0	**Eriogonum codium**	**Umtanum desert buckwheat**	
Arachnida, (CLASS)	v	Arachnida, spider	TNC/USFWS 1998
Coleoptera (ORDER)	v	Coleoptera, beetle	TNC/USFWS 1998
Diptera (FAM.)	p	Diptera, fly	TNC/USFWS 1998
Formicidae (FAM.)	v	Formicidae, ant	TNC/USFWS 1998
Lepidoptera (ORDER)	p	Lepidoptera, butterfly	TNC/USFWS 1998
Strymon melinus	p	Lepidoptera, gray hairstreak	Patti Ensor, 1995. unpub. record
moths	p?	Lepidoptera, moth	TNC/USFWS 1998
PDBOR0G0T0	**Hackelia venusta**	**showy stickseed**	
Andrena nigrocaerulen	p	Andrenidae, mining bee	Taylor 2008
Nicioles (GENUS)	v	Asilidae, robber fly	Taylor 2008
Eulonchus possibly tristis	p	Diptera, small-headed fly	Taylor 2008
Protosmia rubifloris	p	Megachidae, bee	Taylor 2008
PDAPI1B030	**Lomatium bradshawii**	**Bradshaw's lomatium**	
Andrenidae (FAM.)	p	Andrenidae, mining bee	Kagan 1980
Andrena (GENUS) sp. 3	p	Andrenidae, mining bee	Kaye and Kirkland 1994
Andrena (GENUS) sp. 2	p	Andrenidae, mining bee	Kaye and Kirkland 1994
Andrena (GENUS) sp. 1	p	Andrenidae, mining bee	Kaye and Kirkland 1994
Ceratina (GENUS)	p	Apidae, carpenter bee	Kaye and Kirkland 1994
Berytidae (FAM.)	v	Berytidae, stilt bug	Kaye and Kirkland 1994
Calophoridae (FAM.)	v	Calophoridae, blow fly	Kaye and Kirkland 1994
Lebia moesta	p	Carabidae, ground beetle	Kaye and Kirkland 1994
Diabrotica undecempunctata	p	Chrysomelidae, leaf beetle	Kaye and Kirkland 1994
Bruchus brachialis	v	Chrysomelidae, weevil	Kaye and Kirkland 1994
Cixiidae (FAM.).	v	Cixiidae, planthopper	Kaye and Kirkland 1994
Tachinidae (FAM.)	p	Diptera, fly	Kaye and Kirkland 1994
Diptera (misc.)	v	Diptera, fly	Kagan 1980, Kaye and Kirkland 1994
Dalopius (GENUS)	v	Elateridae, click beetle	Kaye and Kirkland 1994
Empididae (FAM.) sp. 3	v	Empididae, dagger fly	Kaye and Kirkland 1994
Empididae (FAM.) sp. 2	p	Empididae, dagger fly	Kaye and Kirkland 1994
Empididae (FAM.) sp. 1	v	Empididae, dagger fly	Kaye and Kirkland 1994
Formica fusca	v	Formicidae, black ant	Kaye and Kirkland 1994
Halictidae (FAM.) sp. 1	p	Halictidae, sweat bee	Kaye and Kirkland 1994

Table 1. Pollinators Recorded by Other Studies - Continued

Element Code	**Scientific Name**	**Common Name**	
Floral Visitor	Pollinator or visitor *	Group, common name	Reference
Halictidae (FAM.) sp. 2	p	Halictidae, sweat bee	Kaye and Kirkland 1994
Lasioglossum (GENUS)	p	Halictidae, sweat bee	Kaye and Kirkland 1994
Ichneumonidae (FAM.)	p	Ichneumidae, wasp	Kaye and Kirkland 1994
Anthomyidae (FAM.)	p	Muscoidea, fly	Kaye and Kirkland 1994
Anthomyidae (FAM.)	p	Muscoidea, fly	Kaye and Kirkland 1994
Sphaerophoria (GENUS)	p	Syrphidae, fly	Kaye and Kirkland 1994
Xylota (GENUS)	p	Syrphidae, fly	Kaye and Kirkland 1994
Syrphus (GENUS)	p	Syrphidae, fly	Kaye and Kirkland 1994
Sphaerophoria (GENUS)	p	Syrphidae, fly	Kaye and Kirkland 1994
Rhagio (GENUS)	p	Syrphidae, fly	Kaye and Kirkland 1994
Platycheirus (GENUS)	p	Syrphidae, fly	Kaye and Kirkland 1994
Paragus (GENUS)	p	Syrphidae, fly	Kaye and Kirkland 1994
Mesograpta marginata	p	Syrphidae, fly	Kaye and Kirkland 1994
Melanostom (GENUS)	p	Syrphidae, fly	Kaye and Kirkland 1994
Toxomerus (GENUS)	p	Syrphidae, fly	Kaye and Kirkland 1994
Cheilosia (GENUS)	v	Syrphidae, hover fly	Kaye and Kirkland 1994
Tenthredinidae (FAM.) sp. 2	v	Tenthredinidae, saw fly	Kaye and Kirkland 1994
Tenthredinidae (FAM.) sp. 1	p	Tenthredinidae, saw fly	Kaye and Kirkland 1994
Tricoptera (ORDER)	v	Tricoptera, caddisfly	Kaye and Kirkland 1994
Polistes (GENUS)	p	Vespidae, paper wasp	Kaye and Kirkland 1994
PDFAB2B2W1	**Lupinus sulphureus ssp. kincaidii**	**Kincaid's sulfur lupine**	
Andrena (GENUS)	p	Andrenidae, mining bee	Wilson et al. 2003
Anthophora furcata	p	Anthrophoridae, bee	Wilson et al. 2003
Habropoda (GENUS)	p	Anthrophoridae, digger bee	Wilson et al. 2003
Bombus (GENUS)	p	Apidae, bumble bee	Kaye 1999
Bombus mixtus	p	Apidae, bumble bee	Wilson et al. 2003
Bombus californicus	p	Apidae, bumble bee	Wilson et al. 2003
Apis mellifera	p	Apidae, honey bee	Wilson et al. 2003
Dialictus (GENUS)	p	Halictidae, sweat bee	Wilson et al. 2003
Osmia lignaria	p	Megachilidae, bee	Wilson et al. 2003
PDBRA1N270	**Physaria douglasii ssp. tuplashensis**	**White Bluffs bladderpod**	
Bombus (GENUS)	v	Apidae, bumble bee	Beck and Caplow 1998
Coleoptera (ORDER)	v	Coleoptera, beetle	Beck and Caplow 1998
Diptera (FAM.)	v	Diptera, fly	Beck and Caplow 1998
Formicidae (FAM.)	v	Formicidae, ant	Beck and Caplow 1998
Lepidoptera (ORDER)	v	Lepidoptera, butterfly	Beck and Caplow 1998
moths	v	Lepidoptera, moth	Beck and Caplow 1998
Vespidae (FAM.)	v	Vespidae, wasp	Beck and Caplow 1998

Table 1. Pollinators Recorded by Other Studies - Continued

Element Code	Scientific Name		Common Name
Floral Visitor	Pollinator or visitor *	Group, common name	Reference
PDMAL110H0	**Sidalcea nelsoniana**		**Nelson's checker-mallow**
Bombus vosnesenskii	p	Apidae, bumble bee	Gisler 2003
Bombus sitkensis	p	Apidae, bumble bee	Gisler 2003
Bombus californicus	p	Apidae, bumble bee	Gisler 2003
Ceratina acantha	p	Apidae, carpenter bee	Gisler 2003
Ceratina micheneri	p	Apidae, carpenter bee	Gisler 2003
Synhalonia (GENUS)	p	Apidae, digger bee	Gisler 2003
Diadasia nigrafrons	p	Apidae, digger bee	Gisler 2003
Apis mellifera	p	Apidae, honey bee	Gisler 2003
Melissodes (GENUS)	p	Apidae, long-horned bee	Gisler 2003
Diabrotica undecimpunctata	p	Chrysomelidae, leaf beetle	Gisler 2003
Macrorhoptus sidalceae	p	Coleoptera, weevil	Gisler 2003
Eulonchus tristis	p	Diptera, small-headed fly	Gisler 2003
Agapostemon (GENUS)	p	Halictidae, sweat bee	Gisler 2003
Halictus (GENUS)	p	Halictidae, sweat bee	Gisler 2003
Lasioglossum (GENUS)	p	Halictidae, sweat bee	Gisler 2003
Ichneumonidae (FAM.)	p	Ichneumidae, wasp	Gisler 2003
Strymon melinus	p	Lepidoptera, gray hairstreak	Gisler 2003
Hesperia juba	p	Lepidoptera, Juba skipper	Gisler 2003
Vanessa annabella	p	Lepidoptera, west coast lady	Gisler 2003
Osmia (GENUS)	p	Megachilidae, bee	Gisler 2003
Meloidae (FAM.)	p	Meloidae, blister beetle	Gisler 2003
Nomada (GENUS)	p	Nomadinae, bee	Gisler 2003
Syrphidae (GENUS) sp. 1	p	Syrphidae, fly	Gisler 2003
Syrphidae (GENUS) sp. 3	p	Syrphidae, fly	Gisler 2003
PDMAL110K4	**Sidalcea oregana var. calva**		**Wenatchee Mountain checker-mallow**
Bombus bifarius	p	Apidae, bumble bee	Zimmerman and Reichard 2005
Bombus mixtus	p	Apidae, bumble bee	Zimmerman and Reichard 2005
Bombus insularis	p	Apidae, bumble bee	Zimmerman and Reichard 2005
Bombus vandykei	p	Apidae, bumble bee	Zimmerman and Reichard 2005
Diadasia nigrifrons	p	Apidae, digger bee	Zimmerman and Reichard 2005
Osmia (GENUS)	p	Megachilidae, bee	Zimmerman and Reichard 2005
Osmia malina	p	Megachilidae, bee	Zimmerman and Reichard 2005
Osmia densa	p	Megachilidae, bee	Zimmerman and Reichard 2005
Hoplitis albifrons argentifrons	p	Megachilidae, bee	Zimmerman and Reichard 2005
PDCAR0U1S0	**Silene spaldingii**		**Spalding's silene**
Bombus fervidus	p	Apidae, bumble bee	Lesica and Heidel 1996
Dienoplus rugulosis	v	Halictidae, sweat bee	Lesica and Heidel 1996

Table 1. Pollinators Recorded by Other Studies - Continued

Element Code Scientific Name		Common Name	
Floral Visitor	Pollinator or visitor *	Group, common name	Reference
Lasioglossum (GENUS)	v	Halictidae, sweat bee	Lesica and Heidel 1996
Halictus tripartitus	v	Halictidae, sweat bee	Lesica and Heidel 1996
Lasioglossum ovaliceps	v	Halictidae, sweat bee	Lesica and Heidel 1996
PMORC2B100 Spiranthes diluvialis		**Ute ladies' tresses**	
Anthophora terminalis	p	Anthrophoridae, bee	Sipes and Tepedino 1995, Pierson et al 2000
Anthophora (GENUS)	p	Anthrophoridae, bee	Sipes and Tepedino 1995, Pierson et al 2000
Bombus griseocollis	p	Apidae, bumble bee	Pierson et al. 2000
Bombus fervidus	p	Apidae, bumble bee	Sipes and Tepedino 1995, Pierson et al 2000
Bombus occidentalis	p	Apidae, bumble bee	Pierson et al. 2000
Bombus rufocinctus	p	Apidae, bumble bee	Pierson et al. 2000
Bombus (GENUS)	p	Apidae, bumble bee	Pierson et al 2000
Bombus bifarius	p	Apidae, bumble bee	Pierson et al. 2000
Bombus appositus	p	Apidae, bumble bee	Pierson et al. 2000
Bombus morissoni	p	Apidae, bumble bee	Sipes and Tepedino 1995, Pierson et al 2000
Ceratina pacifica	v	Apidae, carpenter bee	Sipes and Tepedino 1995
Apis mellifera	p	Apidae, honey bee	Pierson et al. 2000
Colletes (GENUS)	v	Colletidae, plasterer bee	Pierson et al. 2000
Halictus (GENUS)	v	Halictidae, sweat bee	Pierson et al. 2000
Dialictus (GENUS)	v	Halictidae, sweat bee	Sipes and Tepedino 1995
Hyles lineata	v	Lepidoptera, hawkmoth	Sipes and Tepedino 1995
Osmia (GENUS)	v	Megachilidae, bee	Pierson et al. 2000
Ashmeadiella aridula	v	Megachilidae, leaf-cutter bee	Sipes and Tepedino 1995, Pierson et al. 2000
Heriades variolosus	v	Megachilidae, mason bee	Sipes and Tepedino 1995
Syrphidae	v	Syrphidae, fly	Pierson et al. 2000
Myzinum (GENUS)	p	Thynnidae, wasp	Sipes and Tepedino 1995
Vespula maculata	v	yellow jacket	Pierson et al. 2000

* Pollinator/visitor p - Known or likely to be a pollinator
v - Unlikely to be a pollinator

Table 2. Potential Pollinators Recorded by This Study

Element Code	Scientific Name		Common Name		
Scientific Name	Site		Date	County	On/Near*
PDSCR0D1S0	**Castilleja levisecta**		**golden paintbrush**		
Apoidea (SUPERFAM.)	Naas Preserve		8 June 2011	Island	near
Apoidea (SUPERFAM.)	Naas Preserve		8 June 2011	Island	near
Apoidea (SUPERFAM.)	Naas Preserve		8 June 2011	Island	on
Apoidea (SUPERFAM.)	Naas Preserve		8 June 2011	Island	on
Apoidea (SUPERFAM.)	Rocky Prairie NAP		24 May 2011	Thurston	near
Apoidea (SUPERFAM.)	Rocky Prairie NAP		24 May 2011	Thurston	near
Bombus californicus	Rocky Prairie NAP		24 May 2011	Thurston	on
Bombus flavifrons	Naas Preserve		8 June 2011	Island	on
Bombus melanopygus	Naas Preserve		8 June 2011	Island	near
Bombus mixtus	Naas Preserve		8 June 2011	Island	near
Bombus sitkensis	Naas Preserve		8 June 2011	Island	near
Bombyliidae (FAM.)	Rocky Prairie NAP		24 May 2011	Thurston	near
Coleoptera (ORDER)	Naas Preserve		8 June 2011	Island	on
Coleoptera (ORDER)	Rocky Prairie NAP		24 May 2011	Thurston	near
Coleoptera (ORDER)	Rocky Prairie NAP		24 May 2011	Thurston	on C
Diptera (ORDER)	Naas Preserve		8 June 2011	Island	near
Diptera (ORDER)	Naas Preserve		8 June 2011	Island	near
Diptera (ORDER)	Rocky Prairie NAP		24 May 2011	Thurston	near
Ichneumonidae (FAM.)	Rocky Prairie NAP		24 May 2011	Thurston	near
Paragus (GENUS)	Naas Preserve		8 June 2011	Island	near
Syrphidae (FAM.)	Rocky Prairie NAP		24 May 2011	Thurston	near
unidentified	Rocky Prairie NAP		24 May 2011	Thurston	near
Vespinae (SUBFAM.)	Rocky Prairie NAP		24 May 2011	Thurston	near
PDPGN086Y0	**Eriogonum codium**		**Umtanum desert buckwheat**		
Asilidae (FAM.)	Umtanum Ridge		22 July 2010	Benton	near
Bombus centralis	Umtanum Ridge		22 July 2010	Benton	on
Crioscolia (GENUS)	Umtanum Ridge		22 July 2010	Benton	near
Cylindromyia (GENUS)	Umtanum Ridge		22 July 2010	Benton	near
Eumeninae (FAM.)	Umtanum Ridge		22 July 2010	Benton	near
Metatrichia (GENUS)	Umtanum Ridge		22 July 2010	Benton	near
Metatrichia (GENUS)	Umtanum Ridge		22 July 2010	Benton	near
Stenodynerus (GENUS)	Umtanum Ridge		22 July 2010	Benton	near
Tiphiidae (FAM.)	Umtanum Ridge		22 July 2010	Benton	near
Tiphiidae (FAM.)	Umtanum Ridge		22 July 2010	Benton	near
Tiphiidae (FAM.)	Umtanum Ridge		22 July 2010	Benton	near
Tiphiidae (FAM.)	Umtanum Ridge		22 July 2010	Benton	near
Tiphiidae (FAM.)	Umtanum Ridge		22 July 2010	Benton	near

Table 2. Potential Pollinators Recorded by This Study - Continued

Element Code	Scientific Name	Common Name		
Scientific Name	Site	Date	County	On/Near*
Tiphiidae (FAM.)	Umtanum Ridge	22 July 2010	Benton	near
unidentified	Umtanum Ridge	22 July 2010	Benton	on
Vespidae (FAM.)	Umtanum Ridge	22 July 2010	Benton	near
PDBOR0G0T0	**Hackelia venusta**	**showy stickseed**		
Apis mellifera	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Apoidea (SUPERFAM.)	Tumwater Canyon	2 June 2011	Chelan	near
Coleoptera (ORDER)	Tumwater Canyon	2 June 2011	Chelan	near
Eulonchus (GENUS)	Tumwater Canyon	2 June 2011	Chelan	on
Eulonchus (GENUS)	Tumwater Canyon	2 June 2011	Chelan	near
Eulonchus (GENUS)	Tumwater Canyon	2 June 2011	Chelan	near
Eulonchus (GENUS)	Tumwater Canyon	2 June 2011	Chelan	on
Eulonchus (GENUS)	Tumwater Canyon	2 June 2011	Chelan	on
Eulonchus (GENUS)	Tumwater Canyon	2 June 2011	Chelan	on
Orthoptera (ORDER)	Tumwater Canyon	2 June 2011	Chelan	on
Orthoptera (ORDER)	Tumwater Canyon	2 June 2011	Chelan	on
unidentified	Tumwater Canyon	2 June 2011	Chelan	near
unidentified	Tumwater Canyon	2 June 2011	Chelan	near
PDAPI1B030	**Lomatium bradshawii**	**Bradshaw's desert-parsley**		
Apis mellifera	Lacamas Prairie	10 May 2011	Clark	near
Apoidea (SUPERFAM.)	Lacamas Prairie	9 May 2011	Clark	near
Apoidea (SUPERFAM.)	Lacamas Prairie	10 May 2011	Clark	near
Apoidea (SUPERFAM.)	Lacamas Prairie	10 May 2011	Clark	near
Apoidea (SUPERFAM.)	Lacamas Prairie	10 May 2011	Clark	near
Apoidea (SUPERFAM.)	Lacamas Prairie	18 May 2011	Clark	near
Apoidea (SUPERFAM.)	Lacamas Prairie	18 May 2011	Clark	on
Apoidea (SUPERFAM.)	Lacamas Prairie	18 May 2011	Clark	on

Table 2. Potential Pollinators Recorded by This Study - Continued

Element Code **Scientific Name** **Common Name**

Scientific Name	Site	Date	County	On/Near*
Apoidea (SUPERFAM.)	Lacamas Prairie	18 May 2011	Clark	on
Apoidea (SUPERFAM.)	Lacamas Prairie	18 May 2011	Clark	on
Apoidea (SUPERFAM.)	Lacamas Prairie	18 May 2011	Clark	near
Apoidea (SUPERFAM.)	Lacamas Prairie	18 May 2011	Clark	near
Apoidea (SUPERFAM.)	Lacamas Prairie	18 May 2011	Clark	on
Apoidea (SUPERFAM.)	Lacamas Prairie	18 May 2011	Clark	on
Bombus melanopygus	Lacamas Prairie	18 May 2011	Clark	near
Bombus mixtus	Lacamas Prairie	10 May 2011	Clark	near
Bombus vosnesenskii	Lacamas Prairie	10 May 2011	Clark	near
Bombyliidae (FAM.)	Lacamas Prairie	10 May 2011	Clark	near
Bombyliidae (FAM.)	Lacamas Prairie	10 May 2011	Clark	near
Coleoptera (ORDER)	Lacamas Prairie	9 May 2011	Clark	near
Coleoptera (ORDER)	Lacamas Prairie	9 May 2011	Clark	near
Coleoptera (ORDER)	Lacamas Prairie	18 May 2011	Clark	near
Diptera (ORDER)	Lacamas Prairie	10 May 2011	Clark	near
Diptera (ORDER)	Lacamas Prairie	9 May 2011	Clark	near
Diptera (ORDER)	Lacamas Prairie	9 May 2011	Clark	near
Diptera (ORDER)	Lacamas Prairie	10 May 2011	Clark	near
Diptera (ORDER)	Lacamas Prairie	18 May 2011	Clark	near
Empidoidea (FAM.)	Lacamas Prairie	9 May 2011	Clark	near
Empidoidea (FAM.)	Lacamas Prairie	10 May 2011	Clark	near
Empidoidea (FAM.)	Lacamas Prairie	9 May 2011	Clark	near
Empidoidea (FAM.)	Lacamas Prairie	9 May 2011	Clark	near
Empidoidea (FAM.)	Lacamas Prairie	18 May 2011	Clark	near
Empidoidea (FAM.)	Lacamas Prairie	18 May 2011	Clark	near
Hippodamia ? (GENUS)	Lacamas Prairie	18 May 2011	Clark	near
Hippodamia convergens	Lacamas Prairie	10 May 2011	Clark	near
Paragus (GENUS)	Lacamas Prairie	9 May 2011	Clark	near
Paragus (GENUS)	Lacamas Prairie	18 May 2011	Clark	on
Paragus (GENUS)	Lacamas Prairie	18 May 2011	Clark	on
Paragus (GENUS)	Lacamas Prairie	18 May 2011	Clark	on
Rhagionidae (FAM.)	Lacamas Prairie	18 May 2011	Clark	near
Rhagionidae (FAM.)	Lacamas Prairie	18 May 2011	Clark	near
Rhagionidae (FAM.)	Lacamas Prairie	18 May 2011	Clark	on
unidentified	Lacamas Prairie	9 May 2011	Clark	near
unidentified	Lacamas Prairie	9 May 2011	Clark	near
unidentified	Lacamas Prairie	9 May 2011	Clark	near
unidentified	Lacamas Prairie	9 May 2011	Clark	near

Table 2. Potential Pollinators Recorded by This Study - Continued

Scientific Name	Site	Date	County	On/Near*
Element Code	**Scientific Name**	**Common Name**		
unidentified	Lacamas Prairie	9 May 2011	Clark	near
unidentified	Lacamas Prairie	9 May 2011	Clark	near
unidentified	Lacamas Prairie	9 May 2011	Clark	near
Vespidae (FAM.)	Lacamas Prairie	10 May 2011	Clark	near
Vespidae (FAM.)	Lacamas Prairie	18 May 2011	Clark	near
Vespidae/Syrphidae	Lacamas Prairie	9 May 2011	Clark	near
PDFAB2B2W1	**Lupinus sulphureus ssp. kincaidii**	**Kincaid's sulfur lupine**		
Apis mellifera	Toledo Softball Complex	8 July 2010	Lewis	near
Apoidea (SUPERFAM.)	Toledo Softball Complex	17 June 2011	Lewis	on
Apoidea (SUPERFAM.)	Toledo Softball Complex	17 June 2011	Lewis	near
Apoidea (SUPERFAM.)	Toledo Softball Complex	17 June 2011	Lewis	near
Bombus flavifrons	Boisfort Cemetery	8 July 2010	Lewis	near
Bombus flavifrons	Toledo Softball Complex	17 June 2011	Lewis	on
Bombus flavifrons	Toledo Softball Complex	8 July 2010	Lewis	near
Bombus mixtus	Mallanee Farm	21 June 2011	Lewis	on
Bombus mixtus	Toledo Softball Complex	17 June 2011	Lewis	near
Bombus mixtus	Toledo Softball Complex	17 June 2011	Lewis	on
Bombus mixtus	Toledo Softball Complex	17 June 2011	Lewis	near
Bombus vosnesenskii	Boisfort Cemetery	8 July 2010	Lewis	near
Bombus vosnesenskii	Mallanee Farm	21 June 2011	Lewis	on
Bombus vosnesenskii	Mallanee Farm	21 June 2011	Lewis	on
Bombus vosnesenskii	Mallanee Farm	21 June 2011	Lewis	on
Bombus vosnesenskii	Toledo Softball Complex	17 June 2011	Lewis	near
Ceratina (GENUS)	Boisfort Cemetery	8 July 2010	Lewis	near
Coleoptera (ORDER)	Mallanee Farm	21 June 2011	Lewis	on
Coleoptera (ORDER)	Mallanee Farm	21 June 2011	Lewis	near
Diptera (ORDER)	Toledo Softball Complex	17 June 2011	Lewis	near
Hesperia comma hulbirti	Toledo Softball Complex	17 June 2011	Lewis	near
Ichneumonidae (FAM.)	Mallanee Farm	21 June 2011	Lewis	near
Lepidoptera (ORDER)	Toledo Softball Complex	17 June 2011	Lewis	on
Lepidoptera (ORDER)	Toledo Softball Complex	17 June 2011	Lewis	near
Paragus (GENUS)	Mallanee Farm	21 June 2011	Lewis	on
Paragus (GENUS)	Mallanee Farm	21 June 2011	Lewis	near
Syrphidae (FAM.)	Mallanee Farm	21 June 2011	Lewis	near
Syrphidae (FAM.)	Toledo Softball Complex	17 June 2011	Lewis	near
unidentified	Boisfort Cemetery	8 July 2010	Lewis	near
unidentified	Boisfort Cemetery	8 July 2010	Lewis	near
unidentified	Mallanee Farm	21 June 2011	Lewis	on

Table 2. Potential Pollinators Recorded by This Study - Continued

Element Code	Scientific Name	Common Name		
Scientific Name	Site	Date	County	On/Near*
unidentified	Mallanee Farm	21 June 2011	Lewis	near
unidentified	Toledo Softball Complex	17 June 2011	Lewis	on
unidentified	Toledo Softball Complex	8 July 2010	Lewis	near
unidentified	Toledo Softball Complex	8 July 2010	Lewis	near
unidentified	Toledo Softball Complex	8 July 2010	Lewis	near
unidentified	Toledo Softball Complex	8 July 2010	Lewis	near
Vespidae (FAM.)	Toledo Softball Complex	17 June 2011	Lewis	near
PDMAL110H0	**Sidalcea nelsoniana**	**Nelson's checker-mallow**		
Apoidea (SUPERFAM.)	Ridgefield National Wildlife Refuge	24 June 2011	Clark	on
Apoidea (SUPERFAM.)	Ridgefield National Wildlife Refuge	24 June 2011	Clark	near
Apoidea (SUPERFAM.)	Ridgefield National Wildlife Refuge	24 June 2011	Clark	on
Apoidea (SUPERFAM.)	Ridgefield National Wildlife Refuge	24 June 2011	Clark	near
Apoidea (SUPERFAM.)	Ridgefield National Wildlife Refuge	24 June 2011	Clark	on
Apoidea (SUPERFAM.)	Ridgefield National Wildlife Refuge	24 June 2011	Clark	on
Apoidea (SUPERFAM.)	Rose Site	21 June 2011	Lewis	on
Apoidea (SUPERFAM.)	Rose Site	21 June 2011	Lewis	on
Apoidea (SUPERFAM.)	Rose Site	21 June 2011	Lewis	on
Apoidea (SUPERFAM.)	Rose Site	21 June 2011	Lewis	near
Apoidea (SUPERFAM.)	Rose Site	21 June 2011	Lewis	near
Apoidea (SUPERFAM.)	Rose Site	21 June 2011	Lewis	near
Bombus californicus	Ridgefield National Wildlife Refuge	24 June 2011	Clark	on
Bombus californicus	Rose Site	21 June 2011	Lewis	on
Bombus californicus	Rose Site	21 June 2011	Lewis	near
Bombus flavifrons	Ridgefield National Wildlife Refuge	24 June 2011	Clark	on
Bombus flavifrons	Ridgefield National Wildlife Refuge	24 June 2011	Clark	on
Bombus flavifrons	Rose Site	21 June 2011	Lewis	near
Bombus rufocinctus	Ridgefield National Wildlife Refuge	24 June 2011	Clark	on
Bombus sitkensis	Ridgefield National Wildlife Refuge	24 June 2011	Clark	on
Bombyliidae (FAM.)	Rose Site	21 June 2011	Lewis	on
Coleoptera (ORDER)	Rose Site	21 June 2011	Lewis	on
Coleoptera (ORDER)	Rose Site	21 June 2011	Lewis	near
Conopidae (FAM.)	Ridgefield National Wildlife Refuge	24 June 2011	Clark	on
Ichneumonidae (FAM.)	Ridgefield National Wildlife Refuge	24 June 2011	Clark	near
unidentified	Rose Site	21 June 2011	Lewis	on
unidentified	Rose Site	21 June 2011	Lewis	on
Vespinae (SUBFAM.)	Rose Site	21 June 2011	Lewis	near
PDMAL110K4	**Sidalcea oregana var. calva**	**Wenatchee Mountain checker-mallow**		
Anoplodera (GENUS)	Camas Meadows NAP	16 July 2010	Chelan	on

Table 2. Potential Pollinators Recorded by This Study - Continued

Element Code	Scientific Name	Common Name		
Scientific Name	Site	Date	County	On/Near*
Anoplodera (GENUS)	Mountain Home Lodge	15 July 2010	Chelan	near
Anoplodera (GENUS)	Mountain Home Lodge	15 July 2010	Chelan	near
Anoplodera (GENUS)	Mountain Home Lodge	15 July 2010	Chelan	near
Bombus bifarius	Camas Meadows NAP	16 July 2010	Chelan	on
Bombus mixtus	Mountain Home Lodge	15 July 2010	Chelan	near
Bombus vandykei	Camas Meadows NAP	16 July 2010	Chelan	on
Bombus vandykei	Camas Meadows NAP	16 July 2010	Chelan	on
Leptochilus ?	Camas Meadows NAP	16 July 2010	Chelan	on
Osmia (GENUS)	Camas Meadows NAP	16 July 2010	Chelan	on
Osmia (GENUS)	Camas Meadows NAP	16 July 2010	Chelan	on
Osmia (GENUS)	Mountain Home Lodge	15 July 2010	Chelan	near
Osmia (GENUS)	Mountain Home Lodge	15 July 2010	Chelan	near
Osmia (GENUS)	Mountain Home Lodge	15 July 2010	Chelan	near
Philaronia (GENUS)	Mountain Home Lodge	15 July 2010	Chelan	near
Philaronia (GENUS)	Mountain Home Lodge	15 July 2010	Chelan	near
Philaronia (GENUS)	Mountain Home Lodge	15 July 2010	Chelan	near
unidentified	Camas Meadows NAP	16 July 2010	Chelan	on
unidentified	Camas Meadows NAP	16 July 2010	Chelan	on
unidentified	Camas Meadows NAP	20 July 2010	Chelan	on
unidentified	Camas Meadows NAP	16 July 2010	Chelan	on
unidentified	Mountain Home Lodge	15 July 2010	Chelan	on
unidentified	Mountain Home Lodge	15 July 2010	Chelan	near
unidentified	Mountain Home Lodge	15 July 2010	Chelan	near
PDCAR0U1S0	**Silene spaldingii**	**Spalding's silene**		
Agapostemon texanus	Fairchild Air Force Base	28 July 2010	Spokane	near
Apis mellifera	Fairchild Air Force Base	28 July 2010	Spokane	near
Apodemia mormo	Smoothing Iron Wildlife Management Area	29 July 2010	Asotin	near
Apoidea (SUPERFAM.)	Fairchild Air Force Base	28 July 2010	Spokane	near
Apoidea (SUPERFAM.)	Fairchild Air Force Base	28 July 2010	Spokane	near
Bombus appositus	Asotin Creek Wildlife Area	30 July 2010	Asotin	near
Bombus appositus	Fairchild Air Force Base	27 July 2010	Spokane	near
Bombus bifarius	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Bombus californicus	Asotin Creek Wildlife Area	29 July 2010	Asotin	on
Bombus californicus	Asotin Creek Wildlife Area	30 July 2010	Asotin	on
Bombus fervidus	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Bombus fervidus	Fairchild Air Force Base	28 July 2010	Spokane	on
Bombus fervidus	Fairchild Air Force Base	28 July 2010	Spokane	near
Bombus griseocollis	Fairchild Air Force Base	28 July 2010	Spokane	near

Table 2. Potential Pollinators Recorded by This Study - Continued

Element Code	**Scientific Name**	**Common Name**		
Scientific Name	Site	Date	County	On/Near*
Bombus huntii	Fairchild Air Force Base	27 July 2010	Spokane	near
Bombus rufocinctus	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Bombus rufocinctus	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Bombus rufocinctus	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Bombus rufocinctus	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Bombus rufocinctus	Asotin Creek Wildlife Area	30 July 2010	Asotin	near
Bombus rufocinctus	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Bombus rufocinctus	Fairchild Air Force Base	28 July 2010	Spokane	near
Bombus rufocinctus	Fairchild Air Force Base	27 July 2010	Spokane	near
Bombus rufocinctus	Fairchild Air Force Base	27 July 2010	Spokane	near
Bombus rufocinctus	Fairchild Air Force Base	27 July 2010	Spokane	near
Bombus rufocinctus	Fairchild Air Force Base	27 July 2010	Spokane	near
Bombus vagans ?	Fairchild Air Force Base	27 July 2010	Spokane	near
Bombyliidae (FAM.)	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Bombyliidae (FAM.)	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Bombyliidae (FAM.)	Fairchild Air Force Base	28 July 2010	Spokane	near
Bombyliidae (FAM.)	Fairchild Air Force Base	28 July 2010	Spokane	near
Cercyonis pegala	Fairchild Air Force Base	28 July 2010	Spokane	near
Colias eurytheme	Smoothing Iron Wildlife Management Area	29 July 2010	Asotin	near
Colletes (GENUS)	Fairchild Air Force Base	27 July 2010	Spokane	near
Colletes (GENUS)	Fairchild Air Force Base	27 July 2010	Spokane	near
Diptera (ORDER)	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Diptera (ORDER)	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Diptera (ORDER)	Fairchild Air Force Base	28 July 2010	Spokane	near
Dolichovespula arenaria	Asotin Creek Wildlife Area	29 July 2010	Asotin	on
Dolichovespula arenaria	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Dolichovespula arenaria	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Dolichovespula arenaria	Fairchild Air Force Base	27 July 2010	Spokane	near
Empidoidea (FAM.)	Fairchild Air Force Base	28 July 2010	Spokane	near
Epicauta (GENUS)	Fairchild Air Force Base	28 July 2010	Spokane	near
Epicauta (GENUS)	Fairchild Air Force Base	28 July 2010	Spokane	near
Hesperia colorado idaho	Fairchild Air Force Base	28 July 2010	Spokane	near
Hippodamia convergens	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Hippodamia convergens	Fairchild Air Force Base	28 July 2010	Spokane	near
Ichneumonidae (FAM.)	Asotin Creek Wildlife Area	30 July 2010	Asotin	near
Ichneumonidae (FAM.)	Asotin Creek Wildlife Area	30 July 2010	Asotin	near
Lycaena nivalis	Fairchild Air Force Base	28 July 2010	Spokane	near
Megachilidae (FAM.)	Asotin Creek Wildlife Area	29 July 2010	Asotin	near

Table 2. Potential Pollinators Recorded by This Study - Continued

Element Code	Scientific Name	Common Name		
Scientific Name	**Site**	**Date**	**County**	**On/Near***
Megachilidae (FAM.)	Asotin Creek Wildlife Area	30 July 2010	Asotin	near
Megachilidae (FAM.)	Fairchild Air Force Base	28 July 2010	Spokane	near
Nicrophorus guttula	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
Ochlodes sylvanoides	USFS Umatilla National Forest	30 July 2010	Asotin	near
Ochlodes sylvanoides?	Smoothing Iron Wildlife Management Area	29 July 2010	Asotin	near
Osmia (GENUS)	Fairchild Air Force Base	28 July 2010	Spokane	near
Paragus (GENUS)	Fairchild Air Force Base	28 July 2010	Spokane	near
Perdita (GENUS)	Fairchild Air Force Base	28 July 2010	Spokane	near
Perdita (GENUS)	Fairchild Air Force Base	28 July 2010	Spokane	near
Perdita (GENUS)	Fairchild Air Force Base	28 July 2010	Spokane	near
Physocephala (GENUS)	Fairchild Air Force Base	27 July 2010	Spokane	near
Pieris rapae	Smoothing Iron Wildlife Management Area	29 July 2010	Asotin	near
Syrphidae (FAM.)	Fairchild Air Force Base	27 July 2010	Spokane	near
unidentified	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
unidentified	Asotin Creek Wildlife Area	30 July 2010	Asotin	near
unidentified	Asotin Creek Wildlife Area	30 July 2010	Asotin	near
unidentified	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
unidentified	Asotin Creek Wildlife Area	29 July 2010	Asotin	near
unidentified	Asotin Creek Wildlife Area	30 July 2010	Asotin	near
unidentified	Asotin Creek Wildlife Area	30 July 2010	Asotin	near
unidentified	Fairchild Air Force Base	28 July 2010	Spokane	near
unidentified	Fairchild Air Force Base	28 July 2010	Spokane	near
unidentified	Fairchild Air Force Base	28 July 2010	Spokane	near
unidentified	Fairchild Air Force Base	27 July 2010	Spokane	on
Vespidae (FAM.)	Fairchild Air Force Base	28 July 2010	Spokane	near
PMORC2B100	**Spiranthes diluvialis**	**Ute ladies' tresses**		
Agapostemon femoratus	Beebe Springs/PUD	4 August 2010	Chelan	near
Agapostemon femoratus? texanus?	Beebe Springs/PUD	4 August 2010	Chelan	near
Apis mellifera	Gallagher Flats	4 August 2010	Chelan	near
Apis mellifera	Gallagher Flats	4 August 2010	Chelan	near
Bembicinae (FAM.)	BLM/Stocker	3 August 2010	Chelan	near
Bombus fervidus	BLM/Stocker	3 August 2010	Chelan	near
Bombus griseocollis	Beebe Springs/PUD	4 August 2010	Chelan	near
Bombus griseocollis	BLM/Stocker	3 August 2010	Chelan	near
Bombus griseocollis	BLM/Stocker	3 August 2010	Chelan	near
Bombus griseocollis	Gallagher Flats	4 August 2010	Chelan	near
Bombus huntii	BLM/Stocker	3 August 2010	Chelan	near

Table 2. Potential Pollinators Recorded by This Study - Continued

Element Code	**Scientific Name**	**Common Name**		
Scientific Name	Site	Date	County	On/Near*
Bombus huntii	Gallagher Flats	4 August 2010	Chelan	near
Bombus mixtus	BLM/Stocker	3 August 2010	Chelan	near
Bombus rufocinctus	BLM/Stocker	3 August 2010	Chelan	near
Bombus rufocinctus	BLM/Stocker	3 August 2010	Chelan	near
Ceratina (GENUS)	BLM/Stocker	3 August 2010	Chelan	near
Cerceris convergens	Beebe Springs/PUD	4 August 2010	Chelan	near
Colletes (GENUS)	BLM/Stocker	3 August 2010	Chelan	near
Crabronidae (FAM.)	BLM/Stocker	3 August 2010	Chelan	near
Crabronidae (FAM.)	BLM/Stocker	3 August 2010	Chelan	near
Crabronidae (FAM.)	BLM/Stocker	3 August 2010	Chelan	near
Cylindromyia (GENUS)	Beebe Springs/PUD	4 August 2010	Chelan	near
Cylindromyia (GENUS)	Beebe Springs/PUD	4 August 2010	Chelan	near
Diptera (ORDER)	BLM/Stocker	3 August 2010	Chelan	near
Dolichovespula arenaria	Beebe Springs/PUD	4 August 2010	Chelan	near
Dolichovespula arenaria	BLM/Stocker	3 August 2010	Chelan	near
Empidoidea (FAM.)	BLM/Stocker	3 August 2010	Chelan	near
Euceris vittatifamis	BLM/Stocker	3 August 2010	Chelan	near
Heriades (GENUS)	Gallagher Flats	4 August 2010	Chelan	near
Hippodamia convergens	BLM/Stocker	3 August 2010	Chelan	near
Ichneumonidae (FAM.)	BLM/Stocker	3 August 2010	Chelan	near
Megachilidae (FAM.)	Beebe Springs/PUD	4 August 2010	Chelan	near
Megachilidae (FAM.)	BLM/Stocker	3 August 2010	Chelan	near
Osmia (GENUS)	BLM/Stocker	3 August 2010	Chelan	near
Paragus (GENUS)	BLM/Stocker	3 August 2010	Chelan	near
Paragus (GENUS)	BLM/Stocker	3 August 2010	Chelan	near
Philanthus (GENUS)	BLM/Stocker	3 August 2010	Chelan	near
Philaronia (GENUS)	BLM/Stocker	3 August 2010	Chelan	near
Satyrium sylvinus/californica	BLM/Stocker	3 August 2010	Chelan	near
Stenodynerus (GENUS)	BLM/Stocker	3 August 2010	Chelan	near
Stratiomyidae (FAM.)	Gallagher Flats	4 August 2010	Chelan	near
unidentified	Beebe Springs/PUD	4 August 2010	Chelan	near
unidentified	BLM/Stocker	3 August 2010	Chelan	near
unidentified	BLM/Stocker	3 August 2010	Chelan	near
unidentified	BLM/Stocker	3 August 2010	Chelan	near
unidentified	BLM/Stocker	3 August 2010	Chelan	near
unidentified	Gallagher Flats	4 August 2010	Chelan	near
unidentified	Gallagher Flats	4 August 2010	Chelan	near
unidentified	Gallagher Flats	4 August 2010	Chelan	near

Table 2. Potential Pollinators Recorded by This Study - Continued

Element Code	Scientific Name		Common Name	
Scientific Name	**Site**	**Date**	**County**	**On/Near***
unidentified	Gallagher Flats	4 August 2010	Chelan	near
Vespidae (FAM.)	Gallagher Flats	4 August 2010	Chelan	near
Vespidae (FAM.)	Gallagher Flats	4 August 2010	Chelan	near
Vespidae (FAM.)	Gallagher Flats	4 August 2010	Chelan	near
Vespidae (FAM.)	Gallagher Flats	4 August 2010	Chelan	near

* On/Near - Whether the specimen was collected on the target plant species or elsewhere on the site.