Land uses that support wild bee (Hymenoptera: Apoidea: Anthophila) communities within an agricultural matrix

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Dedication

This thesis is dedicated to *Bombus terricola*, once the most common bees in eastern North Dakota, now <0.00001% of the bees there. It is my hope that habitat improvements such as those recommended in this work can help populations of this and other bees suffering declines recover and remain a part of our world.

Abstract

My main aim in this thesis was to explore if there are habitat elements within the agricultural matrix that support bee diversity and abundance. I examined the influence of land-use on bee diversity in a predominantly agricultural landscape at sites varying in habitat thought to be bee-friendly, such as semi-natural lands, grasslands, and crops providing bee forage. I sought to determine whether and to what extent these potentially bee-friendly land uses support diverse bee communities.

Bees found near crops not providing forage, including corn, soybean, and wheat, had less functional diversity. Bees found near semi-natural lands that contained flowers providing bee forage had increased functional diversity. Wooded areas were associated with increased bee species richness and bee abundance, and wetlands were associated with greater bee abundance. Crops providing bee forage were associated with increased bee species richness and diversity. Altering land management practices to promote retention and enhancement of these land uses will help support diverse wild bee communities within agricultural matrices. I also compared responses of wild bees and commercially managed honey bee colonies to bee-friendly land uses. Both honey bees and wild bees responded positively to semi-natural lands and crops providing bee forage.

Examination of past and present bee and floral visitation records revealed a 16 to 30% loss of species richness. The bee genera *Lasioglossum*, *Mellisodes, Halictus,* and *Ceratina* increased in relative abundance more than 50%, while the genera *Bombus, Megachile,* and *Colletes,* decreased in relative abundance more than 65% and the genus *Andrena* decreased in relative abundance by 47%. The plant genera that received the most bee visits from 2010 to 2012 were *Melilotus, Sonchus,* and *Cirsium,* while the plants with the highest number of bee species visitors were *Solidago, Cirsium*, and *Sonchus*. The plant genera *Zizia*, *Hydrophyllum*, and *Dalea* all received more visitation in the past. This survey of flower visitors revealed a community in need of conservation with a remaining species pool to enable recovery given improvements in available habitat.

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Chapter 1 .

Bees of the Northern Great Plains: biology and conservation concerns

1.1 Importance of bees for pollination

Angiosperms (flowering plants) are the most diverse land plants and the cornerstone of terrestrial ecosystems, encompassing over one hundred times the number of species compared to other seed-bearing plants (Gorelick 2001). It is estimated that 85% of flowering plants, or approximately 299,200 species, rely on animals to transport pollen (Ollerton et al. 2011). Bees (Hymenoptera: Apoidea: Anthophila) are recognized as the most important taxon of pollinators globally in terms of their impact on plant pollination due to their diversity and near complete reliance on floral products to meet their nutritional needs. Most pollinator networks are complexes that involve not only bees but also flies, moths, and other taxa that vary in life-histories and phenologies over time (Kearns et al. 1998). The importance of bees to plants has been demonstrated by correlations between bee decline and the decline in bee-pollinated plant abundance and pollen deposition (Biesmeijer et al. 2006; Burkle et al. 2013). Historically resilient plant-pollinator networks are likely to decay with loss of pollinators (Kearns et al. 1998; Memmott et al. 2007).

Loss of pollinators is also a concern for crop pollination since 35% of global crop production is dependent to some extent on pollinators (Klein et al. 2007). Although most staple crops, such as wheat, rice, and corn, are wind-pollinated, we depend on animal pollinated crops such as fruits, vegetables, nuts, and seeds to provide most of our vitamin C, vitamin A, calcium, and other important nutrients and anti-oxidants (Eilers et al. 2011). In the U.S., where crop pollination relies on managed honey bees, the value of honey bees in 2009 was estimated to be $11.68 billion and for wild bees and other pollinators was $3.44 billion (Calderone 2012). Globally, wild-insect pollinators are important contributors to crop production. In a study of 41 common fruit, nut, and stimulant crops (coffee, cocoa, etc.), all crops had increased fruit set with wild insect pollinator visitation, but only 14% had increased fruit set with the presence of honey bees (Garibaldi et al. 2013).

1.2 Bee natural history

1.2.1 Bee phylogeny

All bees belong to the hymenopteran Superfamily Apoidea, which includes two monophyletic groups, the Spheciformes (sphecid wasps) and the Apiformes (bees) (Michener 2000). The characters that distinguish bees from sphecid wasps are the presence of branched hairs and broadened hind basitarsi (Michener 2000). The seven broadly recognized bee families are Strenotrididae, Colletidae, Andrenidae, Halictidicae, Mellitidae, Megachilidae, and Apidae (Michener 2000). All but Strenotritidae are present in North America (Michener 2000). The life history characteristics of bee genera from the Northern Great Plains (NGP) region of the U.S, where my study took place, are outlined below.

1.2.2 Bee habitat

The habitat needs of bees can be divided into two categories: foraging and nesting habitat. Foraging habitat includes flowers that bees rely on as their food source to support both larval and adult stages. Food for bees includes pollen, nectar, and in some cases floral oils. Nesting habitat includes locations where bees can complete their development and life-cycle undisturbed. The nesting habitats house all life stages: larval, pupal, and adult. Most bees nest in the ground, while others nest in cavities, plant stems and wood tunnels, or sheltered in debris on the ground surface.

1.2.2.1 Floral habitat preferences

In general, bees are less choosey about the flowers they visit for nectar compared to the flowers they visit to gather pollen. Floral preference most often refers to pollen collecting preferences. The breadth of floral preferences for pollen collection varies widely. Monolectic bees forage on one flower species, such as the North American species *Hesperapis oraria* (Mellitidae), which only collects nectar and pollen from *Balduina angustifolia* (Asterceae) (Cane & Snelling 1996). Oligolectic bees forage on a limited range of flowers often in the same genus, such as the North American species *Melissodes agilis* (Apidae), which visits flowers belonging to the tribes Astereae and Heliantheae (Robertson 1926). Polylectic bees, such as various species of *Bombus* (Apidae) forage on a wide range of plant genera and families (Milliron 1971). These floral preferences are tied to differing abilities of bees to utilize nutrients present in pollen (Praz et al. 2008). For example, larvae of monolectic species are either unable to develop or develop poorly, taking longer to reach maturity and remaining smaller, when feeding on pollen from flowers other than their preferred species.

Floral preferences can also be based on the interaction of the morphology of flowers and the morphology of their bee visitors. For example, *Bombus* spp. are polylectic, visiting a wide range of flowers for pollen collection, but flower usage varies among species, with long-tongued bumble bees visiting flowers with long corollas more frequently than short-tongued bumble bees. Although long-tongued bumble bees are not dependent on flowers with long corollas for all their nutritional needs, there appears to be an association between the abundance of flowers with long corollas in an area and the abundances of long-tongued bumble bees. For example, abundance of red clover, a long-tubed plant, has been associated with abundance of long-tongued bumble bees (Carvell, Westrich, et al. 2006; Carvell, Roy, et al. 2006).

1.2.2.2 Nesting habitat

Bees construct nests in various materials (Figure 1-1). Globally, roughly 55% of bees form their nest by tunneling in the ground, 30% of bees form their nests in stems or tunnels in wood or other materials, 1% nest in pre-existing cavities or undisturbed vegetative debris, and 14% of bees are parasitic, usurping nests of other bees (based on estimates from Cane & Neff 2011). Within these broad categories there are preferences for varying soil types. Some ground-nesting bees prefer sand, and many prefer sandy-loam (Stephen et al. 1969; Michener 1979; Wuellner 1999; Cane et al. 2007; Davis et al. 2010; Černá et al. 2013). Little is known about preferences of many stem nesting bees.

Some stem-nesting bees are associated with certain plants, but the preference seems to be based primarily on stem size and availability, as many species will nest in artificial structures constructed from holes drilled into wood. Some species of stem and ground nesting bees collect materials to use in their nest construction. These materials include leaves (showing preferences for certain plants), mud, resin, and pebbles (O'Toole & Raw 1991). Pre-existing cavities used by bees are often formed by other animals, most commonly rodents (Michener 2000). Accumulations of undisturbed vegetative debris are used as nesting materials for some bees (Michener 2000). Cleptoparasitic bees do not construct their own nests but rather lay their eggs within the nests of their hosts. Cleptoparasites parasitize both ground and cavity nesting bees (Michener 2000).

1.2.3 Solitary and social bees

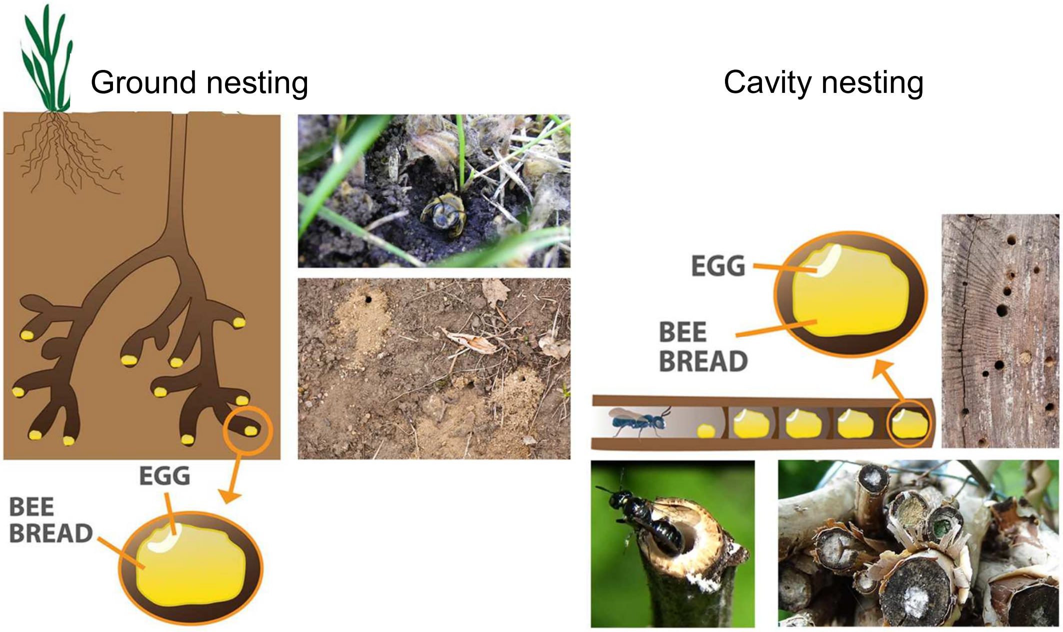

Figure 1-1. Ground and cavity nesting bees. Bee bread refers a substance bees provide to their developing offspring consisting of pollen mixed with nectar. Ground nests are constructed of tunnels dug into soil. Cavity nests are formed from either use of pre-existing tunnels such as those left by bark beetles in wood, or from use of pithy stems. Illustrations: Heather Holm. Photos: Heather Holm, Colleen Satyshur, and Elaine Evans.

Most bees are solitary, meaning that they do not share a nest or care for each other's young. Some bees are social. Truly social insects (eusocial) have multiple individuals of overlapping generations in one nest, they cooperate in caring for the brood, and they display reproductive division of labor in which one female lays all or most of the eggs (Wilson 1971). Within Apoidea, sociality only occurs in the families Halictidae (1,000 species or more) and Apidae (a few hundred species) (Michener 1974).

Bees can live in close proximity to each other without being social. Solitary bees that nest in close proximity to one another are called gregarious. Bees that share a common nest entrance, but care only for their own young within the nest are communal. Within Halictidae and Apidae, there are solitary, social, and facultatively social species. Facultatively social species form groups only under certain circumstances. For example, the length of the season may be an important factor driving sociality, with daughters remaining in the nest when the warm season is long enough in some species (Schwarz et al. 2007). For other species, the tendency of adults to reuse their natal nest drives sociality (Rehan et al. 2014).

1.2.4 Life history traits of Northern Great Plains bee genera

The Northern Great Plains is an area of flat land lying west of the Mississippi River tallgrass prairie states and east of the Rocky Mountains in the United States and Canada, much of it covered in prairie, steppe and grassland. Historically, it was one of the largest grassland ecosystems on earth. It is historically home to six bee families: Colletidae, Andrenidae, Halictidae, Megachilidae, Mellitidae, and Apidae. Table 1-1 lists common genera of the Northern Great Plains (NGP) and their life history traits. There are two colletid genera found in the NGP: *Hylaeus* and *Colletes*. *Hylaeus* are usually small, not very hairy, and short-tongued. *Hylaeus* usually make up a small percentage of the total bee fauna (Michener 2000). Many *Hylaeus* nest in dead stems (Michener 2000). *Hylaeus* are unique among bees in that they have no external structures to carry pollen; instead they carry pollen in their crop. *Colletes* are robust, hairy bees. Many species of the genus are oligolectic, specializing in collecting pollen from one or several closely related plant species (Robertson 1926; O'Toole & Raw 1991). Most species of *Colletes* nest in burrows in the ground. Both *Hylaeus* and *Colletes* have solitary life cycles.

Andrenid species are all solitary and nest in the ground, often gregariously (Michener 2000). Common NGP andrenid genera include *Andrena*, *Calliopsis*, *Pseudopangurgus,* and *Perdita*. Andrenids are more typically oligolectic compared to other bee families. *Andrena* are medium sized, hairy bees. Many *Andrena* are oligolectic (Michener 2000). Some *Calliopsis* and *Pseudopanurgus* are oligolectic (Robertson 1926; Michener 2000). *Perdita* are mostly oligolectic (Michener 2000).

Halictid bees are among the most common bees (O'Toole & Raw 1991). Most nest in the ground (O'Toole & Raw 1991). Halictid genera found in the NGP include *Dufourea, Dieunomia, Lasioglossum*, *Halictus*, *Agapostemon*, *Sphecodes. Augochlorella,* and *Augochlora*. Most *Dufourea* are oligolectic. *Dieunomia* nest in sandy soil, sometimes in aggregations, and are oligolectic (Michener 2000). *Lasioglossum* and *Halictus* both contain solitary and eusocial bees. *Agapostemon* are sometimes communal (Roberts 1973). *Sphecodes* are cleptoparasites, laying their eggs in nests of other bees, mostly other Halictids (Michener 2000). *Augochlorella* and *Augochlora* are solitary, sometimes nesting in aggregations.

Megachilids found in the NGP include *Megachile, Stelis, Hoplitis, Coelioxys, Ashmeadiella, Heriades,* and *Osmia*. There is much variability in nesting substrates used by Megachilids. Many nest in pithy stems, pre-existing holes in wood, and tunnels in the soil (Michener 2000). Some nest in snail shells (Michener 2000). *Stelis* and *Coelioxys* are cleptoparasites that use other megachilids as their host (Michener 2000). Many Megachilids are generalists, but some *Ashmeadiella* are oligolectic, with different species specializing on different plant genera (Michener 1939). Some *Megachile* are also oligolectic (Robertson 1926).

Mellitids are not commonly found in the Great Plains. They are ground nesting, oligolectic bees (Michener 2000). *Hesperapis* specialize on several different plant genera. *Macropis* bees collect oil from flowers of *Lysimachia* to line the cells.

Apids found in the Great Plains include *Apis, Bombus, Ceratina, Melissodes, Svastra, Anthophora, Nomada, Triepeolus*, and *Holcopasites*. The only *Apis* species in North America is the European honey bee, *Apis mellifera.* In the wild, honey bees nest in

Family	**Genus**	**Nest site**	**Sociality**	**Parasite**	**Lecticity**
Coll	*Colletes*	soil	Solitary	No	Some oligolectic
	Hylaeus	stem	Solitary	No	Some oligolectic
And	*Andrena*	soil	Solitary	No	Many oligolectic
	Calliopsis	soil	Solitary	No	Some oligolectic
	Perdita	soil	Solitary	No	Some oligolectic
	Pseudopanurgus	soil	Solitary	No	Many oligolectic
Hal	*Agapostemon*	soil	Fac. social	No	Polylectic
	Augochlora	wood	Solitary	No	Polylectic
	Augochlorella	soil	Eusocial	No	Polylectic
	Dieunomia	soil	Solitary	No	Some oligolectic
	Dufourea	soil	Solitary	No	Some oligolectic
	Halictus	soil	Fac. social to eusoc.	No	Polylectic
	Lasioglossum	soil	Solitary to eusoc.	Some	Some oligolectic
	Sphecodes	soil	Solitary	Yes	Polylectic
Meg	*Coelioxys*	stem	Solitary	Yes	Polylectic
	Heriades	stem	Solitary	No	Polylectic
	Hoplitis	stem	Solitary	No	Polylectic
	Megachile	variable	Solitary	No	Most polylectic
	Osmia	stem	Solitary	No	Most polylectic
	Stelis	stem	Solitary	Yes	Polylectic
Mel	*Hesperapis*	soil	Solitary	No	Oligolectic
	Macropis	soil	Solitary	No	Oligolectic
Api	*Anthophora*	soil or wood	Solitary	No	Polylectic
	Apis	cavity	Eusocial	No	Polylectic
	Bombus	cavity	Eusocial/solitary	Some	Polylectic
	Ceratina	stem	Fac. social	No	Polylectic
	Eucera	soil	Solitary	No	Polylectic
	Holcopasites	soil	Solitary	Yes	Polylectic
	Melissodes	soil	Solitary	No	Many oligolectic
	Nomada	soil	Solitary	Yes	Polylectic
	Svastra	soil	Solitary	No	Polylectic
	Triepeolus	soil	Solitary	Yes	Polylectic

Table 1-1. Life history traits of bee genera of the Northern Great Plains. Col=Colletidae, And=Andrenidae, Hal=Halictidae, Meg=Megachilidae, Mel=Mellitidae, Api=Apidae. Fac. social = Facultatively social

large cavities, typically hollows in trees. Most honey bees in the NGP are managed colonies. This highly social, commercially managed bee is commonly brought to the NGP during the summer for honey production. *Ceratina* nest in the pith of dead, broken twigs (Rehan & Richards 2010). Some are sub-social, with females remaining in their nests to care for the young (Rehan & Richards 2010). *Bombus* are primitively eusocial, nesting in cavities in the ground or in piles of grass or brush on the surface. *Melissodes* and *Svastra* are ground nesting bees. Many *Melissodes* specialize on flowers in the sunflower family (Hurd et al. 1980). *Anthophora* are ground nesting solitary bees, some with very long tongues (O'Toole & Raw 1991). *Nomada, Triepeolus*, and *Holcopasites* are cleptoparasites (Michener 2000). *Nomada* primarily parasitize *Andrena* (Michener 2000). *Triepeolus* primarily parasitize *Melissodes* and *Svastra* (Michener 2000). *Holcopasites* hosts include *Calliopsis* and *Pseudopanurgus* (Michener 2000).

1.3 Bee decline

While the causes of honey bee colony losses remain a complex puzzle, the extent of colony loss can be easily monitored since there is one species, *Apis mellifera*, and most colonies are managed. Determining the extent of wild bee population decline is more difficult because there is high species diversity (over 20,000 bee species globally) (Michener 2000), there is paltry information on historic population levels of most species, and they have highly variable annual population cycles (Franzén & Nilsson 2013). In areas where sufficient historic records exist, comparisons between current and past bee diversity often reveal drastic declines over time. Examination of bee diversity at a site in Illinois revealed a loss of 50% of bee species over 120 years (Burkle & Alarcón 2011). A study comparing bee species richness within 10 km x 10 km grid cells, conducted pre- and post- 1980 in Britain and the Netherlands found significant decreases in species richness in 52% of the grid cells in Britain and in 67% of the grid cells in the Netherlands (Biesmeijer et al. 2006). There were increases in species richness in only 10% and 4% of the grid cells in Britain and the Netherlands, respectively. A study of trends in bee species richness and relative abundance over 140 years in Northeastern North America found little change in species richness, but found that 56% of species decreased in relative abundance, primarily those species with specialized diets and large body size (Bartomeus et al. 2013). An additional concern is the susceptibility of bees to population fragmentation due to their haplo-diploid method of sex-determination (Packer & Owen 2001; Zayed & Packer 2005). In addition to increased risk of inbreeding depression, when genetic diversity decreases, bees have an increased risk of producing infertile diploid males.

One bee group with consistent evidence of decline is *Bombus*, with declines documented in North America, Europe, and Asia, the areas of the world where the majority of *Bombus* species live (Goulson et al. 2008; Colla & Packer 2008; Williams, Colla, et al. 2009; Grixti et al. 2009; Williams, Tang, et al. 2009; Cameron et al. 2011; Koch 2011; Colla et al. 2012; Bommarco et al. 2012; Bartomeus et al. 2013). The existence of more thorough and reliable records of bumble bees compared to other bee groups is due to a combination of their increased visibility due to their size and charisma, and their relative ease of identification. Comparing relative abundance of museum specimens, Colla et al. (2012) found that half of the twenty-one bumble bee species examined were in varying levels of decline, while the other half of the species were stable or increasing in relative abundance. Focusing on eight formerly abundant North American bumble bee species, Cameron et al. (2011) found that four of the eight species had declined up to 96% in relative abundance and their geographic ranges decreased 23-87%. Grixti et al. (2009) found that half of the sixteen bumble bee species historically present in Illinois have been either locally extirpated or have experienced declines. While there are many parts of world and many bee groups for which such examinations of bee diversity are not possible due to lack of historic records with which to compare current records, these studies indicate that loss of bee diversity is a global concern.

Possible causes of bee decline include habitat loss, pesticides, climate change, invasive species (both plant, animal, and microbial), and diseases, parasites, and pests (Brown & Paxton 2009). Bees are likely to suffer from combinations of these causes. Due to diversity in foraging and nesting habits and other life history characteristics, not all bee species respond in the same ways to different stressors. For example, bees that have specialized needs for either floral resources or nesting materials are generally more susceptible to decline than their generalist counterparts (Grundel et al. 2010; Bartomeus et al. 2013; Sheffield et al. 2013). Life history characteristics such as nesting habit, foraging preferences, size, and social habits can be important predictors of bee species' responses to environmental disturbances that are possible causes of bee decline (Williams et al. 2010). For example, ground-nesting species are more strongly affected by overall agricultural intensification than tunnel-nesting bees, and specialists tend to be more strongly affected than generalists by overall agricultural intensification and tilling, possibly because of scarcity of suitable floral resources (Williams et al. 2010).

1.3.1 Habitat Loss

Habitat loss is broadly recognized as the leading cause of declining species richness for all plants and animals (Murphy & Romanuk 2014), and bees are no exception. Land-use change leading to fragmentation and habitat loss is the most universal factor thought to be driving bee declines (Brown & Paxton 2009), although the magnitude of response to habitat loss varies among environments (Winfree et al. 2009). In a meta-analysis that included 54 studies, Winfree et al. (2009) found that both bee abundance and species richness were negatively affected by anthropogenic disturbance, but the magnitude of the effects was small and was only statistically significant in areas with extreme habitat loss. Habitat loss, in general, negatively affects the availability of floral resources and nesting sites.

1.3.1.1 Floral resources

Since all bees depend on flowers for food, floral resources are an important factor structuring bee populations. Floral abundance is a primary driver of bee abundance (Hines & Hendrix 2005; Kwaiser & Hendrix 2008; Hopwood 2008; Sjödin et al. 2008; Roulston & Goodell 2011). However, there is some evidence that the previous season's floral abundance is a better predictor of bee abundance than the current season (Kohler et al. 2008), which may explain why in some areas there is no evident relationship between floral characteristics and pollinator communities (Davis et al. 2008). Patch size also can be an important factor in attracting bees to foraging sites, particularly larger bees such as bumble bees (Wojcik & McBride 2011).

Floral diversity is highly correlated with bee diversity (Potts et al. 2003; Albrecht et al. 2007; Hopwood 2008; Hendrix et al. 2010) Diverse floral assemblages can provide the resources needed to support a diverse bee population due to variety in both floral preference and seasonal activity among different bee species.

1.3.1.2 Nesting resources

To date, few studies have assessed the effects of the availability of nesting resources on bee populations (Roulston & Goodell 2011). Monitoring floral use by bees is relatively easy through observations of bees at flower patches or through analysis of pollen present on bees. In contrast, monitoring where bees nest is more difficult due to the cryptic nature of many bee-nesting sites. With increased interest in bee declines, more studies are focusing on the impact of nesting resources on bee abundance and richness (Grundel et al. 2010; Moroń et al. 2011). The bees for which we have the most information are gregarious ground nesting bees, due the relative ease of finding their nesting sites. Gregarious nesting sites can contain hundreds of bees nesting next to each other often in an open area, and their flight activity draws attention to their nest entrances. These areas are often reused for several years, facilitating multi-year studies. In some cases, gregarious nesting is an indication of limited sites that satisfy the preferences of particular bee species (Wuellner 1999). These preferences can include aspect, vegetation cover, lighting, and landmarks, as well as soil type, moisture, temperature and surface. For example, compacted soils associated with human disturbance result in lower densities of *Andrena camellia*, a ground-nesting miner bee (Xie et al. 2013). Nest colonization by cavity-nesting bees, tested by placing trap nests in different habitats, increases in habitats with a high proportion of undisturbed land (Holzschuh et al. 2010). For bumble bees, which often nest in formerly occupied rodent holes, the composition and habits of local rodent fauna can influence both the relative and absolute abundance of different species (Harder 1986).

1.3.2 Land use

Agricultural land is an important land-use category to examine due to its global dominance. According to the Food and Agriculture Organization of the United Nations, croplands cover about 12% of Earth's ice-free land while pastures cover another 26% (Foley et al. 2011). In the United States, agricultural production, including cropland and pasture, accounts for around 45% of the land base (Nickerson et al. 2011). The NGP is a major area of agricultural production (U.S. Department of Agriculture 2013). Ninety percent of private land in the prairie pothole region of the NGP, where this study took place, is agricultural land (Rashford et al. 2011). In recent years, decreases in potentially bee-friendly agricultural land uses due to shifts to row crops grown for biofuel production have raised concerns about the fate of pollinators in these landscapes (Gallant et al. 2014; Otto et al. 2016; Smart et al. 2016a).

Examinations of bee diversity in agricultural lands can help us understand how to support bees in these areas. Meta-analyses of the effects of land use on pollinators show that landscape complexity is important for bees (Kennedy et al. 2013; Shackelford et al. 2013). Kennedy et al. (2013) found that more diverse fields and organic practices had a positive impact on total bee abundances. Shackelford et al. (2013) found that both local and landscape level complexity had a positive effect on bee abundance and species richness. In an examination of bee diversity and land use in prairie remnants in Iowa, sites with more agricultural row crops and open water have lower bee diversity (Hendrix et al. 2010). In grassland habitats in Germany, bee species richness is highest in areas with dry soil, increased age of grasslands, and percentage cover of flower rich agricultural land (Dauber et al. 2003).

Discovering elements within existing areas that can support bees holds great potential to increase bee habitat. Potential bee habitat elements within the agricultural matrix in the NGP include wooded areas, wetlands, crops providing bee forage, and pastures. Previous research in other regions found that wooded areas, including hedgerows and shelterbelts, positively impacted bee communities (Carré et al. 2009; Morandin & Kremen 2013a; Jha & Kremen 2013; Moroń et al. 2014). Many shelterbelts in the NGP are remnants from soil conservation efforts during the 1930s and these aging shelterbelts are being removed and not replaced (Marttila-Losure 2013). While little is currently known about effects of wetlands on bee communities, there is some evidence connecting wetland loss with declines in bee abundance, particularly in the mid-western United States (Koh et al. 2015). Increased areas of mass-flowering crops have been associated with increases in bee abundances (Westphal et al. 2003; Scheper et al. 2014; Riedinger et al. 2015). The area dedicated to flowering crops known to be used by bees, such as alfalfa, canola, and sunflowers in the NGP, declined significantly between 2002 and 2010, and acreage planted in corn and soybean, crops that provide few resources to bees, has dramatically increased (U.S. Department of Agriculture 2013; Gallant et al. 2014). The effects of pasture on bee communities are variable. A previous study in heavily grazed sites in the Mediterranean found greater abundances of ground nesting bees in heavily grazed areas (Vulliamy et al. 2006), possibly due to increased availability of bare ground. However, other studies have found negative effects of active grazing on bee communities (Kearns & Oliveras 2009; Le Feon et al. 2010). Overall declines in habitat thought to support bees and concomitant increases in habitat thought to provide little or no value to bees have raised concerns about bee communities in the NGP.

1.3.3 Pesticides

Pesticides, including insecticides, fungicides, and herbicides, have been implicated in global bee declines. The effects of pesticides on honey bees has been widely studied due to their importance as commercial pollinators and the relative ease of studying them. However, studies have focused on effects of pesticides on individual honey bees and not on colonies or populations. Most non-*Apis* bees feed on pollen directly to their larvae, possibly increasing the risk of direct exposure of larvae to pesticides. For example, Devillers at al. (2003) compared the adverse effects of 158 pesticides (acaricides, biological agents, bird repellents, blossom thinners, fungicides, herbicides, insecticides, molluscicides, nematicides, and plant growth regulators) on individual honey bees (*Apis mellifera*), alfafa leafcutting bees (*Megachile rotundata*), and alkalai bees (*Nomia melanderi*). The effects of a smaller subset of pesticides (32) were tested on bumble bees (*Bombus* spp.). No difference in susceptibility was found between bumble bees and honey bees, but the alfalfa leaf-cutting bee and the alkalai bee were more susceptible to the effects of pesticides than honey bees (Devillers et al. 2003). In addition to lethal effects, there is a growing awareness of the sub-lethal effects of pesticides on bees. Sub-lethal exposure to neonicitinoid pesticides was shown to reduce reproductive success of *Osmia bicornis*, a solitary bee (Sandrock et al. 2014), and to reduce queen survival, foraging, nectar storage, and brood production in bumble bees (Laycock & Cresswell 2013; Scholer & Krischik 2014).

There is increasing evidence documenting neagitive effects of pesticides both on short-term bee abundance and diversity as well as long-term populations levels. In canola, seed treatment with neonicitinoids has been associated with declines in nesting and repoduction (Rundlöf et al. 2015) as well as long-term population declines (Woodcock et al. 2010). In a forest setting, spraying fenitrothion, an organophosphate insecticide, to control spruce budworm caused a substantial reduction in bumble bee population densities that persisted for two years after use was discontinued (Plowright 1978). In an agricultural field setting, Brittain et al. (2010) showed that bee species richness declined after the second and third spraying of insecticides including fenitrothion, on vine crops and corn within one season (Brittain et al. 2010). In winter cereal fields in Hungary, insecticide application had a significant negative effect on total and small bee species richness and on large bee abundance (Kovács-Hostyánszki et al. 2011).

1.3.4 Climate Change

Climate change has potential to negatively impact bees through changes in the physical environment and through altering flowering time or nectar rewards in the plants on which bees depend (Memmott et al. 2007; Roberts et al. 2011; Giannini et al. 2012). Climate change has been shown to cause range shifts and contractions for bees in the far North and the far South where climate change is occurring more rapidly (Franzén & Öckinger 2011; Kuhlmann et al. 2012). There also have been several demonstrations of mismatches in timing, or phenology, between plants and their pollinators due to differing responses to climatic shifts. For example, a sub-alpine lily, *Erythronium gradiflorum*, has had increased pollinator limitation as its bloom time has shifted earlier (Thomson 2010). However, currently most plants and their pollinators appear to remain in synchrony (Bartomeus et al. 2011). As pollinator communities shift in range, these communities might become dominated by the mobile, habitat generalists that can make their way to the remaining habitat islands (Vanbergen 2013).

1.3.5 Introduced species

Introduced species are plants, animals, or pathogens that are not native to a specific region. When these non-natives are likely to cause harm they are called invasive species. Although some introduced species cause great ecological harm and economic loss, the effects of introduced species on native organisms are not consistently negative. Many native bees are found as frequently, or even more frequently, on introduced and invasive plants as they are on native plants (Hinners & Hjelmroos-Koski 2009; Hanley et al. 2014). In some cases though, bees prefer to forage on native plants instead of co-occurring weedy, exotic plants (Morandin & Kremen 2013b).

Introduced plants can indirectly affect bees through their impact on native plants. Invasive plants can either facilitate the success of native plants through supporting mutually shared pollinators, or can reduce the success of native plants through competition (Lopezaraiza-Mikel et al. 2007; Van Riper & Larson 2008; Stout & Morales 2009; Larson et al. 2014). Specialist bees may be more susceptible to the negative effects of invasive plants due to their dependence on a limited range of plant species (Tepedino et al. 2008).

Introduced insects can also affect bee populations. The invasive Argentine ant, *Linepithema humile*, can reduce the amount of time native bees spend foraging on flowers and can displace them altogether (Lach 2008). There is concern about the impact of non-native invasive bees, including introduced *Bombus, Apis,* and non-native solitary bees on native bees, discussed below.

1.3.6 Competition among bees

Competition for floral resources is thought to be an important factor structuring bee communities (Schaffer et al. 1979, 1983; Eickwort & Ginsberg 1980; Tepedino & Stanton 1981; Thomson et al. 1987; Corbet et al. 1995; Sugden et al. 1996). Bumble bees are hypothesized to have evolved a variety of tongue lengths, foraging preferences, and emergence times in response to competition with other bees for floral resources (Pyke 1982; Prys-Jones 1982; Pyke et al. 2012) Competition is not necessarily constant across the season or across environments. For example, Tepedino and Stanton (1981) found that competition among bees for floral resources in short-grass prairie was only intermittent.

Special consideration is often given to competition between honey bees and other bees because honey bees are not native to North America. In addition, typical beekeeping practices bring several dozen colonies that each contain tens of thousands of bees into an area. It is estimated that each honey bee colony gathers 300 to 700 pounds of honey and 50 to 75 pounds of pollen each year (Standifer et al. 1968; Wille et al. 1985). Honey bees could potentially compete with native bees for floral resources if honey bees are using the same floral resources as other bees, and those floral resources are limiting to bee populations. A negative effect of honey bee presence on bumble bees has been shown in several studies (Evans 2001; Thomson 2004, 2016; Goulson & Sparrow 2008; Herbertsson et al. 2016). Thomson (2004) and Evans (2001) showed decreased pollen collection and forager abundance at colonies closer to honey bee apiaries. Goulson and Sparrow (2008) showed that bumble bees in areas with honey bees were smaller. However, competitive effects have not been clearly demonstrated between honey bees and bees other than bumble bees. A study of the impact of honey bees on solitary bees based on monitoring of bee populations over 17 years, including 4 years of monitoring before the presence of honey bees, found no negative impact of honey bee presence on solitary bee populations (Roubik & Villanueva-Gutiérrez 2009).

1.3.7 Natural Enemies

Natural enemies, including, pests, parasites, and pathogens, are universally important factors affecting insect population dynamics. Bees support a wide variety of parasites, pests, and pathogens (Roulston & Goodell 2011), but few studies have documented direct links between natural enemies and bee declines. An examination comparing the effects of parasites and land use on cavity-nesting bees found that parasites were not as important as nest-site availability in structuring cavity-nesting bee populations (Steffan-Dewenter & Schiele 2008). In contrast, an examination of population dynamics of a ground nesting bee (*Andrena humilis*) found that fluctuations in populations were not related to nest-site availability, floral abundance, or weather, and although there is no direct evidence, the authors posit that natural enemies may be the drivers of the examined population fluctuations (Franzén & Nilsson 2013). However, overall, natural enemies do not seem to be as important in shaping bee communities as floral resource availability (Roulston & Goodell 2011).

1.3.8 Pathogens

Pathogen spillover from commercially managed bees has been shown to increase the prevalence of some natural enemies (Genersch et al. 2006; Colla et al. 2006; Singh et al. 2010; Graystock et al. 2014). However, for most of the transferred pathogens, there is no evidence of ill effects on wild bees carrying these pathogens. There is some evidence that the honey bee pathogen *Nosema ceranae* can negatively affect infected *Bombus* (Graystock et al. 2013). A study of bumble bee decline in North America found higher levels of the microsporidian *Nosema bombi* in the subset of bumble bee species that were experiencing decline (Cameron et al. 2011). It is suspected that there could be a strain of *Nosema bombi* that was introduced from commercial bumble bee rearing facilities that is having a stronger negative impact on come groups of bumble bees than the strain that is wild in North America, but there is no direct evidence of this at this time (Evans et al. 2008; Meeus et al. 2011). Horizontal transmission of the trypanosome parasite *Crithidia bombi* and the neogregarine *Apicystis bombi* are additional concerns (Meeus et al. 2011). There is increasing evidence of virus transmission between bee species (Singh et al. 2010; McMahon et al. 2015; Dolezal et al. 2016) Other factors, such as poor nutrition or reduced immune function, may combine to increase susceptibility to existing natural enemies.

1.4 Agricultural land uses supporting wild bee communities

Habitat loss is a key driver of global bee declines. Given the dominance of agriculture as a land use and the potential for habitat elements within the agricultural matrix to support bee diversity and abundance, I examined the influence of land use on bee diversity and abundance in a predominantly agricultural landscape in the prairie pothole region in North Dakota. I surveyed bees at sites that varied in habitat considered bee-friendly, such as Conservation Reserve Program (CRP), grasslands, and crops providing bee forage. The aim was to determine whether and to what extent these potentially bee-friendly land uses support diverse bee communities. Discovering potential bee-friendly habitat elements within the disturbed agricultural matrix in the NGP can help guide efforts to support and increase healthy wild bee communities on a broad-scale.

Semi-natural areas including grasslands and CRP lands; wooded areas including shelterbelts and woodlots; wetlands including areas of cattail and ephemeral wetlands; and crops providing bee forage, such as sunflower, canola, and alfalfa; have all experienced declines in recent years, primarily due to increases in corn and soybean for biofuel production (Hellerstein & Malcolm 2011). The loss of flowering and nesting habitats is considered a leading cause of declining wild bee communities, which raises concern about pollinator conservation. I assessed wild bee communities and surrounding land uses at radii of 1500 m, 700 m, and 300 m at 18 locations over three years.

My findings showed that bees found near crops that did not provide forage, including corn, soybean, and wheat, had less functional diversity (traits considered predictors of bee community stability), and there were fewer ground nesting bees and bees with shorter active season durations (traits negatively impacted by agricultural intensity). Areas of semi-natural land, bee forage crops, woods and wetlands, were all associated with more successful bee communities. At all observed scales, bees found near semi-natural lands had increased functional diversity. Crops providing bee forage (canola, sunflower, and alfalfa) were associated with increased bee species richness and diversity at a local scale. Both semi-natural and crop lands providing bee forage were associated with increased abundances of bees with shorter active seasons. Wooded areas were associated with increased bee species richness and bee abundance, and wetlands were associated with greater bee abundance. Altering land management practices to promote retention and enhancement of semi-natural areas, wooded area, wetlands, and crops providing bee forage will help support the growth, reproduction, and survival of diverse wild bee communities within agricultural matrices in the NPG. Each of these land uses should be included in pollinator conservation efforts due to their support of different aspects of bee communities.

1.5 Response of honey bees and wild bees to pollinator habitat

Bee habitat is particularly important in the NGP as it is home to both diverse native wild bee populations and many honey bee colonies during the summer months. In 2013, North Dakota was the top honey producing state in the U.S. with 480,000 honey bee colonies producing over 15 million kilograms of honey valued at over $67 million (National Agricultural Statistics Service, Agricultural Statistics Board, US Department of Agriculture, Mar. 21, 2014, ND Dept. of Agriculture, pers. com. April 17, 2015). Many of the honey bee colonies in North Dakota produce honey in the summer and are transported throughout the country for crop pollination in late winter and early spring. In addition to being important to honey bees, the NGP in North Dakota is also home to many wild bees, with historic records showing around 300 bee species and the actual number present assumed to be closer to 500 (Stevens 1948a), making this area well suited for an examination of the responses of both honey bees and wild bees to predominantly agricultural landscapes differing in the amount of pollinator friendly habitat. Concerns over loss of wild bee biodiversity and continuing problems with colony mortaility in commercial honey bee operations have prompted actions to create and maintain pollinator friendly landscapes for both of these important bee groups.

My study compared the responses of wild bees and commercially managed honey bee colonies to varying amount of bee-friendly land. The goal of this comparison was to inform pollinator habitat conservation measures in areas that are commonly home to both honey bees and wild bees, such as many parts of the NGP. I examined success measures of wild bee communities in locations surrounding honey bee apiaries that varied in the amount of land thought to support pollinators in general: semi-natural land (land in pasture, grasslands, Conservation Reserve Program, fallow land, roadside ditches, flowering trees and shrubs, and shelterbelts), wetlands (open water, cattails, and ephemeral wetlands), and potential bee forage crops (canola, sunflower, and alfalfa). Criteria used to evaluate wild bee communities were abundance, species richness, species diversity, functional diversity, and community-weighted means of particular functional traits. The colony response criteria used to judge honey bee success were the number of colonies alive from May of one year to March of the following year and the average amount of honey produced annually, based on an examination honey bee success at the apiaries housed at the same study sites by Smart et al. (2016b).

Honey bee colonies had higher honey production and annual colony survival when surrounded by semi-natural land. Wild bee functional diversity was significantly greater at all observed scales in locations surrounded by higher proportions of semi-natural lands. Species diversity of wild bees and the number of floral specialists, a group of special concern for conservation, were significantly greater with increased areas of crops providing bee forage at the 300 m scale. Honey production by honey bee colonies also increased with increasing amounts of bee forage crops within 500 m. Honey production was positively correlated with wild bee abundance and species diversity at all sites, indicating that the two bee groups had similar responses to site characteristics.

The association of semi-natural lands with honey bee survival, honey production, and wild bee diversity, and the association of crops providing bee forage with species diversity, floral specialists, and honey production show the potential for these lands to support both honey bees and wild bees. Pollinator habitat efforts should focus both on planting flowers for all bees and on retaining and enhancing habitat elements that provide nesting habitat for wild bees.

1.6 Bees and other flower visitors in agricultural lands in the prairie pothole region of North Dakota

The prairie pothole region of North Dakota is an area of biological interest because it encompasses range limits for many western and eastern species plant species and is in a transition zone between northern and southern climatic zones (Upham 1892; Stevens 1920a). The bee fauna of North Dakota was previously studied by O.A. Stevens, a botany professor at the Agricultural College at University of North Dakota in Fargo, who surveyed bees throughout eastern North Dakota from the 1910s to the 1940s (Stevens 1917; Stevens 1919; Stevens 1920b; Stevens 1921; Stevens 1948a; Stevens 1950; Stevens 1951). There are no published studies of native bees in North Dakota since that time and few collection records, pointing to the importance of documenting the current bee fauna. This study provided an opportunity to examine bee diversity in this region and compare findings with historical bee records.

For this study, all collection methods resulted in 14,947 bee specimens representing 166 species or species groups from 756 collection events. The Jack1 estimate of species richness was 236.52 ± 10.7. The Shannon index of diversity was 3.27 ± 0.03. The ten most frequently collected species using all methods in descending order were: *Lasioglossum* cf. *novascotiae, L. pruinosum, Halictus confusus, L. albipenne, L. semicaeruleum, L. zonulum, Melissodes trinodis, Hylaeus leptocephalus, L. admirandum,* and *L. sagax*. There were 17 new state records for North Dakota.

Comparison with estimated richness from the current survey showed a 16 to 30% loss in species richness between the historic and current surveys. There were several major shifts in relative abundances of bee genera between the two survey periods. The genera *Lasioglossum*, *Mellisodes, Halictus,* and *Ceratina* increased in relative abundance more than 50%. The genera *Bombus, Megachile,* and *Colletes,* decreased in relative abundance by more than 65%.

The most abundant species from the historic survey was *Bombus terricola* (122 individuals, 4% relative abundance), currently of particular interest due to conservation concerns (Evans et al. 2008). *Bombus terricola* was also found in the current survey but was represented by a single specimen (<0.001% relative abundance). Overall, six of the nine bumble bee species shared between surveys declined, while one species increased in relative abundance and two showed no differences. Seven species of *Bombus* found in the historic survey were absent in the current survey. *Megachile* had four of five species showing declines and six species present in the historic survey but absent in the current survey. Only one out of three *Colletes* species shared between surveys showed declines, but there were nine *Colletes* species absent from the current survey.

Floral visitation was also compared between survey periods by examining the abundance and species richness of visitors to plant genera. The plant genera *Sisymbrium, Heliopsis, Thlaspi, Brassica, Salix, Melilotus, Sonchus*, and *Anemone* had over 70% increase in the relative abundance of bee visitors. The plant genera *Sisymbrium, Thlaspi, Sonchus, Anemone,* and *Cirsium* all had over 60% increase in the relative species richness of bee visitors. The plant genera *Trifolium*, *Hydrophyllum*, *Amorpha*, *Dracocephalum*, *Zizia*, *Ratibida*, and *Centaurea* had over 70% decrease in the relative abundance of bee visitors. *Centaurea, Ratibida, Zizia, Symphyotrichum,* and *Hydrophyllum* had over 50% reduction in relative species richness of bee visitors.

Although nearly all land formerly occupied by tall grass prairie in the prairie pothole region of North Dakota has been replaced by agricultural land, many native bee species are still present, though there have been significant shifts in composition of the bee community. The native bee community in this region has experienced a decline in biodiversity and major shifts in community structure, but a species rich community of bees remains. My survey of flower visitors revealed that the remaining species pool is a community in need of conservation and increased habitat plantings, which would enable recovery of bees as well as plant communities.

1.7 Future directions

My findings predict that increasing the area of land in semi-natural areas, wooded area, wetlands, and crops providing bee forage will help support the growth, reproduction, and survival of diverse wild bee communities. I found many bee species in the region but the overall bee community was much less diverse than historical records due to the dominance of several bee species. Thus, the species pool needed to create a diverse bee community still exists in the region but would benefit from habitat enhancements. Habitat enhancements supported by my research include the installation of wind-breaks or hedge rows with flowering trees or shrubs, increased acreage of crops providing foraging resources, and enrollment in CRP or other land set-aside programs, particularly those with pollinator specific plantings. Reassessment of the bee community after adoption of these recommendations would demonstrate the effectiveness of these measures.

Crops providing bee forage hold great potential to provide important resources for bees. Common bee forage providing crops in the NGP include sunflower, alfalfa, and canola. The diversity of bee crops could be expanded, such as including flowering cover crops. Research into the ability of other bee forage crops to support bee communities would help determine their utility in pollinator habitat improvement schemes.

Most of the bee surveys took place along roadsides as that was where floral resources were. Research into the effects of alteration of roadside management including mowing schedules, herbicide use, and plantings could provide important information to managers of roadways interested in pollinator conservation.

Pollinators are usually only taken in consideration in agricultural areas when they are being used as pollinators, but there are diverse and interesting bee communities living in many agricultural areas around the world. Habitat enhancement and restoration in agricultural areas has great potential as a pollinator conservation tool.

Chapter 2 .

Agricultural land uses supporting wild bee communities: benefits of semi-natural lands, wooded areas, crops providing bee forage, and wetlands

Summary

This study examined the impact of land uses on bee diversity and abundance in a predominantly agricultural landscape in the prairie pothole region of the North American Northern Great Plains. Agriculture is the predominant land use in this region, accounting for roughly 90% of land use. Semi-natural areas including grasslands and Conservation Reserve Program lands, wooded areas including shelterbelts and woodlots, wetlands including areas of cattail and ephemeral wetlands, and crops providing bee forage, such as sunflower, canola, and alfalfa, have all experienced declines in recent years, primarily due to increases in corn and soybean for biofuel production. The loss of flowering and nesting habitats is considered a leading cause of declining wild bee diversity and abudance, which raises concern about pollinator conservation. The aim of this study was to determine the extent to which agricultural and semi-natural habitats in this region support diverse bee communities and their diverse habitat requirements. Sites where bees were examined varied in potentially bee-friendly habitat, habitat with less disturbance and more bee-prefered floral resources. Wild bee communities and surrounding land uses at radii of 1500 m, 700 m, and 300 m were assessed at 18 locations over three years. In all, 13,426 bees representing 149 species, morpho-species, or species groups were included in this analysis. The bees found near crops that did not provide forage, including corn, soybean, and wheat, had less functional diversity (traits considered predictors of bee community stability), and there were fewer ground nesting bees and bees with shorter active season durations (traits negatively impacted by agricultural intensity). Semi-natural land, bee forage crops, wooded areas, and wetlands, were all associated with more diverse bee communities or increases in bee abundance. At all observed scales, bees found near semi-natural lands had increased functional diversity. Crops providing bee forage were associated with increased bee species richness and diversity at a local scale.

Both semi-natural and crop lands providing bee forage were associated with increased abundances of bees with shorter active seasons. Wooded areas were associated with increased bee species richness and bee abundance, and wetlands were associated with greater bee abundance. Altering land management practices to promote retention and enhancement of semi-natural areas, wooded area, wetlands, and crops providing bee forage will help support the growth, reproduction, and survival of diverse wild bee communities within agricultural matrices in the Northern Great Plains. Each of these land uses should be included in pollinator conservation efforts due to their support of different aspects of bee communities.

2.1 Introduction

In recent years, awareness of the importance of wild bees for crop and wild plant pollination has increased (Ollerton et al. 2011; Garibaldi et al. 2013), concerns have been raised for conservation of native bee biodiversity (National Academy of Sciences 2007; Brown & Paxton 2009; Winfree 2010; Colla et al. 2012), and evidence of declines in wild bee populations has accumulated (Biesmeijer et al. 2006; Burkle et al. 2013; Senapathi et al. 2015). Habitat loss is broadly recognized as the leading cause of declining species richness for all plants and animals (Murphy & Romanuk 2014) and also may be an important factor in bee decline. Bee species vary in their responses to different types and magnitudes of land-use changes (Cariveau & Winfree 2015), but in general, anthropogenic land use leading to fragmentation and loss of habitat is the most universal factor thought to be driving bee declines (Brown & Paxton 2009).

A large portion of wild habitat throughout the world has been converted to agricultural land use. According to the Food and Agriculture Organization of the United Nations, croplands cover about 12% of Earth's ice-free land while pastures cover another 26% (Foley et al. 2011). In the United States, agricultural production, including cropland and pasture, accounts for around 45% of the land base (Nickerson et al. 2011). The Northern Great Plains (NGP) is a major area of agricultural production (U.S. Department of Agriculture 2013). Ninety percent of private land in the prairie pothole region of the Great Plains, where this study took place, is agricultural land (Rashford et al. 2011). In recent years, decreases in potentially bee-friendly agricultural land uses due to shifts to row crops grown for biofuel production in the NGP have raised concerns about the fate of pollinators in these landscapes (Gallant et al. 2014; Otto et al. 2016; Smart et al. 2016a).

Because of the pre-eminence of agriculture, it is important to find habitat within agricultural land that can support bee communities. Key habitat elements for bees are floral resources and nesting habitat. The total amount of flowers (Roulston & Goodell 2011) as well floral diversity (Potts et al. 2003; Hopwood 2008; Jha & Kremen 2013) and the availability and diversity of bee nesting resources (Potts et al. 2005) can have strong effects on bee communities. Nesting habits for bees vary greatly in terms of location and materials used (Cane 1991; Michener 2000). Understanding more about which land uses support bee communities could help focus habitat retention and restoration efforts.

One major component of potential wild bee habitat in agricultural areas is semi-natural lands. In the U.S., roughly 4% of national cropland area was enrolled the Conservation Reserve Program (CRP) in 2015, a program paying rental fees or cost-sharing for land owners to set aside cropland in environmentally sensitive areas (U.S. Department of Agriculture 2015), making CRP land a significant proportion of semi-natural land in agricultural areas in the U.S. However, with changing crop values and incentives, enrollment in CRP has decreased, particularly in the Northern Great Plains. The amount of land held in CRP in North Dakota decreased by 55% from peak enrollment of 1,370,000 hectares (3,389,000 acres) in 2007 to 620,000 hectares (1,528,000 acres) in 2015 (U.S. Department of Agriculture 2016).

Other potential bee habitat elements in the NGP include wooded areas, wetlands, crops providing bee forage, and pastures. Previous research in other regions found that wooded areas, including hedgerows and shelterbelts, positively impacted bee communities (Carré et al. 2009; Morandin & Kremen 2013a; Jha & Kremen 2013; Moroń et al. 2014). Many shelterbelts in the NGP are remnants from soil conservation efforts during the 1930s and these aging shelterbelts are being removed and not replaced (Marttila-Losure 2013). While little is currently known about effects of wetlands on bee communities, there is some evidence connecting wetland loss with declines in bee abundance, particularly in the mid-western United States (Koh et al. 2015). Increased areas of mass-flowering crops have been associated with increases in bee abundances (Westphal et al. 2003; Scheper et al. 2014; Riedinger et al. 2015). The area dedicated to flowering crops known to be used by bees, such as alfalfa, canola, and sunflowers in the NGP has significantly declined between 2002 and 2010 and acreage planted in corn and soybean, crops that provide few resources to bees in this region, has dramatically increased (U.S. Department of Agriculture 2013; Gallant et al. 2014). The effects of pasture on bee communities are variable. A previous study in heavily grazed sites in the Mediterranean found greater abundances of ground nesting bees in heavily grazed areas (Vulliamy et al. 2006), possibly due to increased availability of bare ground. However, other studies have found negative effects of active grazing on bee communities (Kearns & Oliveras 2009; Le Feon et al. 2010). Overall declines in habitat thought to support bees and concomitant increases in habitat thought to provide little or no value to bees have raised concerns about bee communities in the NGP.

This study examined the influence of land use on bee diversity and abundance in a predominantly agricultural landscape in the prairie pothole region in North Dakota at sites varying in habitat thought to be bee-friendly, such as CRP, grasslands, and crops providing bee forage. The aim was to determine whether and to what extent these potentially bee-friendly land uses support diverse bee communities. Discovering potential bee-friendly habitat elements in the agricultural matrix in the NGP can help guide efforts to support healthy wild bee communities on a broad scale.

2.2 Methods

2.2.1 Study area

This study covered parts of Stutsman, Barnes, and Griggs counties in the state of North Dakota, from latitude 46°57'13"N to 47°16'48" N and longitude 98°1'49" W to

98°56'3"W. Historically, the prairie pothole region of the NGP was an area of prairie grasslands with many shallow wetlands, known as potholes, created by past glacial activity during the Wisconsin glaciation ~12,000 years ago (Euliss et al. 1999). Many of the potholes are supplied with water only from spring snow melt and so are ephemeral.

2.2.2 Survey locations

Survey locations were nested within six sites that varied in the area occupied by habitat thought to provide foraging resources to bees, including wooded areas, wetlands, semi-natural land, pastures, and bee forage crops (Fig. 2-1). The six sites housed centrally located honey bee apiaries used for an examination of honey bee colony performance (Smart et al. 2016 b) and comparison of honey bee and wild bee success (Chapter 3). Three of the six sites were surrounded by more habitat that is considered to be bee friendly. Survey locations were chosen so they were at least 1 km from each other and within 2.5 km of the center of the site to keep the foraging range of most bees within the area of quantified land use (3.2 km) (Fig. 2-2). Survey locations were chosen based on land access and the presence of floral resources on which to survey bees. Most survey locations were along roadside ditches as that was predominantly where floral sources were located. In 2010, there were two bee survey locations within each site, resulting in twelve bee survey locations. These two survey locations were chosen to emcompass variability in amount of surrounding potentially bee-friendly land. In 2011 and 2012, an additional survey location was added at each site resulting in eighteen bee survey locations to better encompass variability in landscape.

2.2.3 Landscape characterization

Each year from 2010 to 2012, a GIS technician from the USGS Northern Prairie Wildlife Research Center in Jamestown, ND surveyed land use within a 3.2 km (2.0 mile) radius of the center of the six locations. The technician visited each apiary site three times (once each spring in May-June, summer in July-early August, and autumn in late August-September) each year to verify land use in the field and this data, in addition to data from the National Agricultural Statistics Survey (NASS), were entered into ArcGIS v.10 for final quantifications of the area of various types of land use within the 3.2-km radius around each site. Additionally, during each visit the surveyor visually assessed and estimated floral cover of the most commonly occurring flowers within each land category around each site including, sweet clover *Melilotus* spp.; alfalfa *Medicago sativa*; gumweed *Grindelia squarrosa*; native sunflower *Helianthus* spp.; sow thistle *Sonchus* spp.; and goldenrod *Solidago* spp. Proprietary CRP data was accessed via an FSA/USGS Interagency Agreement. One site was located inside the Arrowwood National Wildlife Refuge; approximately 75,000 acres of U.S. Fish and Wildlife Service (FWS) land composed primarily of grassland. A special use permit was granted to allow collection of bees on this site. The following land uses were assessed: CRP, soybeans, corn, wheat, legume rich CRP, canola, oil sunflower, alfalfa hayland, shelterbelt, wet wetlands, dry/ephemeral wetlands, flowering trees/shrubs, grassland, cattails, non-alfalfa hayland (non-flowering), pasture, fallow, and ditch.

Land use surrounding the survey locations nested within the sites was summarized at radii of 1500 m, 700 m, and 300 m (Fig. 2-2). All scales were included in these analyses to capture potential variability among different bee community measures across scales. Most (88%) of the bees found in the surveys are predicted to have typical foraging distances less than 300 m using the R package BeeIT (Cariveau et al. 2016), which uses inter-tegular distances to predict foraging distances (Greenleaf et al. 2007). Almost all (97%) of the bees were predicted to have foraging distances less than 700 m. The remaining bees with longer flight distances were primarily bumble bees, many of which forage within 1500 m of their nests (Westphal et al. 2006; Charman et al. 2010; Hagen et al. 2011). At the 1500 m scale, some survey locations overlapped with each other. It is assumed that this overlap did not bias observed relationships as the area of overlap was a small proportion of the total area examined and the majority of bees would not be foraging towards the edge of the 1500 m buffer. Land within 1500 m of survey locations that fell outside of the radii assessed by USGS technicians was characterized using aerial photographs, ground-truthing, and land use maps provided by the National Agricultural Statistics Service (USDA-NASS 2015). In 2011 and 2012, diversity and abundance of blooming flowers were measured at four randomly selected 1 m^2 quadrats located along a 100 m transect at each survey location. The percent cover of each blooming plant species within the quadrat was estimated.

Land use factors were combined into groupings based on similarities in land management and potential to provide foraging or nesting habitat for bees (Table 2-1). Wooded land uses (shelterbelts and flowering trees) were combined due to similarity in possible nesting habitat, particularly for cavity nesting bees. Ephemeral wetlands and cattails were combined due to similarity in land management with exposure to seasonal flooding, and possible nesting and foraging habitat. Open water was examined separately due to lack of nesting sites and minimal floral availability. Semi-natural land uses (CRP and grasslands) were combined due to their similarity as untilled, open areas with little pesticide exposure and many possible foraging and nesting opportunities. Non-alfalfa hayland was examined separately as disturbed land with moderate floral cover. Pasture was examined separately as disturbed land with relatively high floral cover. Both pasture and hay lands are considered to provide potential nesting opportunities. Crops with potentially high value as bee forage (alfalfa, canola, and sunflower) were combined due to the high level of disturbance, probable pesticide exposure, and high floral cover. Crops with low potential bee forage value (corn, soybean, wheat, and oats) were combined due to the high level of disturbance, probable pesticide exposure, and low floral cover. Although both corn and soybean produce pollen and soybean sometimes also produces nectar, casual observations found no wild bee visitation to these crops at any study sites. Many survey locations were near corn and soybean fields and these fields were visually scanned for bee activity. Ruderal land (fallow land and ditches) also had a high level of disturbance, low floral cover, and primarily indirect pesticide exposure. Survey locations varied widely in the amount of land uses in these categories (Table 2-2).

2.2.4 Wild bee survey

2.2.4.1 Survey methods

Bees were surveyed between May and September, once every three weeks at twelve survey locations in 2010, for a total of six sampling rounds per survey location, and once every four weeks at eighteen locations in 2011 and 2012, for a total of five sampling rounds per survey location. Logistic constraints led to a compromise between number of survey locations and frequency of sampling rounds, resulting in less frequent sampling in 2011 and 2012. All sites were sampled within three to four days during each sampling round. Due to extreme flooding, several survey locations were inaccessible during the first collection in May of 2011, and those collections were delayed by a week. Two different collection methods (sweep netting and bowl traps) were used. Sweep netting observer bias was minimized by training observers to sweep at a consistent rate and by rotating observers among survey locations. Although bowl traps are both efficient and unbiased in terms of observer bias (Westphal et al. 2008), they have other potential biases. Sweep netting and bowl traps tend to collect different sizes of bees, with larger bees being more frequently captured with sweep nets (Jean 2010). The two collection methods were included to maximize the number of species caught and to compensate for variable performance of individual collection methods.

Each survey location was visited twice a day, once earlier and once later in the day, for sweep netting during each collection period. The timing of "early" and "late" shifted with the season, with early ranging between 10 a.m. and 1 p.m. and late ranging between 1 p.m. and 6 p.m. Surveys took place when there was no precipitation and the temperature was greater than 15° C. Timers were paused for retrieving insects out of nets, so that handling time was not included in sweep time. Only bees were collected from the nets. Other insects were released. Honey bees were counted and released as they were readily identifiable. Their numbers were not included in these analyses. When possible, other bees, primarily bumble bees, were also identified to species, counted, and released. In 2010, a total of 30 minutes of sweep time was spent at each survey location per collection period, focusing on blooming flowers. Thus, the area covered in the 2010 surveys varied depending on available floral resources. The area covered during each survey, the currently blooming plants present, and estimated amount of flowers in bloom were recorded. General sweeping methods were similar in 2011 and 2012, but sampling at each site was reduced to 20 minutes per collection period, due to the increase in the number of survey locations, and sweep netting took place along a meandering transect. Observers walked at a consistent pace, covering approximately 100 m in 10 minutes with the path of the transect varying over the season to encounter patches of blooming flowers. The same transect was used for "early" and "late" sweeps. Floral visitation records were preserved by pausing timers and collecting bees from sweep nets before moving to a different plant species.

In 2010, thirty-six bowl traps were set up at each survey location each collection period. The traps consisted of 200 ml plastic bowls painted either fluorescent blue, fluorescent yellow, or white. These bowls were attached to bamboo stakes so that the bowl was elevated slightly above vegetation height to ensure visibility. The bowls were placed along two orthogonal lines when possible, or along one straight line with 5 m between bowls. These lines were placed along roadside ditches or other open areas. Bowls were filled with a 2% soap solution (Dawn dish soap, Procter &Gamble, Cincinnati, OH) and left out for approximately twenty-four hours. Due to the increase in the number of survey locations, the number of bowls was reduced to twenty-four for 2011 and 2012 to enable timely processing of samples.

2.2.4.2 Specimen processing

Bees were identified to species whenever possible using keys and comparisons with previously identified materials (Mitchell 1960; Laberge 1969; Gibbs 2010; Ascher & Pickering 2015). A subset of bees (5%) was sent to experts (Dr. John Ascher, Joel Gardner, Dr. Jason Gibbs, Dr. Mike Arduser, Sam Droege, Dr. Karen Wright) for creation of a synoptic set, confirmation of identifications, and identification of groups for which there were no available keys. Species level identification was not possible in all cases. Ten bee types were identified to species groups (1% of specimens) or as cf. species, meaning that either the species was not well documented from that part of the continent or there were potentially undescribed species that matched the characters of that specimen (14% of all specimens). Most specimens are deposited in the University of Minnesota Insect Collection. A portion of the specimens is in the research collection at the University of Minnesota Bee Lab. All records are databased as will be shared with DiscoverLife and the USGS Pollinator Library.

2.2.4.3 Bee community variables

Bee communities were characterized using measures of abundance, species richness, effective species diversity, functional trait diversity, and community weighted means for individual functional traits. Bee abundance was the total number of bees collected at each survey location summarized over all collection periods each year. Associations of land uses with abundance would indicate effects on overall bee population size.

Species richness was measured as the number of species and also quantified using two non-parametric estimators to correct for potential bias from patchiness or small sample size. The first, incidence-based coverage estimator (ICE), was chosen for its suitability for diverse groups and ability to deal with patchiness for estimating richness over the entire study area to determine sufficiency of sampling (Gotelli & Colwell 2011; Urrutia-Escobar & Armbrecht 2013). The second non-parametric estimator, first-order jackknife estimation, was chosen because it can control for the confounding effects of sampling effort due to potential bias and smaller sample sizes for estimates at each survey location and year (Walther & Morand 1998). Both non-parametric estimators were calculated using the program EstimateS (Colwell 2013). Associations of land uses with species richness would indicate effects on individual species, with greater species richness indicating an ability to support more bee species.

Effective species diversity, an index including both the number and evenness of species, was quantified using the exponential Shannon's index of entropy in EstimateS version 9 (Colwell 2013). This index takes into consideration the abundance of each bee species, the evenness (how equal the abundances are) of the community, and has the ability to weight bee species by their frequency without disproportionately favoring either rare or common species (Jost 2006). High values indicate that species are more evenly represented in the community. Low values indicate that some species are much more abundant, possibly dominating the community. Associations of land uses with species diversity would indicate effects on the bee community due to effects on abundances of individual species, with more even communities indicating potential for greater stability (McCann 2000).

Functional trait diversity quantifies trait distribution in a community, just as species diversity quantifies the distribution of species. Functional traits are morpho-physio-phenological traits that impact fitness indirectly via their effects on growth, reproduction, and survival, the three components of individual performance (Violle et al. 2007). Differences in functional traits across survey locations were examined to provide additional information on land use effects on the bee community. Important changes in functional diversity may occur with minimal change in species richness (Cadotte et al. 2011), showing that functional diversity can add information about the impacts of environmental gradients, such as land use. It is important to choose functional traits that are relevant to the ecosystem processes, community structure, or assembly processes under consideration (Nock et al. 2016). The following traits were included in these analyses: nesting habit, duration of seasonal activity, season of active foraging, floral specialization, tongue length, and body size (Table 2-3). This suite of traits represents functional response traits, traits that influence the abilities of species to colonize or thrive in a habitat and to persist in the face of environmental changes, as opposed to functional effect traits, which are a measure of ecosystem services (Diaz et al. 2013) and were chosen because they are important descriptors of bee ecology and can be predictors of bee community stability (Michener 2000; Moretti et al. 2009; Williams et al. 2010; Sheffield et al. 2013; Hopfenmüller et al. 2014; De Palma et al. 2015). Differential responses of bees with different nesting habits can be caused by different disturbance responses. Bees that nest above ground have been found to be negatively affected by agricultural intensity, while bees that nest underground are negatively affected by tilling practices (Williams et al. 2010). Bees with shorter active season duration have been negatively associated with agricultural intensity (De Palma et al. 2015). Bees active early in the season have greater potential susceptibility to negative effects of climate change (Fründ et al. 2013). Floral specialization (Grundel et al. 2010; Weiner et al. 2014), cleptoparasitism as a nesting habit (Sheffield et al. 2013), and longer tongues (particularly for *Bombus*) (Goulson et al. 2008) are traits suggested for use as indicators of bee community health or as traits indicating susceptibility to decline.

Functional diversity creates a multi-dimensional space based on the distribution of functional traits and the abundances of species with those traits (Cadotte et al. 2011). If species abundances are distributed with more regularity within the functional space, then that site has higher functional diversity. Higher functional diversity indicates the presence of mechanisms enabling a community with diverse traits (Ricotta & Moretti 2011). The distribution of many of the functional traits included in this study, such as nesting habit and floral specialization, are related to habitat availability. Functional diversity was measured as functional dispersion, an abundance-weighted measure of functional trait diversity that is unaffected by species richness and is less sensitive to species with extreme trait values (Laliberte et al. 2010). Functional dispersion was calculated using the FD package (Laliberte et al. 2010) in R version 3.2.1 (R Core Team 2015) with the following traits: nesting habit, active season, active season duration, floral specialization, and tongue length. Bee size was not included due to its correlation with tongue length. A correction was applied on the species-by-species functional distance matrix to ensure it was Euclidean (Cailliez 1983). Associations of land uses with functional diversity would indicate effects on the trait diversity of the bee community. Positive associations would show that the land use is able to support a bee community that exhibits a broad variety of nesting habits, diets, lengths of active flight seasons, timing of active flight seasons, and body sizes.

In addition to functional dispersion, which summarizes over a suite of traits, the community weighted means, the average of trait values weighted by the relative abundances of each species (Lavorel et al. 2008; Ricotta & Moretti 2011), were calculated for individual functional traits using R package FD (Laliberte et al. 2010). The individual traits used for these analyses were chosen based on previous research indicating their potential sensitivity to land management. The individual traits included in the analysis were above ground nesting, active season duration, early season bees, floral specialists, tongue length, and bee size. Although cleptoparasitism as a nesting habit is suggested as good monitor of bee community health (Sheffield et al. 2013), the low frequency of this nesting habit among the bees of this study (1%) prevented their inclusion as a response variable. Associations of land uses with individual functional traits would indicate that life-history characteristics, and thus fitness, of bees with those traits are affected by that land use. For example, if above-ground nesting bees are negatively affected by a particular land use it indicates that their nesting habitat is disrupted by that land use.

2.2.5 Statistical analyses

Statistical analyses were performed in R version 3.2.1 (R Core Team 2015).

2.2.5.1 Analysis of bias of collection methods

Potential bias of bowl trap collection methods in relation to floral cover was examined using mixed-effects linear regression models. Bee abundances and numbers of bee species captured in bowl traps and those captured in sweep nets at each collection site were summarized for each collection period. Floral cover at each collection site was estimated using floral assessments at bee survey locations in 2011 and 2012 and was summarized as the estimated blooming plant cover at each survey location at each collection period. Mixed-effects linear regression models were run with bee abundances and species richness measures from bowl trap and sweep net collections as the response variables, floral cover and years as fixed effects, and survey locations and collection periods as random effects (package lme4 1.1-12) (Bates et al. 2015). Bee abundances and species richness measures were natural log-transformed to correct for heteroscedasticity.

2.2.5.2 Analysis of land-use effects on bee communities

The relationships of bee community measures (number of individuals, number of species, species diversity, functional diversity, community weighted means of specific functional traits) to land-use categories (woods, wetlands, open water, semi-natural areas, pastures, hay land, bee-friendly crops, other crops, ruderal lands) were examined using mixed-effects multiple linear regression models with bee community measures as the response variables, land uses and years as fixed effects, and survey locations nested within sites as a random effect. Regression predictors were standardized as z-scores using R package arm version 1.8-6 (Gelman & Su 2015) to permit comparison among regression coefficients.

Models were run excluding bowl traps from the bee community measures including abundances due to possible bias from interaction between floral cover and performance of bee collection methods. Additional models were run with inclusion of both bowl and sweep collections to examine possible collection method bias. Diagnostic plots were examined to check for heteroscedasticity and to ensure normality of errors. Estimates for effects on species richness, species diversity, functional diversity, and community weighted means of individual functional traits were obtained from models with normal error distributions fit using lme4 version 1.1-9 (Bates et al. 2015). Estimates for effects on bee abundance using only sweep netting collection data were obtained from models with negative binomial error distributions with a log link function using glmmADMB version 0.8.3.3 (Fournier et al. 2012; Skaug et al. 2016). To meet assumptions of homoscedasticity, floral specificity and above-ground nesting community weighted mean data were natural log transformed. To avoid collinearity of covariates, predictors with variance inflation factors greater than three were removed from models (Zuur et al. 2010). The land-use grouping "other crops" was removed from models for all bee community measures due to collinearity with other land uses (pasture, semi-natural, bee-friendly crops, wooded areas). Models were also run with only "other crops" included as the predictor to examine the effect of this predominant land use. Remaining land-use factors with correlation coefficients greater than 0.40 were examined with leave-one-out model comparisons to confirm that collinearity did not affect any of the significant effects. Non-alfalfa hay land, ruderal land, and open water were removed from models due to collinearity affecting significance and direction of effects. Conditional and marginal R^2 values were obtained by running models with restricted maximum likelihood and obtaining the pseudo- R^2 for generalized mixed-effect models using R-package MuMIn (Bartoń 2015).

2.3 Results

2.3.1 Bee diversity

Collections using sweep netting and bowl traps yielded 13,426 bees representing 149 species, morpho-species, or species groups. The two non-parametric estimators of species richness (ICE, 71%; Jack1, 75%) showed this collection represented an average of 73% of the estimated minimum number of bee species in the study area. Thus, sampling for this study encompassed a sufficient proportion of potential species to characterize the bee community. Most bees were ground nesting (72% of species, 82% of individuals), polylectic (70% of species, 82% of individuals), and short-tongued, length less than 2.5 mm (60% of species, 70% of individuals). The five most commonly collected species in rank order were *Lasioglossum* cf. *novascotiae*, *L. pruinosum, Halictus confusus*, *L. albipenne*, and *L. semicaeruleum.* Seven of the ten most commonly collected species belonged to the genus *Lasioglossum* and were disproportionally collected via bowl traps (Table 2-4).

Sweep net collections yielded 2,028 bees, representing 117 species, morphospecies, or species groups. The two non-parametric estimators of species richness (ICE, 57%; Jack1, 60%) showed that the bees collected with sweep netting represented an average of 58.5% of the estimated minimum number of bee species in the study area. Of bees collected using only sweep netting, most were ground nesting (73% of species, 77% of individuals), polylectic (69% of species, 78% of individuals), and short-tongued with length less than 2.5 mm (50% of species, 67% of individuals). The five most commonly collected species or species groups in rank order were *Melissodes trinodis*, *Lasioglossum* cf. *novascotiae*, *Halictus confusus*, *L. semicaeruleum*, and *L. albipenne* (Table 2-4).

While bee abundances and species richness measures from bowl trap collections were not affected by floral cover, these measures from sweep net collections increased with increasing proportions of estimated floral cover (Fig. 2-3). Sweep net collections took place at flowers, so floral abundance would be expected to impact the numbers of bees collected, whereas bowl traps act as artificial flowers luring bees to the bowl by trap color. Since this study examined the relationship between bees and land uses at survey locations with great variability in estimated floral cover (0 to 96%), response variables including abundance measures were examined with and without specimens from bowl traps to examine possible bias due to interaction between floral cover and performance of bee collection methods. These variables were bee abundance (number of individuals collected at each survey location per year) and Shannon's exponential index of diversity. Although functional dispersion and community weighted means of individual functional traits included measures of abundance, models were run using data only from sweep netting collections because of the potential importance of floral relationships for these variables.

2.3.2 Bee community measures related to land use

Bee abundance was positively associated with wooded areas and wetlands at the 700 m scale (Fig. 2-4, Table 2-5). Species richness was positively associated with wooded areas at the 700 and 300 m scales and bee forage crops at the 300 m scale. The same associations were seen when the response variable was species richness, measured as the number of species collected, compared to when the response variable was the first-order jackknife estimation of species richness. The effective species diversity measured by the exponential Shannon index of diversity was positively associated with wooded areas at the 700 m scale and bee forage crops at the 300 m scale. Functional diversity, as measured by functional dispersion, was positively associated with semi-natural areas at all examined scales and was negatively associated with non-bee crops (predominantly corn and soybeans) at all examined scales.

Associations also were found between community weighted trait means and land uses. The community weighted trait means for proportions of above-ground nesters were positively associated with semi-natural lands and pasture at the 1500 m and 700 m scales (Fig. 2-5, Table 2-6). Above-ground nesters were negatively associated with non-bee crops at all scales. The community weighted trait means for duration of active season were negatively associated with semi-natural land and bee crops at the 1500 m and 300 m scales, implying that these land uses supported bees with shorter active season durations. There were positive associations between non-bee crops and the community weighted trait means for active season duration at the 700 m and 300 m scales implying an association with bees with longer active seasons. No effects of land use were found for community weighted trait means for the other functional traits: floral specialists, early season active bees, tongue length, or bee size. Floral specialists showed a trend toward positive association with bee forage crops at 300 m. Bees active early in the season showed a trend for positive association with non-bee forage crops.

Including data from both sweep netting and bowl trap collections in measures including abundance did not change the direction of most effects, but changes in variability of the estimates caused some loss in significance (Tables 2-7). An exception was the effect of non-bee crops on bee abundance. With only sweep netting collection data there was no effect of non-bee crops on bee abundance. With the addition of bowl trap collection data, non-bee crops had a positive effect on abundance.

2.3.3 Floral use by bees

Floral records and degree of floral specialization were examined to elucidate relationships among bee species and flowering plants. Three plant species accounted for 31% of all bee visitations and were visited by 62% of bee species collected from sweep netting (Table 2-8). These plants, in rank order of abundances of bees and numbers of bee species found on the plants, were *Melilotus alba/officinalis, Sonchus oleraceus,* and *Grindelia squarrosa*, all of which are weedy, invasive plants commonly found in ruderal areas. Floral assessments revealed that the three flowering plants with the highest cover over all sites were *Melilotus alba/officinalis* (19%), *Brassica rapa* (12%), and *Medicago sativa* (10%). *Sonchus oleraceus* was present at 6% cover and *Grindellia squarrosa* was present at 2% cover. Sweep netting collections from bee forage crops yielded 27 bee species with 14 species from *Medicago sativa,* 11 species from *Brassica rapa*, and 10 species from *Helianthus annuus* (Table 2-9). Of 45 bee species from collections using both methods that were categorized as oligolectic, 69% specialized on plants in the family Asteraceae, 9% on Salicaceae, 7% on Fabaceae, 7% on Onagraceae, 4% on the subfamily Campanuloideae, 2% on the family Apiaceae, and 2% on Verbenaceae.

2.4 Discussion

Wild bee conservation efforts often focus on retaining or recreating isolated, protected areas of native habitat. These efforts are essential for bee conservation, but it is only possible to include a very small proportion of the land base in these efforts. With increased concern about pollinator decline, it is important to discover diverse land uses that can support pollinators within the vast agricultural matrices that dominate the globe. Several land uses commonly found in the agricultural matrix of the Northern Great Plains consistently had positive effects on bee communities. The results of this study show that semi-natural lands including grasslands and CRP lands, bee forage crops including sunflower (*Helianthus annuus*), canola (*Brassica rapa*), and alfalfa (*Medicago sativa*), wooded areas including shelterbelts and woodlots, and wetlands including cattails and ephemeral wetlands positively affected wild bee communities. Each of these land uses should be included in pollinator conservation efforts due to their support of different aspects of bee communities.

Although dominated by agricultural land, the study area in the prairie pothole region of North Dakota supported a species rich bee community. Longer term, broader scale studies are needed to examine population trends in this region, so it is not known if remaining habitat is sufficient to support the current bee community, or if these findings are a marker point along a declining population trend. The current trends of decreasing acreage in CRP programs and bee-preferred flowering crops due primarily to conversion to biofuel crops (Gallant et al. 2014; Otto et al. 2016), as well as the trend to remove shelter belts (Marttila-Losure 2013) show that land management is currently moving in the opposite direction of what would benefit the bee community. Continuation of current land management trends is likely to result in poorer quality habitat for bees leading to possible extirpation of species. Alteration of land management to practices that retain and enhance diverse bee communities is important for maintaining pollination services as well as conserving native bee biodiversity.

Potentially bee-friendly land uses: The positive association of bee communities with several different land uses within the agricultural matrix can provide a basis for land management recommendations to increase pollinator diversity and abundance. Bees in the NGP are currently surviving on dwindling resources, but retention and expansion of bee-friendly land uses could bolster bee populations. Retention and replacement of wooded shelterbelts and other wooded areas in agricultural areas in the NGP could help maintain bee diversity due to their association with increased bee species richness, functional diversity, and bee abundance. Wooded areas are likely to provide nesting resource including stems and holes in wood for cavity nesting bees as well as relatively undisturbed ground for tunnel building ground-nesting bees as well as both above and below ground nesting bumble bees. The low floral cover of wooded areas in this region indicate that nesting resource availability may have had a positive influence on bee communities. This positive influence could become greater if flowering shrubs are planted (Hannon & Sisk 2009) so these areas could provide both nesting and foraging resources. Despite their importance in supporting bee communities, wooded areas were uncommon in the study area (2% of overall land use). Twenty-five percent of wooded areas were shelterbelts planted within agricultural fields. Encouraging planting and conservation of shelterbelts and hedgerows in this region would support wild bee diversity overall. The proximity of the effect (within 700 m) indicates that more benefit could be derived from having shelterbelts dispersed throughout the landscape.

Wetlands are known for providing a wide variety of general ecological benefits, preserving biodiversity as well as enabling nutrient cycling and improving water quality (Mitsch & Gossilink 2000), but little research has focused on the impact of wetlands on bee communities. In the prairie pothole region of North Dakota, there are many small, ephemeral wetlands, scattered throughout the landscape that likely create nesting habitat for ground nesting bees around the edges of these wetlands. In addition, the wetlands in this study may provide more floral resources than were measured during ground-truthing surveys, which were limited to terrestrial habitats. An assessment of pollen collected by the honey bees located at the same study sites revealed a significant contribution of wetland plants to the pollen diet (Cornman et al. 2015). The positive effect of wetlands on the abundance of bees indicated that retaining remaining wetlands as well as sensitive management of farmland containing ephemeral wetlands could help support bee communities in agricultural areas. Wetland restoration efforts in this region show great potential to restore this habitat (Seabloom & Van Der Valk 2003; Gleason et al. 2016).

Expansion of semi-natural areas (grasslands and CRP) could have broad-scale and local positive effects on bee communities by supporting bees with diverse functions (or functional traits). This study found a positive effect of semi-natural lands on bee functional diversity, showing that semi-natural lands support a bee community that exhibits a broad variety of nesting habits, diets, lengths of active seasons, timing of active seasons, and body sizes. Bees with shorter active seasons were associated with semi-natural lands, possibly due to a higher chance of synchrony with key floral resources. Previous research in other areas found positive effects on bee species richness and abundance, showing the potential for this land use to broadly support bee communities (Steffan-Dewenter et al. 2002; Öckinger & Smith 2006; Le Feon et al. 2010; Hopfenmüller et al. 2014). Semi-natural areas in the NGP tended to have moderate floral cover and little disturbance, which likely provided both foraging and nesting habitat for a wide variety of bees. Habitat enhancement programs such as CRP, particularly those that focus on plants for pollinators, are important for supporting wild bee communities.

Increasing acreage of pasture was positively associated with greater proportions of above-ground nesting bees, but not associated with any of the broader bee community measures, such as diversity and abundance. It is possible that plants that were partially grazed could have created stubble providing nesting resources for above-ground nesters. Pasture had relatively high floral cover (9%) but was not associated with a greater abundance of bees. Further study is needed to clarify the impact of pasture, including the impact of different grazing regimes on bee communities.

Crops providing bee forage (sunflower, canola, and alfalfa) were shown to support species richness and diversity, particularly within 300 m of survey locations. These flowering crops also showed a trend for greater abundances of floral specialists. Floral specialists are of particular interest as they are thought to be at greater risk of decline due specialized habitat needs. While degrees of oligolecty vary among bees, with some bees specializing on particular genera or species of plants, many specialists collect pollen from plants within the same family (Cane & Sipes 2006). The majority of bee specialists found in this study were specialists on plants in the family Asteraceae. Crops in Asteraceae, such as sunflower, safflower, and chicory, could provide important resources for many specialist bees. Recent research has shown potential for several cover crops providing bee forage to be used for oil seed production for biofuels (Eberle et al. 2015). Incorporating blooming crops providing floral resources for bees into the agricultural matrix in this region could help support diverse bee communities. Even at extremely low cover in the study area (1%), bee forage crops were shown to support wild bee communities. The site with the highest cover of bee forage crops had 5% of surrounding land use at a radius of 3200 m, approximately 160 hectares, in bee forage crops. Other sites had as little as 0.5%, approximately 16 hectares, of surrounding land use in bee forage crops. This study showed that proximity of bee forage crops is important for supporting bees, but further research is needed to determine the impact of amount of cover in bee forage crops on the bee community.

Land uses with potentially negative impacts on bees: The predominant land use across study sites was cropland containing corn, soybean, and wheat. The variety of commodities grown by North Dakota producers has steadily declined over the past century, with a dramatic increase in acreage dedicated to corn and soybean since 2007 (Gascoigne et al. 2013). If current trends continue, acreage in corn and soybean will continue to increase to the detriment of bee-friendly land uses. These crops were associated with decreased functional diversity, indicating a lack of support for diverse roles in the bee community. When examined individually by community weighted trait means, crops lacking bee forage had a negative effect on above-ground nesting bees and bees with short active season durations, which supports previous research (Williams et al. 2010; De Palma et al. 2015). The high disturbance of this land use likely contributed to negative effects on above-ground nesting bees, due to lack of undisturbed vegetation for nesting sites. This is the land use with the highest likelihood of pesticide application, which could have contributed to the lower number of bees but was not quantified in this study. With benefits to wild bee communities seen when bee forage crops comprised as little as 1% of the landscape, crop diversification to include potential bee forage crops, even at a small scale, such as one acre out of every one hundred, could benefit wild bees.

Floral use: The predominance of floral visits to non-native, weedy, ruderal plants was not surprising given that these were the predominant blooming plants at the survey locations. It should be noted that floral visitation data are an indication of, but not always an accurate representation of pollen usage by bees (Bosch et al. 2009). It is possible that bees were collected while visiting these plants for nectar and that other plants were important pollen sources. Ideally, native bees would have native plants on which to forage, but the ability for many bee species to utilize common plants of ruderal areas indicates the importance of examining management effects on bee diversity for areas supporting these plants, particularly roadsides. There is potential for roadside mowing and weed management strategies to be altered to promote bee diversity in agricultural areas.

Floral preferences of specialist bees and their association with crops providing bee forage shows the potential for crops to provide resources for specialists as a particularly vulnerable section of the bee community. The breadth of floral specialization by bees varies widely, with some specialized on particular species or genera of plants and other others able to use a wide range of plants within a plant family (Cane & Sipes 2006). Recommendations based on association with plant family may not be suitable for bees with narrow ranges of specialization, but may help narrow choices when exploring planting options. Globally, the plant family Asteraceae hosts many specialists (Hurd et al. 1980; Fowler 2016). There are several crops as well as common ruderal plants belonging to this family that have potential to support some of these specialists. There are also crop and ruderal plants in the family Fabaceae that have potential to support bee specialists. Bee specialists on the plant family Salicaeceae could be supported by inclusion of willow species in shelterbelts. Other plant families potentially hosting bee specialists found in this study include Onagraceae, Campanuloideae, Apiaceae, and Verbenaceae. These plant families should be considered for inclusion for pollinator plantings and exploration of alternative crops.

Bias in Bowl Trap Data: The use of bowl traps can introduce bias in sampling methods because these traps may be more attractive in areas that have less floral abundance, and tend to collect smaller bees compared to sweep net sampling (Jean 2010; Baum & Wallen 2011). Although the bowl traps contributed significantly to the numbers of bees collected in this study, exclusion of bowl trap data from measures including abundance was warranted. While most models of land-use effects on bee communities were not affected by exclusion of bowl trap collection data, the few exceptions, such as the positive association between non-bee crops and bee abundance when bowl trap data were included, indicate increased attraction of bees to bowl traps acting as artificial flowers in areas lacking flowers. Bowl trap collections are highly informative for measures of species richness but caution should be used if these data are to be used to assess the relation of bees to surrounding land uses.

Conclusions: The persistence of a diverse native bee community in highly disturbed habitat dominated by non-native vegetation and subject to pesticide use shows the potential for intensively used agricultural habitat to support native bee communities when appropriate and diverse habitat elements are present. This study shows that some habitat elements currently in the agricultural matrix, such as shelterbelts and bee forage crops, potentially provide important support for wild bee communities, thus it is important to retain these land uses and practice pollinator-friendly land management within these land uses. In addition, retention and creation of semi-natural lands through increased participation in CRP or other set-aside programs could help provide important floral availability and nesting opportunities for wild bees that are currently found in the agricultural matrix. Wetlands hold potential to benefit bee communities and should be considered as an element of pollinator friendly landscapes. While bee-friendly habitat in agricultural areas is subject to pesticide exposure (Mogren & Lundgren 2016), the presence of bee-friendly habitat within agricultural areas could and should provide impetus to avoid potential contamination of flowering plants and bee communities with pesticides. Providing bee-friendly habitat within the agricultural matrix is needed at a broad scale to enhance native bee conservation efforts.

2.5 Figures

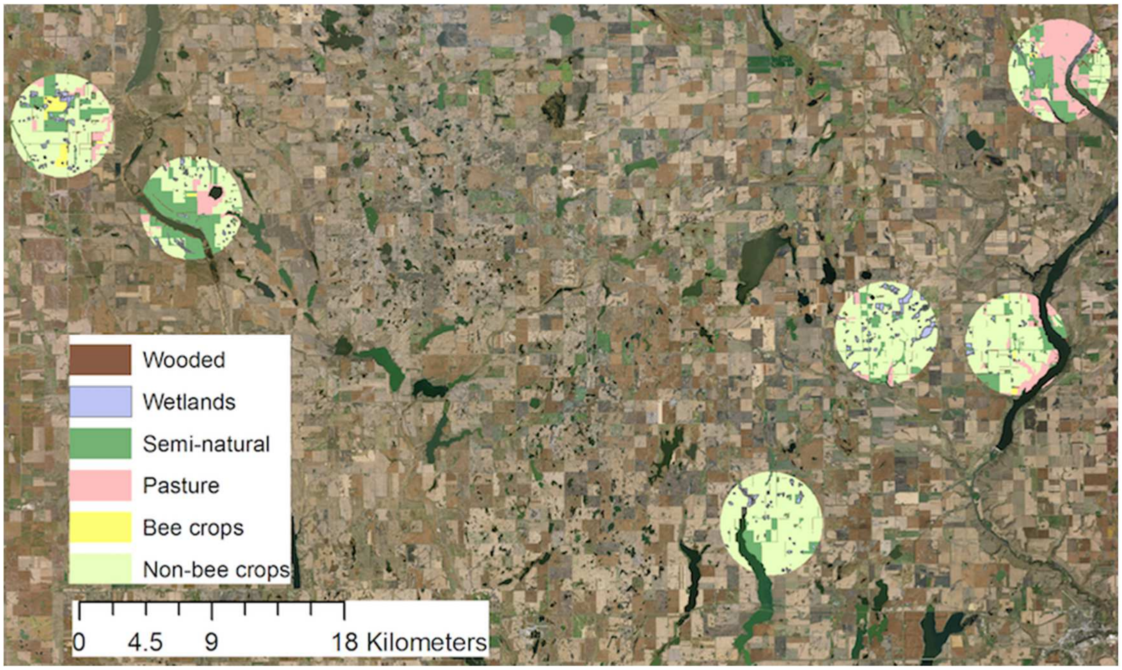

Figure 2-1. Land use at six sites housing survey locations in the prairie pothole region of North Dakota. Wooded included shelterbelts and flowering trees. Wetlands included ephemeral wetlands and cattails. Semi-natural included CRP and grasslands. Pasture included actively, or recently grazed lands. Bee crops included alfalfa, canola, and sunflower. Non-bee crops included corn, soybean, wheat, and oats.

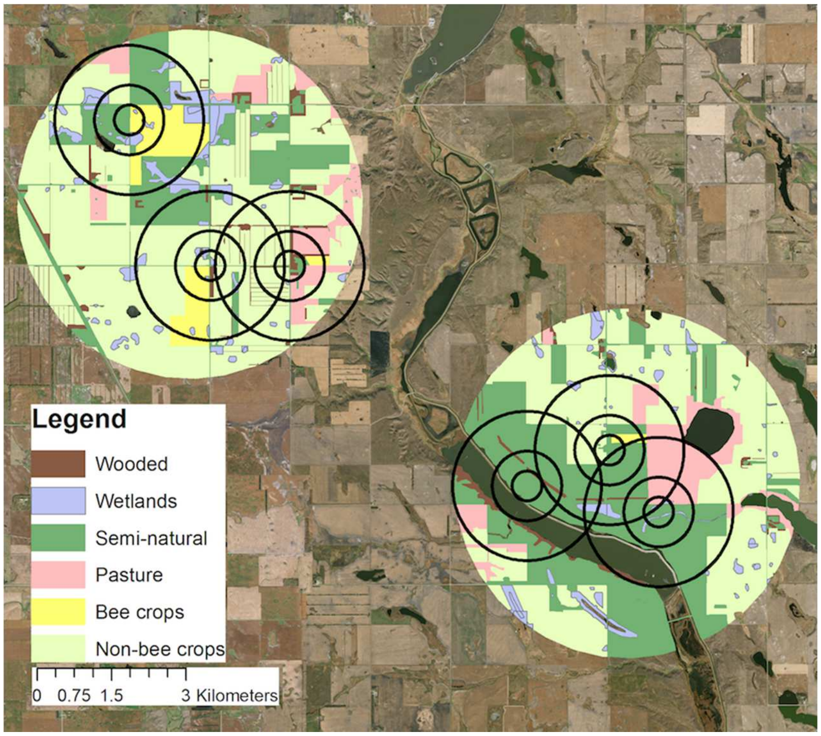

Figure 2-2. Examples of survey locations showing radii of examined land use at two out of six sites. Land use was summarized within 1500 m, 700 m, and 300 m of survey locations as denoted by black circles. Wooded included shelterbelts and flowering trees. Wetlands included ephemeral wetlands and cattails. Semi-natural included CRP and grasslands. Pasture included actively, or recently grazed lands. Bee crops included alfalfa, canola, and sunflower. Non-bee crops included corn, soybean, wheat, and oats.

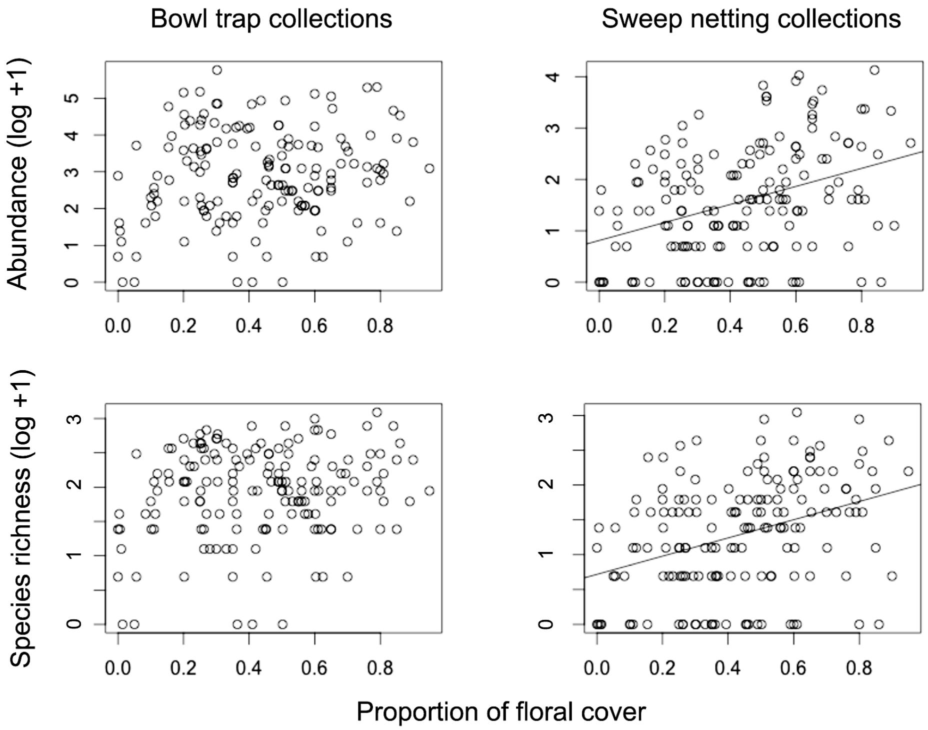

Figure 2-3. The number of bees and bee species collected increased with the proportion of floral cover for sweep netting collections but not bowl trap collections. Proportion of floral cover had no effect on abundance (Estimate = 0.45, 95% CI = -0.22 – 1.13, R^2_{marg}= 0.09, R^2_{cond}= 0.61) or species richness (Estimate =1.72, 95% CI=-0.75 – 4.20, R^2_{marg}= 0.13, R^2_{cond}= 0.51) of bees from bowl traps. Proportion of floral cover positively affected abundance (Estimate = 0.82, 95% CI= 0.16 – 1.48, R^2_{marg}= 0.14, R^2_{cond}= 0.34) and species richness (Estimate = 0.63, 95% CI = 0.13 – 1.13, R^2_{marg}= 0.14, R^2_{cond}= 0.34) of bees from sweep netting. A mixed effects linear model was used with bee abundance and species richness measures as response variables, estimated proportion of floral cover and year as fixed effects, and sampling round and survey location as random effects. Bee abundance and species richness measures were log-transformed to correct for skew. Floral abundance at each collection site was estimated using measures obtained from floral assessments at bee survey locations in 2011 and 2012 and was summarized as the proportion of total cover of blooming plants. Marginal and conditional pseudo R^2 values are reported as determined using R-package MuMIn (Bartoń 2015).

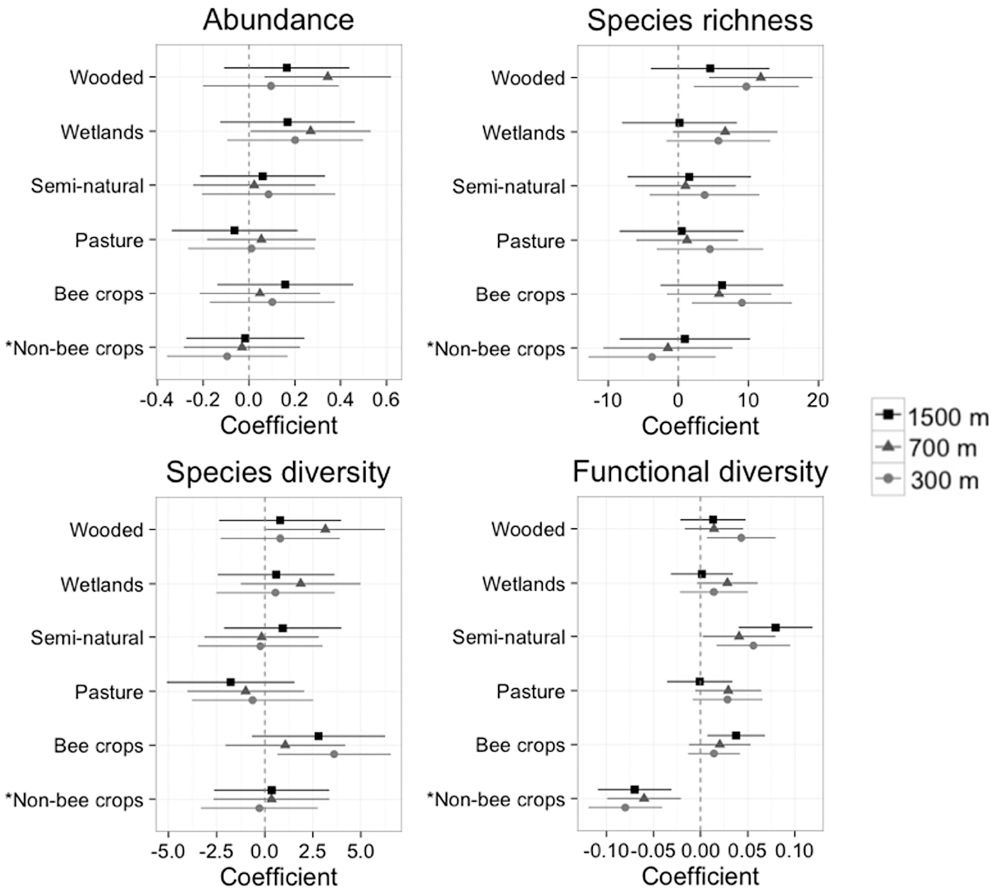
Abundance
Species richness
Species diversity
Functional diversity
Wooded
Wetlands
Semi-natural
Pasture
Bee crops
*Non-bee crops
-0.4 -0.2 0.0 0.2 0.4 0.6
-10 0 10 20
-5.0 -2.5 0.0 2.5 5.0
-0.10 -0.05 0.00 0.05 0.10
Coefficient
1500 m
700 m
300 m

Figure 2-4. Bee community measures and land use. Coefficients of fixed effect variables with 95% confidence intervals (CI) from mixed-effect models with proportion of land use at varying distances from collection locations. Effects of land use variables are significant when the 95% CI does not cross zero. All models are presented as standardized z-scores. *Separate single-effect models were constructed for non-bee crops. Models for abundance were based on a negative binomial distribution and all others on normal distribution. Abundance was total number of bees collected at each survey location each year using sweep netting. Species richness was 1st-order jackknife estimation using bowl trap and sweep netting collections. Species diversity was exponential Shannon's index of diversity using sweep netting collections. Functional diversity was functional dispersion, a multivariate measure of diversity of functional traits using sweep netting collections.

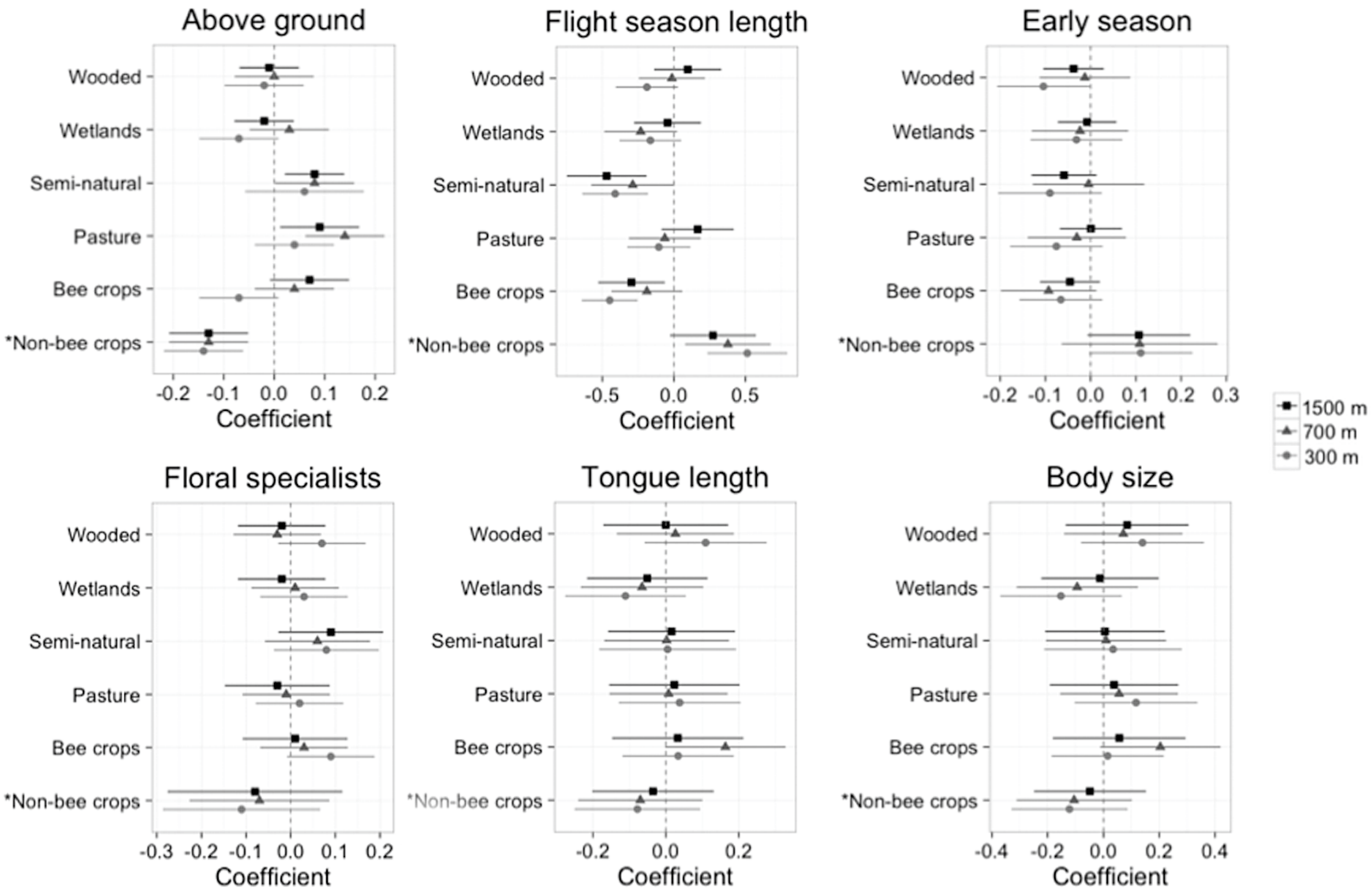
Above ground
Flight season length
Early season
Floral specialists
Tongue length
Body size
Wooded
Wetlands
Semi-natural
Pasture
Bee crops
*Non-bee crops
Coefficient
-0.2 -0.1 0.0 0.1 0.2
-0.5 0.0 0.5
-0.2 -0.1 0.0 0.1 0.2 0.3
-0.3 -0.2 -0.1 0.0 0.1 0.2
-0.2 0.0 0.2
-0.4 -0.2 0.0 0.2 0.4
1500 m
700 m
300 m

Figure 2-5. Bee functional traits and land use. Coefficients of fixed effect variables with 95% confidence intervals (CI) for community weighted means of bees exhibiting particular traits from mixed-effect models with proportion of land use at varying distances from collection locations. Effects of land use are considered significant when the 95% CI does not cross zero. Models are presented as standardized z-scores using only sweep netting collection data. *Separate single-effect models were used for non-bee crops. Above-ground nesters include bees making nests in cavities, stems, or in clumps of grass at the ground surface. Flight season length is the number of months bees are actively foraging. Early season bees include bees active before mid-June. Floral specialists are reliant on a limited range of floral resources. Tongue length and body size were based on inter-tegular distances. Proportions of floral specialists and above-ground nesters were log transformed.

2.6 Tables

Land use	Disturbance	Floral cover	Cover in study area
Wooded: Shelter belts and woods	Low	Low (<0.01%)	2%
Wetlands: Ephemeral wetlands and cattails	Low	Low (<0.01%)	5%
Open water	Low	Low (<0.01%)	8%
Semi-natural: CRP and grasslands	Low	Moderate (3%)	11%
Hay land: Non-alfalfa hay land	Moderate	Moderate (3%)	4%
Pasture: Grazed land	Moderate	High (9%)	12%
Potential bee forage crops: Canola, sunflower, alfalfa	Moderate to high	High (56%)	1%
Other crops: Soybean, corn, wheat	High	Low (<0.01%)	55%
Ruderal land: fallow and ditches	Moderate to high	Low (<1%)	3%

Table 2-1. Land use categories and the degree of disturbance, estimated floral cover, and total land cover within 3.2 km of all six sites. Floral cover was estimated by USGS technicians during site visits made throughout the growing season and included broad estimates of cover of commonly occurring flowers.

	1500 m			700 m			300 m		
	Min %	Max %	Mean %	Min %	Max %	Mean %	Min %	Max %	Mean %
Floral cover	1	83	22	0	100	25	0	100	23
Wooded	0	6	22	0	11	2	0	26	4
Open water	0	22	4	0	30	4	0	4	0
Wetlands	0	22	5	0	18	4	0	29	5
Semi-natural	0	65	18	0	92	22	0	90	24
Hay land	0	13	3	0	33	6	0	42	5
Pasture	0	67	12	0	83	7	0	9	8
Bee crops	0	23	7	0	39	1	0	41	2
Other crops	5	91	50	0	93	50	0	100	46
Ruderal	1	77	18	0	93	18	0	98	20

Table 2-2. Minimum, maximum, and mean percent cover of floral cover and land uses surrounding bee survey locations at 1500 m, 700 m, and 300 m. Floral cover was estimated by USGS technicians during site visits made throughout the growing season and included estimates of cover of commonly occurring flowers. Measures of floral cover and land use were summarized over the three years of the study and the 18 survey locations.

Functional trait	**Categories or unit of measure**	**Source of data**	**Percent of total abundance for categorical traits or mean ± standard deviation for continuous traits**
Nesting habit	Below ground, above ground, cleptoparasitic	(Hobbs 1966; Hobbs 1967; Hobbs 1968; Michener 2000; Sheffield et al. 2008)	Below 77%, Above 22%, Cleptoparasitic 1%
Active season length	Number of months	2010 to 2012 collections and historic collections	Mean 3.3 months ± SD 1.6 months
Active season	Early, mid, late	2010 to 2012 collections and historic collections	Early 78%, Mid 94%, Late 93%
Floral specialization	Polylectic, oligolectic	(Robertson 1926; Hurd et al. 1980; Wolf & Ascher 2008)	Polylectic 78%, Oligolectic 22%
Tongue length	Combined length of tongue, glossa, and prementum	Based on inter-tegular distances of 2010 to 2012 collections using BeeIT package (Cariveau et al. 2016)	Mean 2.8 mm ± SD 1.8 mm
Bee size	Inter-tegular distance	2010 to 2012 collections	Mean 1.8 mm ± SD 0.7 mm

Table 2-3. Traits used to assess functional diversity of bee communities. Nesting habit, categorized as below ground, above ground, or cleptoparasitic, was derived from literature. Active season length is the number of months during which adults were active. Early season bees were active before June, mid-season bees were active in June and July, late season bees were active after July. Floral specialization was categorized as polylectic, visiting a wide variety of floral hosts, or oligolectic, visiting a limited range of floral hosts. Tongue length was the combined length of the tongue, glossa, and prementum. Bee size was the inter-tegular distance. Only data from sweep netting collections were included in functional trait measures.

Bee family	Bee species	Total	Sweep netting	Bowl trap	Proportion from bowl trap
Halictidae	*Lasioglossum* cf. *novascotiae*	1761	165	1596	0.91
Halictidae	*Lasioglossum pruinosum*	1569	42	1527	0.97
Halictidae	*Halictus confusus*	1511	153	1358	0.90
Halictidae	*Lasioglossum albipenne*	1251	116	1135	0.91
Halictidae	*Lasioglossum semicaeruleum*	1020	151	869	0.85
Halictidae	*Lasioglossum zonulum*	878	13	865	0.99
Apidae	*Melissodes trinodis*	692	187	505	0.73
Halictidae	*Lasioglossum admirandum*	507	46	461	0.91
Halictidae	*Lasioglossum sagax*	494	53	441	0.89
Apidae	*Melissodes agilis*	431	50	381	0.88

Table 2-4. Ten most frequently collected bee species. Total numbers of the ten most frequently collected bee species collected over the duration of study as well as total from sweep netting, bowl traps, and the proportion collected from bowl traps.

	1500 m		**700 m**		**300 m**	
Abundance	AIC=471.1		AIC=465.8		AIC=471.2	
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Wooded	0.17	-0.11 – 0.44	**0.34**	**0.07** – **0.62**	0.10	-0.20 – 0.39
Wetlands	0.17	-0.13 – 0.46	**0.27**	**0.01** – **0.53**	0.20	-0.10 – 0.50
Semi-natural	0.06	-0.21 – 0.33	0.02	-0.24 – 0.29	0.09	-0.21 – 0.38
Pasture	-0.06	-0.34 – 0.21	0.05	-0.18 – 0.29	0.01	-0.27 – 0.29
Bee crops	0.16	-0.14 – 0.46	0.05	-0.21 – 0.31	0.10	-0.17 – 0.37
	AIC=571.8		AIC=571.8		AIC=571.3	
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Non-bee crops	-0.02	0.15 - 0.12	-0.03	-0.28 – 0.22	-0.10	-0.36 – 0.17
Species richness	R^2_{marg}= 0.06	R^2_{cond}= 0.19	R^2_{marg}=0.20	R^2_{cond}=0.23	R^2_{marg} =0.16	R^2_{cond}
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Wooded	4.49	-1.42 – 10.41	**8.07**	**2.58 – 13.56**	**6.19**	**0.50 – 11.87**
Wetlands	1.11	-4.54 – 6.76	5.04	-0.47 – 10.56	3.58	-2.06 – 9.23
Semi-natural	0.38	-5.31 – 6.06	-0.41	-5.68 – 4.86	1.53	-4.41 – 7.48
Pasture	-0.13	-6.33 – 6.07	0.52	-4.87 – 5.91	2.32	-3.45 – 8.09
Bee crops	5.24	-1.21 – 11.69	4.05	-1.47 – 9.58	**5.96**	**0.54 – 11.37**
	R^2_{marg}=0.06	R^2_{cond}=0.18	R^2_{marg}=0.05	R^2_{cond}=0.16	R^2_{marg} =0.06	
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Non-bee crops	1.33	-5.12 – 7.77	-0.52	-6.89 – 5.86	-1.82	-8.10 – 4.45
Jack one estimate	R^2_{marg}=0.07	R^2_{cond}=0.25	R^2_{marg}=0.22	R^2_{cond}=0.29	R^2_{marg}=0.24	R^2_{cond}=0.24
	ß	***CI***	***ß***	***ß***	***ß***	***CI***
Wooded	4.57	-3.87 – 13.02	**11.79**	**4.40 – 19.17**	**9.71**	**2.22 – 17.19**
Wetlands	0.19	-8.00 – 8.39	6.71	-0.72 – 14.15	5.74	-1.69 – 13.18
Semi-natural	1.59	-7.22 – 10.41	1.06	-6.10 – 8.21	3.78	-4.05 – 11.60
Pasture	0.50	-8.34 – 9.33	1.27	-5.99 – 8.54	4.53	-3.07 – 12.12
Bee crops	6.25	-2.51 – 15.02	5.84	-1.61 – 13.28	**9.09**	**1.95 – 16.22**
	R^2_{marg}=0.04	R^2_{cond}=0.24	R^2_{marg}=0.04	R^2_{cond}=0.23	R^2_{marg} =0.06	R^2_{cond}=0.22
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Non-bee crops	1.66	-14.44 –	-2.15	-15.78 – 11.47	-6.03	-20.65 – 8.59
Exp *H’*	R^2_{marg}=0.05	R^2_{cond}=0.07	R^2_{marg}=0.10	R^2_{cond}=0.10	R^2_{marg}=0.11	
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Wooded	0.80	-2.37 – 3.97	**3.15**	**0.06 – 6.25**	0.80	-2.30 – 3.91
Wetlands	0.59	-2.44 – 3.62	1.87	-1.24 – 4.98	0.56	-2.52 – 3.63
Semi-natural	0.93	-2.12 – 3.98	-0.17	-3.14 – 2.81	-0.23	-3.48 – 3.01
Pasture	-1.78	-5.10 – 1.55	-0.99	-4.03 – 2.05	-0.63	-3.78 – 2.51
Bee crops	2.79	-0.67 – 6.25	1.06	-2.05 – 4.18	**3.61**	**0.65 – 6.56**
	R^2_{marg}=0.001	R^2_{cond}=0.02	R^2_{marg}=0.001	R^2_{cond}=0.02	R^2_{marg}=0.001	R^2_{cond}=0.03
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Non-bee crops	0.36	-2.64 – 3.36	0.35	-2.66 – 3.36	-0.28	-3.31 – 2.75

continues

	1500 m		700 m		300 m	
FDis	R^2_{marg}=0.34	R^2_{cond}=0.73	R^2_{marg}=0.19	R^2_{cond}=0.60	R^2_{marg}=0.19	
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Wooded	0.02	-0.02 – 0.05	0.01	-0.02 – 0.04	0.05	0.01 – 0.08
Wetlands	-0.01	-0.04 – 0.03	0.02	-0.02 – 0.05	0.01	-0.02 – 0.05
Semi-natural	**0.07**	**0.03 – 0.11**	**0.04**	**0.001 – 0.08**	**0.05**	**0.01 – 0.09**
Pasture	0.00	-0.03 – 0.04	0.02	-0.01 – 0.06	0.03	-0.01 – 0.06
Bee crops	0.02	-0.01 – 0.05	0.02	-0.01 – 0.05	0.01	-0.02 – 0.03
	R^2_{marg}=0.31	R^2_{cond}=0.68	R^2_{marg}=0.29	R^2_{cond}=0.68	R^2_{marg}=0.39	R^2_{cond}=0.69
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Non-bee crops	**-0.07**	**-0.11 – -0.03**	**-0.06**	**-0.10 – -0.03**	**-0.08**	**-0.11 – -0.04**

Table 2-5. Bee community measures and land use. Estimates and 95% confidence intervals from generalized linear mixed effects models for effects of land uses on bee community measures with land use surrounding survey locations at 1500 m, 700 m, and 300 m. Models for non-bee crops were run separately. All models are presented as standardized z-scores. Species richness and Jack-one estimate include data from bowl trap and sweep netting collections. Abundance, species diversity (Exp *H'*), and functional diversity (FDis) include data from sweep netting collections. Values in bold have 95% confidence intervals that do not not include zero. Marginal and conditional R^2 values are provide for model evaluation for models run with normal-error distributions and AIC values are provided for models run with negative binomial error distributions.

	1500 m		700 m		300 m	
Bee size	R^2_{marg}=0.13	R^2_{cond}=0.26	R^2_{marg}=0.18	R^2_{cond}=0.29	R^2_{marg}=0.20,	R^2_{cond}=0.33
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Wooded	0.08	-0.14 – 0.30	0.07	-0.14 – 0.28	0.14	-0.08 – 0.36
Wetlands	-0.01	-0.22 – 0.20	-0.09	-0.31 – 0.12	-0.15	-0.37 – 0.07
Semi-natural	0.01	-0.21 – 0.22	0.01	-0.21 – 0.22	0.03	-0.21 – 0.28
Pasture	0.04	-0.19 – 0.27	0.06	-0.16 – 0.27	0.12	-0.10 – 0.34
Bee crops	0.06	-0.18 – 0.29	0.2	-0.01 – 0.42	0.02	-0.19 – 0.22
	R^2_{marg}=0.11	R^2_{cond}=0.11	R^2_{marg}=0.15	0. R^2_{cond}=18	R^2_{marg}=0.10	R^2_{cond}=0.10
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Non-bee crops	-0.05	-0.25 – 0.15	-0.11	-0.31 – 0.10	-0.12	-0.33 – 0.09

Table 2-6. Bee functional traits and land use. Estimates and 95% confidence intervals for effects of land uses on the community weighted trait mean with land use surrounding survey sites at 1500 m, 700 m, and 300 m from generalized linear mixed effects models including data from sweep netting collections. Models for non-bee crops were run separately. Trait values for above ground nesting bees and floral specialists were log transformed. All models are presented as standardized z-scores. Values in bold have 95% confidence intervals that do not include zero. Marginal and conditional R^2 values are provide for model evaluation.

	1500 m		700 m		300 m	
Abundance	R^2_{marg}=0.16	R^2_{cond}=0.16	R^2_{marg}=0.16	R^2_{cond}=0.16	R^2_{marg}=0.11	R^2_{cond}=0.11
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Wooded	0.09	-0.33 – 0.51	0.25	-0.17 – 0.67	-0.02	-0.46 – 0.42
Wetlands	0.24	-0.16 – 0.64	0.26	-0.16 – 0.69	0.19	-0.25 – 0.62
Semi-natural	-0.32	-0.72 – 0.09	-0.3	-0.70 – 0.10	-0.20	-0.66 – 0.26
Pasture	-0.20	-0.64 – 0.24	-0.15	-0.56 – 0.27	-0.12	-0.57 – 0.33
Bee crops	-0.03	-0.48 – 0.43	-0.12	-0.54 – 0.31	-0.01	-0.43 – 0.41
	R^2_{marg}=0.16	R^2_{cond}=0.16	R^2_{marg}=0.	R^2_{cond}=0.12	R^2_{marg}=0.	R^2_{cond}=0.12
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Non-bee crops	**0.45**	**0.06 – 0.84**	0.33	-0.07 – 0.73	0.32	-0.09 – 0.72
Exp *H’*	R^2_{marg}=0.05	R^2_{cond}=0.07	R^2_{marg}=0.	R^2_{cond}=0.10	R^2_{marg}=0.	R^2_{cond}=0.11
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Wooded	0.42	-2.48 – 3.33	2.52	-0.17 – 5.20	1.60	-1.13 – 4.33
Wetlands	-0.52	-3.30 – 2.26	2.34	-0.44 – 5.13	0.88	-1.82 – 3.58
Semi-natural	0.52	-2.37 – 3.41	0.65	-2.37 – 3.67	-0.26	-3.32 – 2.80
Pasture	1.50	-1.44 – 4.45	1.9	-0.91 – 4.71	0.55	-2.18 – 3.28
Bee crops	1.29	-1.67 – 4.24	0.75	-2.03 – 3.52	**3.25**	**0.80 – 5.70**
	R^2_{marg}=0.00	R^2_{cond}=0.02	R^2_{marg}=0.	R^2_{cond}=0.02	R^2_{marg}=0.	R^2_{cond}=0.03
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Non-bee crops	-0.67	-3.09 – 1.75	-0.42	-2.87 – 2.03	-0.76	-3.21 – 1.68

Table 2-7. Bee community measures and land use with inclusion of sweep netting and bowl trap data. Estimates and 95% confidence intervals from generalized linear mixed effects models for effects of land uses on bee community measures with land use surrounding survey locations at 1500 m, 700 m, and 300 . Models for non-bee crops were run separately. All models are presented as standardized z-scores. Values in bold have 95% confidence intervals that do not include zero. Marginal and conditional R^2 values are provided for model evaluation.

		M. alba/officinalis	*S. oleraceus*	*G. squarossa*
	Total bee abundance	**305**	**247**	**140**
	Total bee species richness	**46**	**45**	**30**
Colletidae	*Colletes kincaidii*	4	0	0
	Colletes lutzi lutzi	1	0	0
	Hylaeus sp. *affinis* group	10	6	4
	Hylaeus leptocephalus	2	0	0
	Hylaeus mesillae	3	0	9
Andrenida	*Andrena chromotricha*	2	6	2
	Andrena commoda	5	0	0
	Andrena helianthi	0	4	0
	Andrena lupinorum	4	0	0
	Andrena nubecula	0	2	0
	Andrena thaspii	6	1	0
	Andrena virginiana	1	0	0
	Andrena wilkella	3	0	0
	Calliopsis coloradensis	0	0	2
	Perdita albipennis pallidipennis	0	0	1
	Perdita bruneri	0	0	3
	Perdita octomaculata	1	1	29
	Pseudopanurgus nebrascensis	0	0	1
	Pseudopanurgus renimaculatus	0	1	4
	Pseudopanurgus simulans	1	9	1
Halictidae	*Agapostemon texanus*	1	0	1
	Agapostemon virescens	3	1	3
	Agapostemon texanus	1	0	1
	Agapostemon virescens	3	1	3
	Dufourea marginata	3	10	2
	Halictus confusus	45	7	5
	Halictus ligatus	0	2	10
	Halictus rubicundus	2	1	0
	Lasioglossum acuminatum	2	0	0
	Lasioglossum admirandum	4	2	2
	Lasioglossum albipenne	34	10	4
	Lasioglossum cf. *ellisiae*	0	3	0
	Lasioglossum cf. *ephialtum*	2	2	0
	Lasioglossum cf. *novascotiae*	29	23	1
	Lasioglossum laevissimum	0	1	0
	Lasioglossum leucozonium	0	8	0
	Lasioglossum lineatulum	1	0	0
	Lasioglossum occidentale	1	1	0
	Lasioglossum oenotherae	0	1	0
	Lasioglossum packeri	0	1	0
	Lasioglossum paraforbesii	9	1	0
	Lasioglossum perpunctatum	1	1	1
	Lasioglossum pruinosum	12	1	0
	Lasioglossum sagax	11	5	0

continues

		M. alba/officinalis	***S. oleraceus***	***G. squarossa***
contd.	*Lasioglossum semicaeruleum*	37	9	5
	Lasioglossum truncatum	0	1	1
	Lasioglossum versans	1	1	0
	Lasioglossum zonulum	2	5	0
	Sphecodes coronus	1	0	0
	Sphecodes dichrous	0	1	0
	Sphecodes sp. *ranunculi* grp.	1	0	0
Megachilidae	*Ashmeadiella bucconis*	0	0	1
	Heriades carinata	1	0	0
	Hoplitis pilosifrons	1	0	0
	Hoplitis producta	1	1	0
	Megachile brevis brevis	0	1	0
	Megachile latimanus	0	2	3
Apidae	*Bombus bimaculatus*	1	0	0
	Bombus griseocollis	8	14	3
	Bombus huntii	11	3	0
	Bombus ternarius	10	4	0
	Bombus vagans	0	1	0
	Ceratina mikmaqi	9	6	4
	Holcopasites heliopsis	0	0	1
	Melissodes agilis	3	16	2
	Melissodes druriellus	0	0	1
	Melissodes illatus	0	0	2
	Melissodes subillatus	1	1	0
	Melissodes trinodis	12	65	32
	Nomada aquilarum	2	0	0
	Triepeolus helianthi	0	3	0

Table 2-8. Bee species found on the three most visited plants. Total bee abundances and numbers of bee species collected from the three most visited plant species: *Melilotus alba/officinalis, Sonchus oleraceus,* and *Grindelia squarrosa.*

		Medicago sativa	***Brassica rapa***	***Helianthus annuus***
Bee family	Total bee species collected from flower	14	11	10
Colletidae	*Colletes kincaidii*	x	-	-
	Hylaeus sp. *affinis* group	x	x	-
	Hylaeus mesillae	-	x	x
Andrenidae	*Andrena accepta*	-	-	x
	Andrena helianthi	-	-	x
	Andrena lupinorum	x	-	-
Halictidae	*Agapostemon texanus/angelicus*	-	x	-
	Dufourea marginata	-	-	x
	Halictus confusus	-	x	-
	Halictus ligatus	-	-	x
	Lasioglossum admirandum	x	-	-
	Lasioglossum albipenne	x	-	-
	Lasioglossum cf. *novascotiae*	x	x	-
	Lasioglossum pectorale	-	x	-
	Lasioglossum perpunctatum	x	x	-
	Lasioglossum pruinosum	x	x	-
	Lasioglossum sagax	x	-	-
	Lasioglossum semicaeruleum	x	x	x
	Lasioglossum versans	x	-	-
	Lasioglossum zonulum	-	x	-
Megachilidae	*Megachile latimanus*	x	-	-
Apidae	*Bombus griseocollis*	x	-	x
	Bombus rufocinctus	-	-	x
	Ceratina mikmaqi	-	x	-
	Melissodes agilis	-	-	x
	Melissodes subillatus	x	-	-
	Melissodes trinodis	-	-	x

Table 2-9. Total bee species numbers and individual bee species collected from bee forage crops during sweep netting surveys.

Chapter 3 .

Do honey bees (*Apis mellifera*) and wild bees (Apoidea) respond differently to pollinator habitat in agricultural areas?

Summary

Concerns over loss of wild bee biodiversity and continuing problems with colony loss in commercial honey bee operations have prompted actions to create and maintain pollinator friendly landscapes. This study examined wild bee abundance and diversity in 18 locations near six apiaries containing commercially managed honey bee colonies that were being monitored for health and survivorship as part of a different study. Wild bee communities and surrounding land uses at radii of 1500 m, 700 m, and 300 m from bee survey locations were assessed over three years. In all, 13,426 bees representing 149 species, morpho-species, or species groups were included in this analysis. Due to the primacy of floral resources to the success of all bees, it was hypothesized that honey bee and wild bee success measures would have similar responses to land use. Specifically, we tested if honey bees and wild bees had increased measures of success in locations surrounded by semi-natural lands and crops providing bee forage, which are rich in floral resources. Semi-natural lands included pasture, grasslands, cost-share conservation lands (CRP), and wooded areas. Bee forage crops included canola, sunflower, and alfalfa. Honey bee colonies had higher honey production and annual colony survival when surrounded by semi-natural land. Wild bee functional diversity, indicating greater stability of bee communities, was significantly greater at all observed scales in locations surrounded by higher proportions of semi-natural lands. Species diversity of wild bees and the number of floral specialists, a group of special concern for conservation, were significantly greater with increased areas of crops providing bee forage at the 300 m scale. Honey production by honey bee colonies also increased with increasing amounts of bee forage crops within 500 m. According to expectation, honey production was positively correlated with wild bee abundance and species diversity at all sites, indicating that the two bee groups had similar responses to site characteristics. Contrary to

expectation honey bee colony survival was not correlated with any measures of wild bee success, but the survival of commercially managed colonies is influenced by beekeeper management and transportation of colonies out of the area over the winter months. The association of semi-natural lands with honey bee survival, honey production, and wild bee community stability, and the association of crops providing bee forage with species diversity, floral specialists, and honey production show the potential for these lands to support both honey bees and wild bees. Pollinator habitat efforts should focus both on planting flowers for all bees and on retaining and enhancing habitat elements that provide nesting habitat for wild bees.

3.1 Introduction

Declines in managed honey bee health (vanEngelsdorp & Meixner 2010; Lee et al. 2015) along with declines in wild pollinator populations (Biesmeijer et al. 2006; National Academy of Sciences 2007; Brown & Paxton 2009; Winfree 2010; Colla et al. 2012; Burkle et al. 2013; Senapathi et al. 2015) have prompted action to create and maintain pollinator friendly landscapes. Efforts to answer questions about landscapes best supporting pollinators often focus on either wild pollinators (Hinners & Hjelmroos-Koski 2009; Winfree, Bartomeus, et al. 2011; Lowenstein et al. 2012; Loos et al. 2014; Hopfenmüller et al. 2014) or honey bees (Couvillon et al. 2014; Gallant et al. 2014). As there is concern about both the decline of wild bees and the health of managed honey bee colonies and they broadly co-occur, it is important to identify landscapes that contribute to bees' success, be they native or non-native, wild or managed. Concurrent assessment of honey bees and wild bee pollinator success in landscapes where they co-occur will help answer questions about how best to support both groups.

The European honey bee, *Apis mellifera*, is unique among bees in its relationship with people. There are several other bee species that are managed, but none to the extent of the honey bee. Agricultural producers are reliant on commercial beekeepers to produce sufficient numbers of honey bee colonies for pollination of many crops (Southwick & Southwick 1992). Annual losses of honey bee colonies continue to severely impact the U.S.beekeeping industry (Lee et al. 2015). These losses are caused by a number of interacting factors including pests, diseases, nutrition, pesticides, and socioeconomic factors (vanEngelsdorp & Meixner 2010). The ability of beekeepers to replace lost colonies in part depends on availability of floral resources to support colony development (Naug & Gibbs 2009; Odoux et al. 2012; Sponsler & Johnson 2015; Smart et al. 2016a). Providing habitat to support commercial honey bee colonies can positively impact honey bee health, enabling commercial beekeepers to provide agricultural producers with required pollination services (Smart et al. 2016a).

Wild bees are also important crop pollinators (Winfree et al. 2008; Isaacs & Kirk 2010; Winfree, Gross, et al. 2011), contributing significantly to global crop production, though their contribution is often unrecognized (Garibaldi et al. 2013). In addition, wild bees are also important pollinators of wild flowers (Biesmeijer et al. 2011; Burkle & Alarcón 2011). Because of their role as pollinators of wild flowers, supporting wild bee populations is a key concern for managers of native landscapes, particularly in the Holarctic and Australia where honey bees are not native. While wild bee conservation efforts often focus on restoring native habitat (Hopwood 2008; Harmon-Threatt & Hendrix 2015), the agricultural landscapes that dominate the globe also have potential to provide habitat for wild bees (M’Gonigle et al. 2015; Kremen & M’Gonigle 2015).

Programs to expand pollinator habitat are being implemented at local, regional, and national levels. Recent federal mandates in the U.S.call for expanded habitat for honey bees and wild bees as well as butterflies (The White House n.d.). Some habitat guidelines focus exclusively on providing habitat for honey bees as a means to help commercial colonies remain viable, such as USDA EQIP Honey Bee Practices (Pollinator Health Task Force 2015), The Bee Buffer Project (http://www.pollinator.org/beebuffer.htm), and the honey bee seed mixes from the Honey Bee and Monarch Butterfly Partnership (http://projectapism.org). Other organizations that promote and protect native ecosystems focus exclusively on native or wild bees, including many state natural resource agencies in the U.S., US National Wildlife Refuges, and some agro-environmental schemes in the UK (Defra 2005). Some programs target pollinators in general, such as the USDA NRCS Pollinator Habitat and Pheasants Forever Youth Pollinator Habitat. Regardless how the habitat is targeted, honey bees (managed and feral) and wild bees co-occur in many of these planted areas.

Efforts to provide pollinator habitat involve assumptions about the utility of generalized habitat requirements for a range of organisms. There are known similarities as well as differences between habitat needs of honey bees and other bee species. All bees rely on floral resources as their source of nutrition. Many pollinators respond positively to increasing abundance and diversity of flowering plants (Pywell et al. 2006; Biesmeijer et al. 2006; Carvell et al. 2007). Honey bees have large colonies and need large areas of nectar rich flowers for honey production as well as steady pollen sources over the growing season (Winston 1987). Wild bees as a whole will visit a wider variety of flowers, and as they do not produce honey they do not need as much nectar, but do require copious and diverse pollen sources (Müller et al. 2006; Leonhardt & Blüthgen 2011; Eckhardt et al. 2013). Some bee species collect pollen only from certain species or genera of plants (Cane & Sipes 2006). If these specialist bee species are to be supported by pollinator habitat, it must include the pollen sources on which they rely.

Another important factor affecting wild bee populations, but not affecting honey bee populations, is the availability of diverse, undisturbed nest habitat (Holzschuh et al. 2010; Xie et al. 2013). Although most honey bee colonies present in the northern U.S.are managed colonies that nest in boxes provided by beekeepers, some honey bees form colonies in the wild. These feral colonies prefer specific sizes of cavities (Seeley 1977). Due to the diversity of nesting preferences among wild bees, there is not one simple recommendation to increase nest sites. Globally, roughly 55% of bees form their nest by tunneling in the ground, 30% of bees form their nests in stems or tunnels in wood, 1% nest in pre-existing cavities or undisturbed vegetative debris, and 14% of bees are parasitic, usurping nests of other bees (based on estimates from Cane & Neff 2011). Parasitic bees use all the previous categories for nesting habitats but are dependent on their hosts to establish nests (Michener 2000). Groups of wild bees, such as ground nesting and stem nesting bees, will likely have different responses to land use (Williams et al. 2010). Nesting habitat is often included as a consideration when pollinator habitat includes wild bees, but there are still many questions about methods for creating these habitats and the efficacy of targeting specific nesting habitat requirements. It is assumed that the nesting needs of most bees will be met by providing undisturbed habitat.

There is evidence of negative effects of honey bees on wild bees presumably due to competitive advantages honey bees may have in floral resource competition due to their ability to work as a colony to efficiently exploit floral resources (Thomson 2004; Goulson & Sparrow 2008; Torné-Noguera et al. 2016). These effects may be more pronounced in areas lacking flower-rich habitat (Herbertsson et al. 2016) or under environmental stress such as drought (Thomson 2016). Honey bees may also transmit pathogens to wild bees (Singh et al. 2010; Fürst et al. 2014; McMahon et al. 2015), though there are knowledge gaps concerning the virulence of shared pathogens and whether honey bees or other flower visitors are responsible for the majority of transmission. This study did not examine competitive effects, or examine novel introductions of honey bees to areas housing wild bee communities, but rather focused on areas that already house both honey bees and wild bees to determine effective strategies to provide wild bee habitat that may complement efforts to support honey bees, potentially increasing the overall positive impact of pollinator habitat efforts.

This study was based in the prairie pothole region of North Dakota in the Northern Great Plains of North America, home to many wild bees year round as well as many honey bee colonies during the summer months. In 2013, North Dakota was the top honey producing state in the U.S. with 480,000 honey bee colonies producing over 15 million kilograms of honey valued at over $67 million (National Agricultural Statistics Service, Agricultural Statistics Board, US Department of Agriculture, Mar. 21, 2014, ND Dept. of Agriculture, pers. com. April 17, 2015). Many of the honey bee colonies in North Dakota produce honey in the summer and are transported throughout the country for crop pollination in late winter and early spring. In addition to being important to honey bees, this area in North Dakota is also home to many wild bees with historic records showing around 300 bee species, with the actual number present assumed to be closer to 500 (Stevens 1948a), making this area well suited for an examination of the responses of both honey bees and wild bees to predominantly agricultural landscapes differing in the amount of pollinator friendly habitat.

This three-year study examined success measures of wild bee communities at locations surrounding honey bee apiaries that varied in the amount of land thought to support pollinators: semi-natural land (land in pasture, grasslands, Conservation Reserve

Program, fallow land, roadside ditches, flowering trees and shrubs, and shelterbelts), wetlands (open water, cattails, and ephemeral wetlands), and potential bee forage crops (canola, sunflower, and alfalfa). Criteria used to judge wild bee community success were abundance, species richness, species diversity, functional diversity, and community-weighted means of particular functional traits. The colony response criteria used to judge honey bee success were the number of colonies alive from May of one year to March of the following year and the average amount of honey produced annually, based on an examination honey bee success at the apiaries housed at the same study sites by Smart et al. (2016b).

Two hypotheses were tested. The first prediction was that both wild bees and honey bees would be more successful with increasing areas of semi-natural lands and potential bee forage crops. Previous research has shown that semi-natural lands positively affect wild bee diversity and abundance (Steffan-Dewenter et al. 2002; Westphal et al. 2003; Öckinger & Smith 2006; Le Feon et al. 2010; Hopfenmüller et al. 2014; Riedinger et al. 2015) and support honey bee success (Sponsler & Johnson 2015; Smart et al. 2016b). While little is currently known about effects of wetlands on bee communities, there is some evidence connecting wetland loss with declines in bee abundance, particularly in the mid-western United States (Koh et al. 2015). While it is known that honey bees need a water source to aid colony temperature regulation, evidence of association between honey bees and wetlands in the landscape is lacking. Increased areas of mass-flowering crops have been associated with increases in wild bee abundances (Westphal et al. 2003; Scheper et al. 2014; Riedinger et al. 2015). Crops providing bee forage are known to support honey bees (Ayers & Harman 1992). There is potential for these land uses, particularly semi-natural lands and bee forage crops, to have a positive impact on both wild bee communities and honey bee colonies.

The second prediction was that sites that supported successful honey bee colonies would also support diverse native bee communities. Due to the primacy of floral resource availability to the success of all bees (Potts et al. 2003; Westphal et al. 2003; Naug & Gibbs 2009; Roulston & Goodell 2011; Odoux et al. 2012; Torné-Noguera et al. 2014; Sponsler & Johnson 2015), honey bees and wild bees are likely to have similar responses to land use at the sites. Wild bee communities at sites that supported healthy honey bee colonies and abundant honey production were predicted to be taxonomically and functionally diverse.

3.2 Methods

3.2.1 Study area

This study covered parts of Stutsman, Barnes, and Griggs counties in North Dakota, from latitude 46°57'13"N to 47°16'48" N and longitude 98°1'49" W to 98°56'3"W, within the prairie pothole region of the Northern Great Plains, an area historically of prairie grasslands with many shallow wetlands, known as potholes, created by past glacial activity during the Wisconsin glaciation ~12,000 years ago (Euliss et al. 1999). Many of the potholes are supplied with water only from spring snow melt and so are ephemeral. Currently, the predominant land use in this area is agricultural. More than half of the potholes have been drained and converted to agriculture, but the remaining potholes provide patches of relatively undisturbed land within the agricultural matrix.

3.2.2 Survey locations

Six apiary sites, around which wild bee surveys took place, were chosen based on variation in historic honey production and landscape quality (Fig. 3-1). Honey bee colonies were located at the center of each apiary site and were managed by the same commercial beekeeper and treated for control of diseases (*Nosema* spp.*)* and parasitic mites (*Varroa destructor*). Survey locations were chosen so they were at least 1 km from each other and within 2.5 km of the center of the site to keep the foraging range of most bees within the area of quantified land use (3.2 km) (Fig. 3-2). There was no attempt to place wild bee survey locations outside of the typical 2 km honey bee foraging range (Seeley 1995) to examine wild bee communities not exposed to honey bees due to presence of other nearby apiaries precluding the possibility of distancing bee survey locations away from foraging honey bees. Survey locations were at least 1 km from each other and the apiary site to lessen foraging overlap. Survey locations were chosen based on land access and the presence of floral resources for bees. Most survey locations were along roadside ditches as that was predominantly where floral sources were located. In 2010, there were two bee survey locations within each site, resulting in twelve bee survey locations. In 2011 and 2012, an additional survey location was added at each site resulting in eighteen bee survey locations to better encompass variability in landscape.

3.2.3 Landscape characterization

Each year from 2010 to 2012, a GIS technician from the USGS Northern Prairie Wildlife Research Center in Jamestown, ND surveyed land use within a 3.2 km (2.0 mile) radius of the center of the six locations. The technician visited each apiary site three times (once each spring in May-June, summer in July-early August, and autumn in late August-September) each year to verify land use in the field and this data, in addition to data from the National Agricultural Statistics Survey (NASS), were entered into ArcGIS v.10 for final quantifications of the area of various types of land use within the 3.2-km radius around each site. Additionally, during each visit the surveyor visually assessed and estimated floral cover of the most commonly occurring flowers within each land category around each site including, sweet clover *Melilotus* spp.; alfalfa *Medicago sativa*; gumweed *Grindelia squarrosa*; native sunflower *Helianthus* spp.; sow thistle *Sonchus* spp.; and goldenrod *Solidago* spp. Proprietary CRP data was accessed via an FSA/USGS Interagency Agreement. One site was located inside the Arrowwood National Wildlife Refuge; approximately 75,000 acres of U.S. Fish and Wildlife Service (FWS) land composed primarily of grassland. A special use permit was granted to allow collection of bees on this site. The following land uses were assessed: CRP, soybeans, corn, wheat, legume rich CRP, canola, oil sunflower, alfalfa hayland, shelterbelt, wet wetlands, dry/ephemeral wetlands, flowering trees/shrubs, grassland, cattails, non-alfalfa hayland (non-flowering), pasture, fallow, and ditch.

For examination of land-use effects on honey bee success, land use surrounding the apiary sites was summarized at radii of 3200 m, 2000 m, 1000 m, and 500 m. These distances were chosen based on typical foraging distances documented for honey bee colonies (Visscher & Seeley 1982; Beekman & Ratnieks 2000) as well as possible closer ranges. For examination of effects of land use on wild bee success, land use surrounding the survey locations nested within the sites was summarized at radii of 1500 m, 700 m, and 300 m. These distances were chosen to include foraging ranges for most bees (Zurbuchen et al. 2010). Most (88%) of the bees found in the surveys are predicted to have typical foraging distances less than 300 m, based on use of the R package BeeIT (Cariveau et al. 2016), which used inter-tegular distances to predict foraging distances (Greenleaf et al. 2007) . Almost all (97%) of the bees were predicted to have foraging distances less than 700 m. The remaining bees with longer flight distances were primarily bumble bees, many of which forage within 1500 m of their nests (Westphal et al. 2006; Charman et al. 2010; Hagen et al. 2011). At the 1500 m scale, some survey locations overlapped with each other. It is assumed that this overlap did not bias observed relationships as the area of overlap was a small proportion of the total area examined and the majority of bees would not be foraging towards the edge of the 1500 m buffer. Land within 1500 m of survey locations that fell outside of the radii assessed by USGS technicians was characterized using aerial photographs, ground-truthing, and land use maps provided by the National Agricultural Statistics Service (USDA-NASS 2015).

Land-use factors were combined into the same groupings used by Smart et al. (2016b) for their analysis of land-use effects on survival and productivity of honey bee colonies: semi-natural land (pasture land, grassland, CRP, hay land, ditch, fallow land, flowering trees and shrubs, and shelterbelt), wetlands (open water, ephemeral wetlands, and cattails), bee crops (oil canola, oil sunflower, and alfalfa) (Table 3-1). This analysis included an addition land-use grouping due its predominance in the region: soy and corn (predominantly soybeans, corn, and wheat with small amounts of oats).

3.2.4 Survey methods

Bees were surveyed between May and September, once every three weeks at twelve survey locations in 2010, for a total of six sampling rounds per survey location, and once every four weeks at eighteen locations in 2011 and 2012, for a total of five sampling rounds per survey location. Due to logistic constraints, a compromise was made between the number of survey locations and frequency of sampling rounds, resulting in less frequent sampling in 2011 and 2012. All sites were sampled within three to four days during each sampling round. Due to extreme flooding, several survey locations were inaccessible during the first collection in May of 2011, and those collections were delayed by a week. Two collection methods, sweep netting and bowl traps, were used to maximize the number of species caught and to compensate for variable performance of individual collection methods. Observer bias from sweep netting was minimized by training observers to sweep at a consistent rate, and rotating people among sites. Although bowl traps are both efficient and unbiased in terms of observer bias (Westphal et al. 2008), they have other potential biases. Sweep nets and bowl traps tend to collect different sizes of bees, with larger bees being more frequently captured with sweep nets (Jean 2010). Different bees or different sexes within the same bee species can be attracted to different bowl colors (Leong & Thorp 1999). Previous research has indicated that bowl traps may be less attractive in areas that have greater floral abundance (Jean 2010; Baum & Wallen 2011). This was of particular concern in this study because the apiary sites varied widely in floral abundance.

Each survey location was visited twice a day, once earlier and once later in the day, for sweep netting during each sampling round. The timing of "early" and "late" shifted with the season, with early ranging between 10 a.m. and 1 p.m. and late ranging between 1 p.m. and 6 p.m. Surveys took place when there was no precipitation and the temperature was greater than 15° C. Timers were paused for retrieving insects out of the nets, so that handling time was not included in sweep time. Only bees were collected from the nets. Honey bees were counted and released as were queen bumble bees as both were readily identifiable. When possible, other bees, primarily bumble bees, were also identified to species, counted, and released. Bee collections from sweep netting on specific flowers were kept separate so that floral records could be attached to each specimen. In 2010, a total of 30 minutes of sweep time was spent at each survey location per visit, focusing on blooming flowers. Thus, the area covered in the 2010 surveys varied depending on available floral resources. The area covered during each survey, the currently blooming plants present, and estimated amount of flowers in bloom were recorded. General sweeping methods were similar in 2011 and 2012, but sampling at each site was reduced to 20 minutes, due to the increase in the number of survey locations, and sweep netting took place along a meandering transect. Observers walked at a consistent pace, covering approximately 100 m in 10 minutes with the path of the transect varying over the season to encounter patches of flowers.

In 2010, thirty-six bowl traps were set up at each survey location each collection period. The traps consisted of 200 ml plastic bowls painted either fluorescent blue, fluorescent yellow, or white. These bowls were attached to bamboo stakes so that the bowl was elevated slightly above vegetation height to ensure visibility. The bowls were placed along two orthogonal lines when possible, or along one straight line with 5 m between bowls. There lines were placed along roadside ditches or other open areas. Bowls were filled with a 2% soap solution (Dawn dish soap, Procter &Gamble, Cincinnati, OH) and left out for approximately twenty-four hours. Due to the increase in the number of survey locations, the number of bowls was reduced to twenty-four for 2011 and 2012 to enable timely processing of samples.

Bees were identified to species whenever possible using keys and comparisons with previously identified materials (Mitchell 1960; Laberge 1969; Gibbs 2010; Ascher & Pickering 2015). A subset of bees (5%) was sent to experts (Dr. John Ascher, Joel Gardner, Dr. Jason Gibbs, Dr. Mike Arduser, Sam Droege, Karen Wright) for creation of a synoptic set, confirmation of identifications, and identification of groups for which there were no available keys. Species level identification was not possible in all cases. Ten bee types were identified to species groups (1% of specimens) or as cf. species, meaning that either the species was not well documented from that part of the continent or there were potentially undescribed species that matched the characters of that specimen (14% of all specimens). Most specimens are deposited in the University of Minnesota Insect Collection. A portion of the specimens are in the research collection at the University of Minnesota Bee Lab. All records are databased as will be shared with DiscoverLife and the USGS Pollinator Library.

3.2.5 Wild bee success measures

Wild bee success was measured using several different variables: total bee abundance, species richness, species diversity, functional diversity, and community-weighted means of functional traits. Data used to assess species richness included both sweep netting and bowl trap collections. All other bee success measures were determined using data only from sweep netting collections due to biased performance of bowls in relation to bee abundance and floral cover (Chapter 2). Bee abundance was the total number of bees collected at each survey location summarized over all collection periods each year. Associations of land uses with abundance would indicate effects on overall bee population size.

Species richness was measured as the number of species as well as quantified using two non-parametric estimators to correct for potential bias from patchiness or small sample size. The first, incidence-based coverage estimator (ICE), was chosen for its suitability for diverse groups and ability to deal with patchiness for estimating richness over the entire study area to determine sufficiency of sampling (Gotelli & Colwell 2011; Urrutia-Escobar & Armbrecht 2013). The second non-parametric estimator, first-order jackknife estimation, was chosen because it can control for the confounding effects of sampling effort due to potential bias and smaller sample sizes for estimates at each survey location and year (Walther & Morand 1998). Both non-parametric estimators were calculated using the program EstimateS (Colwell 2013). Associations of land uses with species richness would indicate effects of land use on individual species, with greater species richness indicating an ability to support more bee species.

Effective species diversity, an index including both the number and evenness of species, was quantified using the exponential Shannon's index of entropy in EstimateS version 9 (Colwell 2013). This index takes into consideration the abundance of each bee species, the evenness (how equal the abundances are) of the community, and has the ability to weight bee species by their frequency without disproportionately favoring either rare or common species (Jost 2006). High values indicate that species are more evenly represented in the community. Low values indicate that some species are much more abundant, possibly dominating the community. Associations of land uses with species diversity would indicate effects on the bee community due to effects on abundances of individual species, with more even communities indicating potential for greater stability (McCann 2000).

Functional trait diversity quantifies trait distribution in a community, just as species diversity quantifies the distribution of species. Functional traits are morpho-physio-phenological traits that impact fitness indirectly via their effects on growth, reproduction, and survival, the three components of individual performance (Violle et al. 2007). Differences in functional traits across survey locations were examined to provide additional information on land-use effects on the bee community. Important changes in functional diversity may occur with minimal change in species richness (Cadotte et al. 2011), showing that functional diversity can add information about the impacts of environmental gradients, such as land use. It is important to choose functional traits that are relevant to the ecosystem processes, community structure, or assembly processes under consideration (Nock et al. 2016). The following traits were included in these analyses: nesting habit, duration of seasonal activity, season of active foraging, floral specialization, tongue length, and body size (Table 3-2). This suite of traits represents functional response traits, traits that influence the abilities of species to colonize or thrive in a habitat and to persist in the face of environmental changes, as opposed to functional effect traits, which are a measure of ecosystem services (Diaz et al. 2013) and were chosen because they are important descriptors of bee ecology and can be predictors of bee community stability (Michener 2000; Moretti et al. 2009; Williams et al. 2010; Sheffield et al. 2013; Hopfenmüller et al. 2014; De Palma et al. 2015). Differential responses of bees with different nesting habits can be caused by different disturbance responses. Bees that nest above ground have been found to be negatively affected by agricultural intensity, while bees that nest underground were negatively affected by tilling practices (Williams et al. 2010). Bees with shorter active season duration have been negatively associated with agricultural intensity (De Palma et al. 2015). Bees active early in the season have greater potential susceptibility to negative effects of climate change (Fründ et al. 2013). Floral specialization (Grundel et al. 2010; Weiner et al. 2014), cleptoparasitism as a nesting habit (Sheffield et al. 2013), and longer tongues (particularly for *Bombus*) (Goulson et al. 2008) are traits suggested for use as indicators of bee community health or as traits indicating susceptibility to decline.

Functional diversity quantifies functional trait distribution in a community, just as species diversity quantifies the distribution of species. Functional diversity creates a multi-dimensional space based on the distribution of functional traits and the abundances of species with those traits (Cadotte et al. 2011). If species abundances are distributed with more regularity within the functional space, then that site has higher functional diversity. Lower functional diversity indicates that environmental filters, such as lack of supportive habitat, are important in community assembly. Higher functional diversity indicates the presence of mechanisms enabling a community with diverse traits (Ricotta & Moretti 2011). The distribution of many functional traits included in this study, such as nesting habit and floral specialization, are related to habitat availability. Functional diversity was measured as functional dispersion, an abundance-weighted measure of functional trait diversity that is unaffected by species richness and is less sensitive to species with extreme trait values (Laliberte et al. 2010). Functional dispersion was calculated using the FD package (Laliberte et al. 2010) in R version 3.2.1 (R Core Team 2015) with the following traits: nesting habit, active season, active season duration, floral specialization, and tongue length. Bee size was not included due to its correlation with tongue length. A correction was applied on the species-by-species functional distance matrix to ensure it was Euclidean (Cailliez 1983). Associations of land uses with functional diversity would indicate effects on the trait diversity of the bee community. Positive associations would show that the land use is able to support a bee community that exhibits a broad variety of nesting habits, diets, lengths of active flight seasons, timing of active flight seasons, and body sizes.

In addition to functional dispersion, which summarizes over a suite of traits, the community weighted means, the average of trait values weighted by the relative abundances of each species (Lavorel et al. 2008; Ricotta and Moretti 2011), was calculated for individual functional traits using R package FD (Laliberte et al. 2010). The individual traits used for these analyses were chosen based on previous research indicating their potential sensitivity to land management. The individual traits included in the analysis were above ground nesting, active season duration, early season bees, floral specialists, tongue length, and bee size. Although cleptoparasitism as a nesting habit is suggested as good monitor of bee community health (Sheffield et al. 2013), the low frequency of this nesting habit among the bees of this study (1%) prevented their inclusion as a response variable. Associations of land uses with individual functional traits would indicate effects on bees based on their functional traits, with implications for the mechanisms of land-use effects. For example, if above-ground nesting bees are affected by a land use it indicates that their nesting habitat is impacted by that particular land use.

3.2.6 Statistical analyses

Statistical analyses were performed in R version 3.2.1 (R Core Team 2015).

3.2.6.1 Comparing honey bee and wild bee responses to land use

Land-use effects on honey bee success measures (colony survival and honey production), were obtained from a study conducted concurrently at the same locations (Smart et al. 2016b). Smart et al. (2016b) examined the relationship of measures of honey bee success to the following land uses: (1) semi-natural land, (2) potential bee forage crop land, and (3) wetlands. One additional land use that was not examined in Smart et al. (2016b), soy and corn, was examined in this study due to its predominance in the landscape. Smart et al. (2016b) examined land use at four different scales: within 3200 m, 2000 m, 1000 m and 500 m of the apiary sites. All scales were included in the current study to capture potential variability among different success measures across scales. Linear mixed effects models using lme4 (Bates et al. 2014) were used to examine the relationship between the predictor (area of land use (log-transformed m^2)) and two responses: (1) annual apiary survival (number of colonies surviving out of 24 at each site and year); and (2) apiary honey production (mean kg per year) with site and year specified as random effects as per Smart et al. (2016b). To avoid collinearity of covariates, predictors with variance inflation factors greater than three were removed from models (Zuur et al. 2010). The land-use grouping of soy and corn was removed from models due to collinearity. Single mixed effect models were run with the land-use grouping soy and corn as the predictor to examine effects of this predominant land use. Remaining land-use factors in multiple effect models lacked strong inter-correlations with other land uses. Akaikae's Information Criterion (AICc) was used to compare models, as per Smart et al. (2016b).

The summary measures of wild bee success were abundance, species richness, species diversity, functional diversity, and community weighted means of individual functional traits. Wild bee responses to land use were examined using mixed-effects multiple linear regression models with bee community measures as the response variables, the proportion of surrounding land uses and years as fixed effects, and survey locations nested within apiary sites as a random effect. Bee community variables were summarized for survey location each year, for each year from 2010 to 2012. Diagnostic plots were examined to check for heteroscedasticity and to ensure normality of errors. The response variable abundance was log transformed to meet the assumption of homoscedaticity. Estimates were obtained from models with normal error distributions fit using lme4 version 1.1-9 (Bates et al. 2015). As above, the land-use grouping soy and corn was found to be collinear and was used as a predictor in separate models. Regression predictors were standardized using z-scores with the arm package version 1.8-6 (Gelman & Su 2015) to permit comparison of regression coefficients. Confidence intervals (95%) were used to determine significance of fixed effects. Model fit was assessed with marginal and conditional R^2 values for mixed-effects models via the r.squaredGLMM function in version 1.15.1 of the MuMIn package in R (Nakagawa and Schielzeth 2013; Bartoń 2014; Johnson 2014). The marginal R^2 describes the proportion of variation explained by fixed effects alone, while the conditional R^2 describes the proportion of variation in the data explained by both fixed and random effects (Nakagawa & Schielzeth 2013).

There were several differences between models used to examine land-use effects on honey bee success (Smart et al. 2016b) and those used to examine effects on wild bee success. For wild bee success models, surrounding land uses were summarized as the proportion of surrounding land use. For honey bee success models, land uses were summarized as the log transformed surrounding area (m^2) due to heteroscedascity. Difference in site numbers between honey bees (six apiary sites per year) and wild bees (12 to 18 survey locations per year) were likely the cause of this difference. Wild bee success models specified year as a fixed effect due to a high degree of variability in wild bee success measures among years indicating that variability may not have been sufficiently encompassed with inclusion of three years. Honey bee success models specified year as a random effect as the three years of the study were not particularly unique in rain or temperature.

3.2.6.2 Comparing honey bee and wild bee success at each site

For comparison of relative success of honey bees and wild bees at the six sites, data for all survey locations within 3.2 km of each apiary site were grouped. These include data collected from two survey locations per apiary in 2010 and three survey locations per apiary in 2011 and 2012. Summary measures of wild bee success (abundance, species richness, species diversity, and functional diversity) were calculated for wild bees surveyed at each apiary site each year. The relationship between measures of wild bee success and honey bee success (average annual honey production and overall proportion of surviving honey bee colonies) was assessed using Pearson's correlation coefficient (*r)* with R package Hmisc (Harrell 2015).

Beta diversity was used to examine differences in wild bee species composition between sites due to either species replacement or species loss (Mugurran 2004). The R-package BAT was used to calculate the total beta diversity using the Jaccard dissimilarity index and to separate species replacement, the replacement of some species by others from site to site, and nestedness, a pattern characterised by the poorest site being a strict subset of the richest site elements (Cardoso et al. 2015) using data from sweep netting collections. The relative importance of species replacement and nestedness was expressed as the proportion of total beta diversity explained by nestedness (β-ratio) (Dobrovolski et al. 2012; Si et al. 2015), with higher ratios indicating the importance of local species loss (extirpation) in beta diveristy differences among sites.

3.3 Results

3.3.1 Wild bee measures

Collections using sweep netting and bowl traps yielded 13,426 bees representing 149 species, morpho-species, or species groups. The two non-parametric estimators of species richness (ICE, 71%; Jack1, 75%) showed that bees collected with both methods represented an average of 73% of the estimated minimum number of bee species in the study area. Sampling encompassed a sufficient proportion of potential species to characterize the bee community. Most bees were ground nesting (72% of species, 82% of individuals), polylectic (70% of species, 82% of individuals), and short-tongued, length less than 2.5 mm (60% of species, 70% of individuals). The five most commonly collected species in rank order were *Lasioglossum* cf. *novascotiae*, *L. pruinosum, Halictus confusus*, *L. albipenne*, and *L. semicaeruleum.*

Sweep net collections yielded 2,028 bees, representing 117 species, morphospecies, or species groups. The two non-parametric estimators of species richness (ICE, 57%; Jack1, 60%) showed that the bees collected with sweep netting represented an average of 58.5% of the estimated minimum number of bee species in the study area. Of bees collected using only sweep netting, most bees were ground nesting (73% of species, 77% of individuals), polylectic (69% of species, 78% of individuals), and short-tongued with length less than 2.5 mm (50% of species, 67% of individuals). The five most commonly collected species or species groups in rank order were *Melissodes trinodis*, *Lasioglossum* cf. *novascotiae*, *Halictus confusus*, *L. semicaeruleum*, and *L. albipenne*.

3.3.2 Honey bee success measures related to land use

Smart et al. (2016b) found a positive association between semi-natural land and honey bee annual colony survival at the 3200 m, 2000 m and 1000 m scales (Table 3-3). In addition, they found a positive association between semi-natural land and honey production at the 3200 m scale. They found no significant associations between bee forage crops and any measures of honey bee success, though there was a positive trend of increased honey production at the 500 m scale. Wetlands were negatively associated with honey production at the 3200 m scale. Our analysis of the effect of non-bee forage crops on honey bee success found a significant negative association between non-bee forage crops and honey bee survival at the 3200 m scale.

3.3.3 Wild bee community success measures related to land use

Relationships between bee community measures and land use were examined across three scales: within 1500 m, 700 m, and 300 m of each survey location. Scales for land use were different for examinations of effects on honey bee and wild bee success due to differences in typical foraging distances. All scales were included in these analyses to capture potential variability among different bee community measures. In addition, the scale at which land uses affected bee community measures could inform land management recommendations. Semi-natural lands were positively associated with functional diversity at all scales (Table 3-4). Semi-natural lands were also positively associated with community weighted trait means of above-ground nesting bees at all scales, and bees with shorter active season lengths at the 300 m scale (Table 3-5). Crops providing bee forage were positively associated with species diversity at the 300 m scale (Table 3-4). There was a trend towards positive association between bee crops and functional diversity. Bee crops were also positively associated with community weighted trait means of above-ground nesting bees at the 700 m scale, bees with shorter active season lengths at the 700m and 300 m scales, and floral specialists at the 300 m scale (Table 3-5). Wetlands were not associated with any bee community measures, but were negatively associated with the community-weighted mean for above-ground nesting bees at the 1500 m scale. Crops lacking bee forage were negatively associated with functional diversity at all scales (Table 3-4). Crops lacking bee forage were also negatively associated with community-weighted means for above ground nesting bees at all scales and bees with shorter flight seasons at the 700 m and 300 m scales.

3.3.4 Honey bee and wild bee success at sites varying in bee-friendly habitat

Both honey bee and wild bee success varied among sites and years (Table 3-6). Pearson’s correlations between honey bee and wild bee success measures at each site and year were run to determine if they were correlated. Honey bee colony survival was not correlated with any of the wild bee success measures. In contrast, annual honey production was positively correlated with wild bee abundance and species diversity (Table 3-7).

Examination of the measures of success for honey bees and wild bees as proportions of their maxima for each site with all years together showed similar responses overall (Fig. 3-3). While the site with highest ranking for honey bee success measures (Site 1) was not highest ranked for success measures for wild bees, the site that was second highest ranked for honey bees (Site 2) was the highest ranked site for wild bees. The site that had the worst ranking for honey bee success measures (Site 6) was also the worst ranked site for wild bee diversity as measured by the exponential Shannon index, but other measures of wild bee success varied in terms of which site was the lowest ranked.

Changes in diversity among sites indicated by beta diversity were separated into species replacement and nestedness. Species replacement is characterized by the substitution of species in one site with different species in the other site, while nestedness is characterized by differences in species richness between sites but not differences in the species present at the sites (Carvalho et al. 2012). The relative importance of species replacement and nestedness was expressed as the proportion of total beta diversity explained by nestedness (β ratio) (Dobrovolski et al. 2012; Si et al. 2015). The highest β ratios were found between Sites 2 and 6 and Sites 2 and 4 (Table 3-8). Wild bees had the highest success at Site 2 in terms of abundance, species richness, and species and functional diversity (Fig. 3-3, Table 3-6). Over the three years, wild bees at Sites 4 and 6 had the least success in terms of abundance, species richness, and species diversity in two of the three years. Site 5 had the lowest functional diversity in two of the three years. Among the 41 bee species that were present at Site 2 and absent at Site 4, 17% were cleptoparasites, 7% were above ground nesters, and 41% were oligolectic bees (Table 3-9). Among the 38 species that were present at Site 2 but absent from Site 6, 7% were cleptoparasites, 12% were above ground nesters, and 39% were oligolectic.

3.4 Discussion

Land management to benefit pollinators is currently prioritized at many different levels of jurisdiction including federal, state, and local mandates. While pollinators as a group encompass a wide range of organisms with wide ranging habitat needs, habitat creation often targets one of two groups of pollinators. Commercial honey bee colonies are often a target due to concern over high rates of colony mortality and their importance as crop pollinators. Wild bee communities are also often a target due to concern about declining populations, loss of bee biodiversity, and the cascading effects of bee biodiversity loss due to their importance as plant pollinators. Because both groups broadly co-occur in many areas, particularly agricultural areas that dominate the landscape in most parts of the globe, this study examined the effects of assumed pollinator friendly habitat on the success of both groups to enable land management decisions targeting both groups. This study showed that semi-natural lands including pasture, grasslands, CRP, and wooded areas, as well as crops providing bee forage including canola, sunflower, and alfalfa, supported success of both commercial honey bee colonies and wild bee communities. Retention and enhancement of these land uses in agricultural areas are likely to benefit both bee groups.

Land-use effects on honey bees and wild bees: Semi-natural lands were important for both honey bees and wild bees. Semi-natural lands were associated with greater success for both honey bees (increased colony survival and honey production) and wild bees (increased functional diversity) at all examined scales (300 m to 1500 m for wild bees, 500 m to 3200 m for honey bees). Despite the lack of positive effects seen on other bee success measures including bee abundance, species richness, or species diversity, a positive effect on functional diversity implies bee community stability through support of bees requiring a diverse range of habitat needs. Semi-natural lands included a variety of land uses (pasture land, grassland, CRP, hay land, road side ditches, fallow land, flowering trees and shrubs, and shelterbelts). An analysis of wild bee community responses to narrower land-use categories found that of the land uses in the semi-natural category, CRP, grasslands, and wooded areas, including flowering trees shrubs and shelterbelts, were particularly important (Chapter 2). Changing crop values and incentives have led to decreasing enrollment in CRP, particularly in the Northern Great Plains. For example, the amount of land held in CRP in North Dakota decreased by 55% from peak enrollment of 1,370,000 hectares (3,389,000 acres) in 2007 to 620,000 hectares (1,528,000 acres) in 2015 (U.S. Department of Agriculture 2016). Shelterbelts are also in decline since many shelterbelts in the NGP are remnants from soil conservation efforts during the 1930s and these aging shelterbelts are being removed and not replaced (Marttila-Losure 2013). These land-use changes away from grasslands to bio-fuel crops have been shown to have a negative effect on beekeeping (Otto et al. 2016). Increasing the area of semi-natural lands, such as CRP, grasslands, and wooded areas, within agricultural lands in the prairie pothole region has potential to support both honey bee and wild bee populations.

At a local scale (within 500 m for honey bees and 300 m for wild bees) crops providing bee forage (alfalfa, canola, and sunflower) were associated with greater success for honey bees (a trend towards greater honey production) and wild bees (greater species diversity, greater support of floral specialists, and support of bees with shorter active seasons). The area dedicated to flowering crops known to be used by bees, such as canola, sunflowers, and alfalfa in the Northern Great Plains has significantly declined between 2002 and 2010 and acreage planted in soybean and corn, crops that provide few resources to bees in this region, has dramatically increased (U.S. Department of Agriculture 2013; Gallant et al. 2014). Recent research has shown potential for several cover crops providing bee forage to be used for oil seed production for biofuels (Eberle et al. 2015). Incorporating blooming crops providing floral resources for bees into the agricultural matrix in this region could help support honey production as well as supporting diverse bee communities. Even at extremely low cover in the study area (1%), bee forage crops supported honey production and wild bee communities within 500 m.

Wetlands did not have positive associations for any honey bee or wild bee success measures. Honey production was negatively associated with wetlands, possibly due lack of floral sources in open waters. The community-weighted mean for above ground nesting bees was also negatively associated with wetlands possibly due to lack of nesting habitat in open waters. However, herbaceous wetlands are likely to provide habitat for both honey bees and wild bees (Moroń et al. 2008; Cornman et al. 2015) and their value should not be discounted due to these results.

Acreage dedicated to soybean and corn has steadily increased since 2007 (Gascoigne et al. 2013). If current trends continue, acreage in soybean and corn will continue to increase to the detriment of bee-friendly land uses. These crops were associated with decreased honey bee colony survival and decreased wild bee community stability as measured by functional diversity. When examined individually by community weighted trait means, these crops that lack bee forage had a negative effect on above-ground nesting bees and bees with short active season durations, which supports previous research (Williams et al. 2010; De Palma et al. 2015). The high disturbance and lack of floral resources on this land use likely contributed to negative effects on the wild bee community. With benefits to honey bees and wild bee communities seen when bee forage crops comprised as little as 1% of the landscape, crop diversification to include potential bee forage crops, even at a small scale, such as one acre out of every one hundred, could benefit wild bees.

Site specific responses of honey bees and wild bees: The wild bee community was more diverse and there was an overall greater abundance of bees at sites where honey bees produced more honey. Although colony survival and honey production were correlated (Smart et al. 2016b), there was no correlation between colony survival and examined measures of wild bee success. The lack of correlation of honey bee colony survival with wild bee success measures may be due to the influence of migratory beekeeping on honey bee colony survival, with honey bee colonies being transported out of the sites from roughly October through April, while wild bee populations remained. Greater honey production implies greater nectar resource availability, which is an important resource for all bees. In addition to nectar, pollen is also of key importance for both wild bees and honey bees (Müller et al. 2006; Alaux et al. 2010; Brodschneider & Crailsheim 2010; Leonhardt & Blüthgen 2011; Di Pasquale et al. 2013; Eckhardt et al. 2013; Smart et al. 2016a). Although plants that produce copious nectar do not necessarily produce copious pollen, the most common honey producing plants in this region (*Melilotus officinalis*, *Medicago sativa, Helianthus* spp.) (Ayers & Harman 1992) are known to produce copious pollen and are commonly used by many species of wild bees (Hurd et al. 1980; Benedek 1997; Tepedino et al. 2008). Although nectar and pollen are limited resources, the positive correlation between wild bee abundance and diversity at locations surrounding apiaries with greater annual honey production indicates that when sufficient floral resources are present, commercial honey bees and wild bee communities as a whole can be successful at the same locations. This assessment of bee community success was based on metrics of the bee community as a whole and does not preclude the possibility that some bees, particularly those with greater possibility for resource overlap with honey bees, such as shorter-tongued bumble bees, could be less successful in areas where honey bees are more successful (Thomson 2004; Goulson & Sparrow 2008). This study was not designed to examine this interaction between honey bees and other bees and so cannot be used to assess it as there were no wild bee survey locations not exposed to honey bees.

Examination of the β ratio showed that nestedness (species gain or loss) was the major contributor to differences between the bee communities at the sites with the highest (Sites 2), and lowest (Sites 4 and 6) species richness. The mechanisms that contribute to species loss or gain include selective extinction, colonization, and dispersal limitation (Novotny & Weiblen 2005; Urban et al. 2006; Ulrich et al. 2009). Because there were no major geographical barriers between sites, it is assumed that colonization and dispersal limitation were not important factors in species loss among these sites. Selective local extinction (extirpation) is a likely cause of decreased diversity at the poor sites. The causes of the local extinction include loss of floral and nesting habitat, as well as pesticide use. The loss of cleptoparasitic and oligolectic bees between the sites with the greatest and least success is consistent with the sensitivity of these functional groups to disturbance (Grundel et al. 2010; Sheffield et al. 2013; Weiner et al. 2014). Including floral resources required by oligolectic bees in pollinator habitat plantings and having these plantings dispersed through the landscape so they are available at a local scale would result in greater support for these sensitive groups that are more prone to local extinction.

Conclusions: Similarity in responses of both wild bee communities and commercial honey bee colonies to land use indicates the potential for pollinator friendly habitat initiatives in agro-ecosystems to serve both groups. The semi-natural lands associated with greater success of both honey bees and wild bees included areas rich in floral resources, such as pastures, as well as areas with potentially high quality nesting habitat, such as grasslands and wooded areas. The association of crops providing bee forage with species diversity, floral specialists, and honey production show the potential for crops to support both honey bees and wild bees. Pollinator habitat efforts that focus on planting flowers and on the retention and enhancement of habitat elements that provide nesting habitat are better suited for efforts to support all pollinators.

In an ideal world, there would be large tracts of florally rich native habitat where wild bee communities could thrive. In reality, the vast majority of land is in agricultural production (Foley et al. 2011). In the prairie pothole region in central North America where this study took place, 90% of the land base is in agriculture with a decreasing land areas dedicated to pollinator-friendly agricultural land uses such as CRP and bee-forage crops (Rashford et al. 2011; Gallant et al. 2014). Restoring native grassland habitat is an ideal way to support wild bees, but enhancing habitats that exist within 90% of the land base that can support wild bees has potential to have a much broader impact. Although the bee communities present in agriculturally dominated landscapes are likely to not include the full range of historic biological diversity, these landscapes can house remnants of native bee populations that are in need of preservation. These remnant bee populations could remain in areas where agricultural conversion of much of the land is relatively recent, such as the Northern Great Plains where tracks of native prairie were more common as recently as the last quarter to half century.

There are several risks to wild bees in agricultural areas that need to be addressed before creating habitat to prevent these areas from acting as population sinks rather than population sources. As one of the top producing honey areas in North America, there are few areas in North Dakota that are not home to honey bees during the summer months. While the use of the same habitat by honey bees and wild bees is inevitable, it is not without potential risk for wild bee populations. With shared and limited floral resources, there is potential for honey bees to outcompete other bees, reducing their potential success (Schaffer et al. 1983; Butz Huryn 1997; Harmon-Threatt 2011; Cane & Tepedino 2016). In addition, due to inter-continental as well as international movement of honey bees, honey bee colonies house a wide range pests and pathogens (vanEngelsdorp et al. 2009; vanEngelsdorp & Meixner 2010). There is evidence of pathogens moving from honey bees to wild bees (Singh et al. 2010; Fürst et al. 2014; Goulson & Hughes 2015) presumably through shared flower use (Durrer & Schmid-Hempel 1994; Graystock et al. 2015). While risks to wild bees have yet to be determined for most of these pathogens, there is some evidence that pathogens carried by honey bees have negative effects on other bees (Graystock et al. 2013). When the primary goal of pollinator habitat improvement is conservation of threatened or endangered native pollinators, the exclusion of honey bees from those areas to reduce risk is a reasonable caution. When addressing pollinator habitat needs in agricultural areas that have been housing honey bees for nearly a century, the potential risks of honey bee competition and disease transmission to wild bee populations may be mitigated by ensuring there are abundant and diverse floral resources to avoid competition for scarce resources. In addition, pathogen transmission at shared flowers may be reduced if the abundance of flowers is high enough to reduce the probability of individual flowers being shared; this idea remains to be tested.

An additional risk to all pollinators is the presence of pesticides in agricultural areas, both those used within crops as well as pesticide drift onto areas containing bee forage (Krupke et al. 2012; Hladik et al. 2016; Mogren & Lundgren 2016). While agricultural areas often exhibit higher risk of pesticide exposure than urban areas (Lawrence et al. 2016), there are few areas of the landscape that are truly refuges from pesticide exposure. Rather than excluding globally dominant agricultural lands from efforts to support bees due to risks from pesticide exposure, it would be preferable to take steps to avoid potential contamination of flowering plants and bee communities with pesticides in agricultural lands. Current common practice in many cropping systems is to use pesticides as prophylactic measures rather than applying them when economic thresholds are met (Goulson 2013), including soybean and corn crops that dominate the Northern Great Plains region. More judicious use of pesticides and containment of pesticide drift are important pieces of creating pollinator friendly lands everywhere, but are particularly important in agricultural areas.

Despite these potential risks, it is still possible to create or enhance habitat that can support both honey bees and wild bees. Providing abundant and diverse floral resources reduces the potential for floral resource limitation resulting in negative impacts on wild bees due to floral competition with honey bees. While there are no current solutions for management of potential shared pathogens, the potential advantage to wild bees of inclusion in a broader range of habitat enhancements serves to directly benefit wild bee populations.

Since wild bees are present in most areas where pollinator habitat would be created, consideration for wild bees' needs should be included in all pollinator habitat management. In areas that are home to significant concentrations of honey bee colonies and wild bees, pollinator habitat enhancements including both diverse floral assemblages and measures to conserve or create suitable nesting habitat can serve all bees as well as other pollinators. Support for CRP and other similar cost-share programs can result in increases in pollinator friendly lands within the agricultural matrix through increasing areas of semi-natural lands, benefitting honey bees and wild bees at local as well as at larger scales. Crops diversification to include crops providing bee forage can provide local scale benefits to both honey bees and wild bees. Expansion of these pollinator friendly elements within the agricultural matrix can have broad reaching impacts for both success of honey bee colonies and wild bee community stability.

3.5 Figures

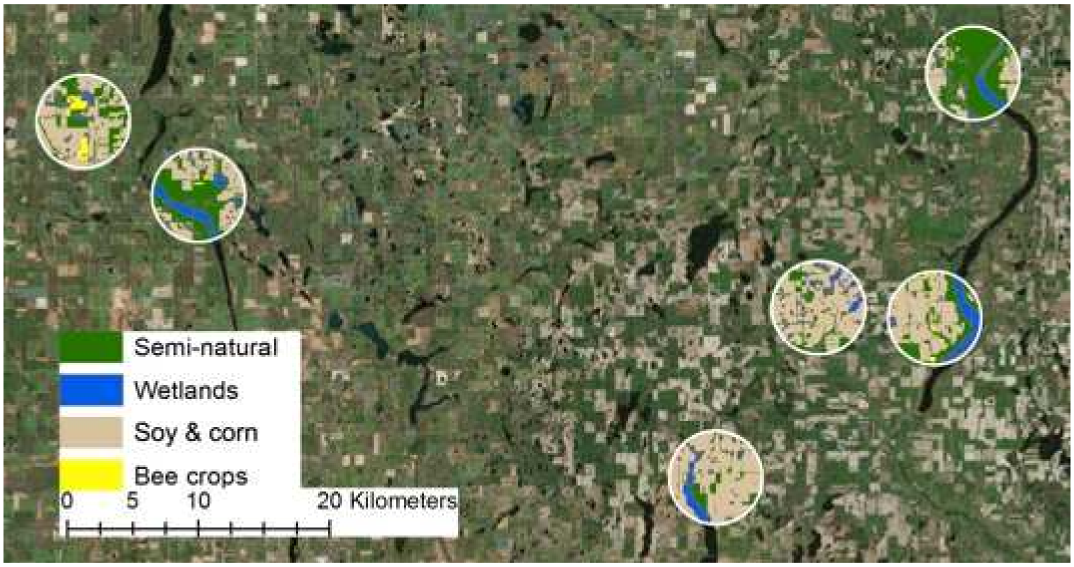

Figure 3-1. Land use at six sites housing survey locations in the prairie pothole region of North Dakota. Semi-natural included pasture land, grassland, Conservation Reserve Program (CRP), hay land, fallow land, ditch, flowering trees and shrubs, and shelterbelt. Wetlands included open water, cattails, and ephemeral wetlands. Soy and corn included soybean, corn, wheat, and oats. Bee crops included canola, sunflower, and alfalfa. Honey bee apiaries are located at the centers of these survey locations. Honey bee apiaries were located at the center of each circle. Multiple wild bee survey locations were located within each circle.

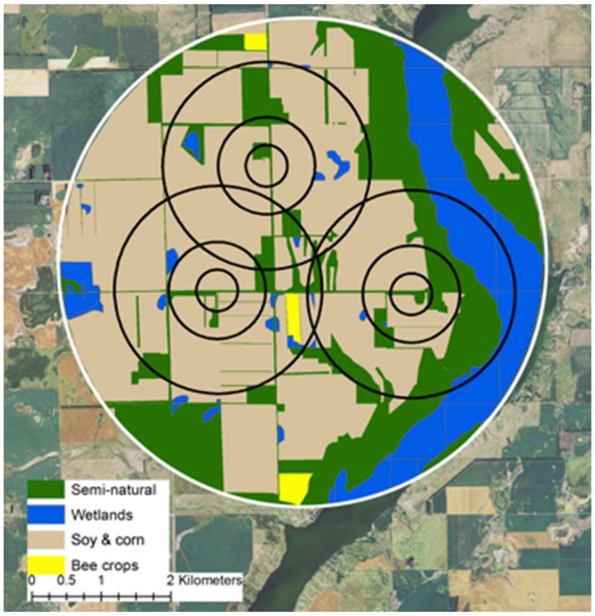

Figure 3-2. Examples of survey locations showing radii of examined land use at one out of six sites. Land use was summarized within 1500 m, 700 m, and 300 m of survey locations as denoted by black circles. Semi-natural included pasture land, grassland, Conservation Reserve Program (CRP), hay land, fallow land, ditch, flowering trees and shrubs, and shelterbelt. Wetlands included open water, cattails, and ephemeral wetlands. Soy and corn included soybean, corn, wheat, and oats. Bee crops included canola, sunflower, and alfalfa. An apiary was located at the center of each of six sites. The three sets of concentric circles represent three survey locations.

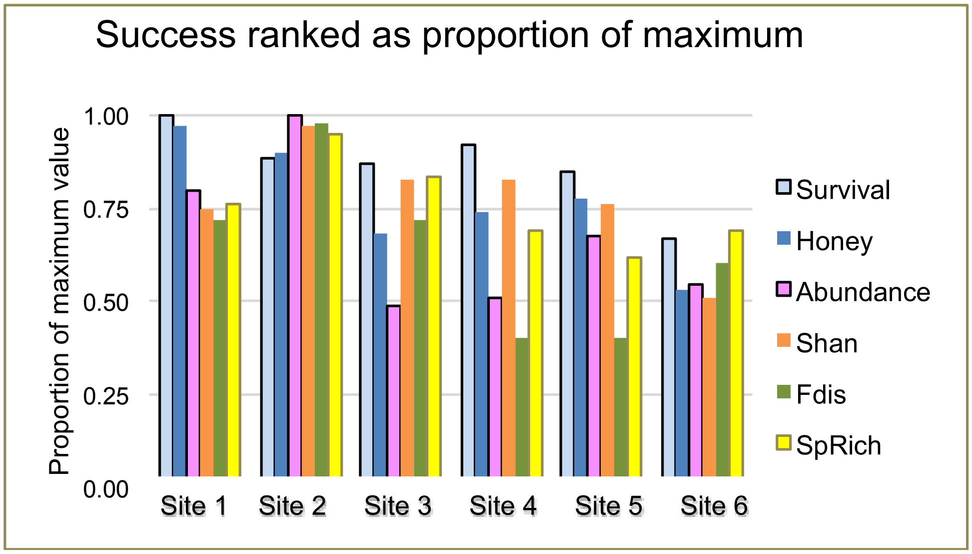

Figure 3-3. Measures of wild bee and honey bee success at the six apiary sites over all three years as the proportion of the maximum value of each measure.

Annual honey bee colony survival and average annual kgs of honey (blue columns) production are from Smart et al. (2016b).Jack-one estimate of species richness (*SpRich*) included all collection methods (sweep netting, bowl traps). Abundance, exponential Shannon index (*Shan*), and functional dispersion index (*Fdis*), included only bees caught using sweep nets.

3.6 Tables

Land-use	**Degree of disturbance**	**Floral cover**	**Cover in study area**
Semi-natural: pasture land (13%), grassland (7%), Conservation Reserve Program (CRP) (6%), hay land (4%), ditch (2%), fallow land (1%), flowering trees and shrubs (1%), and shelterbelt (<1%)	Low disturbance	Moderate (3%)	35%
Wetlands: open water (8%), and cat-tails (4%), ephemeral wetlands (<1%)	Low disturbance	Low (<0.01%)	12%
Soy & corn: soybeans (29%), corn (12%), wheat (11%), and oats (<1%)	High distrubance	Low (<1%)	52%
Potential bee forage crops: oil canola (<1%), oil sunflower (<1%), and alfalfa (<1%)	Moderate to high disturbance	High (56%)	1%

Table 3-1. Land-use categories and the degree of disturbance, estimated floral cover, and total land cover within 3.2 km of all six sites. Floral cover was estimated by USGS technicians during site visits made throughout the growing season and included broad estimates of cover of commonly occurring flowers**.**

Functional trait	Categories or unit of measure	Source of data	Percent of total abundance for categorical traits or mean ± standard deviation for continuous traits
Nesting habit	Below ground, above ground, cleptoparasitic	(Hobbs 1966; Hobbs 1967; Hobbs 1968; Michener 2000; Sheffield et al. 2008)	Below 77%, Above 22%, Cleptoparasitic 1%
Active season length	Number of months	2010 to 2012 collections and historic collections	Mean 3.3 months ± SD 1.6 months
Active season	Early, mid, late	2010 to 2012 collections and historic collections	Early 78%, Mid 94%, Late 93%
Floral specialization	Polylectic, oligolectic	(Robertson 1926; Hurd et al. 1980; Wolf & Ascher 2008)	Polylectic 78%, Oligolectic 22%
Tongue length	Combined length of tongue, glossa, and prementum	Based on inter-tegular distances of 2010 to 2012 collections using BeeIT package (Cariveau et al. 2016)	Mean 2.8 mm ± SD 1.8 mm
Bee size	Inter-tegular distance	2010 to 2012 collections	Mean 1.8 mm ± SD 0.7 mm

Table 3-2. Traits used to assess functional diversity of bee communities. Nesting habit, categorized as below ground, above ground, or cleptoparasitic, was derived from literature. Active season length is the number of months during which adults were active. Early season bees were active before June, mid-season bees were active in June and July, late season bees were active after July. Floral specialization was categorized as polylectic, visiting a wide variety of floral hosts, or oligolectic, visiting a limited range of floral hosts. Tongue length was the combined length of the tongue, glossa, and prementum. Bee size was the inter-tegular distance. Only data from sweep netting collections were included in functional trait measures.

	3200 m		**2000 m**		**1000 m**		**500 m**	
Survival	AIC=93.09		AIC=92.7		AIC=96.85		AIC=96.01	
	ß	*CI*	*ß*	*CI*	*ß*	*CI*	*ß*	*CI*
Semi-natural	**2.57**	**1.10 - 4.09**	**1.63**	**0.66 - 2.63**	**1.39**	**0.22 - 2.52**	0.73	-0.44 - 1.78
Bee forage	0.04	-0.11 - 0.20	0.42	-0.01 - 0.86	-0.03	-0.29 - 0.23	0.17	-0.11 - 0.42
Wetlands	-0.43	-1.42 - 0.53	-0.75	-2.96 - 1.58	-0.43	-1.80 - 1.00	-0.63	-1.56 - 0.25
	AIC=-32.24		AIC=-31.24		AIC=-30.12		AIC=-29.99	
	ß	*CI*	*ß*	*CI*	*ß*	*CI*	*ß*	*CI*
*Soy & corn	**-0.08**	**-0.15 - -0.01**	-0.08	-0.16 - 0.00	-0.07	-0.15 - 0.02	-0.07	-0.16 - 0.03
Honey kgs	AIC=158.49		AIC=158.65		AIC=164.26		AIC=160.9	
	ß	*CI*	*ß*	*CI*	*ß*	*CI*	*ß*	*CI*
Semi-natural	**9.05**	**1.89 - 15.90**	2.47	-3.14 - 7.80	1.82	-5.11 - 8.83	1.68	-3.67 - 6.71
Bee forage	0.07	-0.78 - 0.95	2.78	0.58 - 5.13	0.53	-0.90 - 2.01	1.46	-0.01 - 2.96
Wetlands	**-4.82**	**-9.66 - -0.19**	5.80	-13.72 - 24.75	1.35	-5.31 - 8.85	0.44	-4.13 - 5.51
	AIC=148.53		AIC=149.39		AIC=150.25		AIC=150.45	
	ß	*CI*	*ß*	*CI*	*ß*	*CI*	*ß*	*CI*
*Soy & corn	-6.43	-13.26 - 0.40	-6.06	-14.14 - 2.02	-4.64	-13.27 - 3.99	-4.39	-13.80 - 5.02

Table 3-3. Honey bee success measures related to land use. Estimates (*ß*) and 95% confidence intervals (*CI*) from generalized linear mixed effects models of effects of land use on honey bee success measures with land use surrounding apiaries at 3200 m, 2000 m, 100 m, and 500 m. Values in bold have 95% CIs that do not not include zero. *Models for the land use grouping soy & corn were run separately. Survival was measured as annual apiary survival (number of colonies surviving out of 24 at each site and year). Honey production was measured as annual apiary honey production (mean kg per year).

	1500 m		700 m		300 m	
Abundance	R^2_{marg}=0.04	R^2_{cond}=0.04	R^2_{marg}=0.07	R^2_{cond}=0.07	R^2_{marg}=0.07	R^2_{cond}=0.07
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Semi-natural	-0.17	-0.84 – 0.49	-0.24	-0.86 – 0.39	0.16	-0.46 – 0.79
Bee crops	0.35	-0.29 – 1.00	0.19	-0.42 – 0.79	0.34	-0.28 – 0.96
Wetlands	0.41	-0.28 – 1.09	0.57	-0.05 – 1.19	0.51	-0.12 – 1.13
	R^2_{marg}=0.004	R^2_{cond}=0.004	R^2_{marg}=0.00	R^2_{cond}=0.003	R^2_{marg}=0.01	R^2_{cond}=0.01
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
*Soy & corn	-0.11	-0.73 – 0.51	-0.07	-0.69 – 0.56	-0.2	-0.83 – 0.42
Species rich	R^2_{marg}=0.11	R^2_{cond}=0.19	R^2_{marg}=0.11	R^2_{cond}=0.16	R^2_{marg}=0.12	R^2_{cond}=0.14
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Semi-natural	-0.67	-6.87 – 5.53	-1.39	-6.92 – 4.15	0.37	-5.14 – 5.88
Bee crops	2.85	-2.92 – 8.62	3.70	-1.66 – 9.05	4.87	-0.62 – 10.37
Wetlands	-1.96	-7.90 – 3.99	1.93	-3.58 – 7.44	0.82	-4.68 – 6.33
	R^2_{marg}=0.08	R^2_{cond}=0.18	R^2_{marg}=0.08	R^2_{cond}=0.16	R^2_{marg}=0.08	R^2_{cond}=0.15
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
*Soy & corn	1.25	-4.78 – 7.28	-0.5	-6.43 – 5.43	-1.68	-7.49 – 4.12
Jack 1 est.	R^2_{marg}=0.11	R^2_{cond}=0.26	R^2_{marg}=0.10	R^2_{cond}=0.24	R^2_{marg}=0.12	R^2_{cond}=0.22
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Semi-natural	0.81	-8.24 – 9.86	-0.45	-8.69 – 7.80	1.27	-6.38 – 8.93
Bee crops	2.50	- 5.31 – 10.31	4.17	-3.50 – 11.83	6.69	-0.56 – 13.94
Wetlands	-3.36	-11.11 – 4.38	0.59	-6.82 – 8.00	0.41	-7.11 – 7.93
	R^2_{marg}=0.19	R^2_{cond}=0.62	R^2_{marg}=0.20	R^2_{cond}=0.62	R^2_{marg}=0.23	R^2_{cond}=0.62
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
*Soy & corn	1.09	-7.57 – 9.75	-1	-9.56 – 7.57	-3.08	-11.47 – 5.31
Exp *H’*	R^2_{marg}=0.03	R^2_{cond}=0.07	R^2_{marg}=0.01	R^2_{cond}=0.04	R^2_{marg}=0.11	R^2_{cond}=0.11
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Semi-natural	-1.00	-4.21 – 2.20	-0.99	-4.08 – 2.10	-0.58	-3.52 – 2.36
Bee crops	1.82	-1.30 – 4.94	0.94	-2.05 – 3.93	**3.67**	**0.73 – 6.60**
Wetlands	0.34	-2.96 – 3.64	0.69	-2.38 – 3.76	-0.05	-2.99 – 2.88
	R^2_{marg}=0.002	R^2_{cond}=0.02	R^2_{marg}=0.002	R^2_{cond}=0.02	R^2_{marg}=0.002	R^2_{cond}=0.03
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
*Soy & corn	0.36	-2.64 – 3.36	0.35	-2.66 – 3.36	-0.28	-3.31 – 2.75
FDis	R^2_{marg}=0.37	R^2_{cond}=0.71	R^2_{marg}=0.30	R^2_{cond}=0.68	R^2_{marg}=0.33	R^2_{cond}=0.68
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
Semi-natural	**0.07**	**0.03 – 0.11**	**0.06**	**0.02 – 0.09**	**0.07**	**0.03 – 0.10**
Bee crops	0.02	-0.01 – 0.05	0.03	-0.00 – 0.06	0.01	-0.01 – 0.04
Wetlands	-0.01	-0.04 – 0.03	0.01	-0.03 – 0.05	-0.01	-0.04 – 0.03
	R^2_{marg}=0.32	R^2_{cond}=0.68	R^2_{marg}=0.29	R^2_{cond}=0.68	R^2_{marg}=0.39	R^2_{cond}=0.69
	ß	***CI***	***ß***	***CI***	***ß***	***CI***
*Soy & corn	**-0.07**	**-0.11 – -0.03**	**-0.06**	**-0.10 – -0.03**	**-0.08**	**-0.11 – -0.04**

Table 3-4. Wild bee community measures and land use. Estimates (*β*) and 95% confidence intervals (*CI*) from generalized linear mixed effects models of land-use effects on wild bee community measures with land use surrounding survey locations at 1500 m, 700 m, and 300 m. * Models for soy and corn were run separately due to collinearilty. All models are presented as standardized z-scores. Species richness and Jack-one estimate include data from all collection methods. Exponential Shannon index (exp*H'*) and functional dispersion index (*FDis*), include data from sweep netting collections. Values in bold have 95% CIs that do not not include zero. Marginal and conditional R^2 values are provided for model evaluation.

		1500 m		700 m		300 m	
Above ground nesters		R^2_{marg}=0.47 R^2_{cond}=0.47		R^2_{marg}=0.35 R^2_{cond}=0.35		R^2_{marg}=0.37 R^2_{cond}=0.50	
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	Semi-natural	**0.22**	**0.15 – 0.30**	**0.18**	**0.10 – 0.27**	**0.20**	**0.10 – 0.30**
	Bee crops	0.06	-0.01 – 0.14	**0.1**	**0.02 – 0.18**	-0.06	-0.14 – 0.02
	Wetlands	**-0.14**	**-0.21 – -0.06**	-0.06	-0.15 – 0.02	-0.03	-0.12 – 0.06
		R^2_{marg}=0.23 R^2_{cond}=0.38		R^2_{marg}=0.24 R^2_{cond}=0.38		R^2_{marg}=0.25 R^2_{cond}=0.37	
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	*Soy & corn	**-0.17**	**-0.26 – -0.07**	**-0.17**	**-0.27 – -0.08**	**-0.18**	**-0.28 – -0.08**
Active season length		R^2_{marg}=0.16 R^2_{cond}=0.46		R^2_{marg}=0.21 R^2_{cond}=0.55		R^2_{marg}=0.35 R^2_{cond}=0.55	
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	Semi-natural	-0.3	-0.63 – 0.02	-0.3	-0.59 – 0.00	**-0.33**	**-0.58 – -0.09**
	Bee crops	-0.2	-0.44 – 0.05	**-0.29**	**-0.55 – -0.04**	**-0.45**	**-0.65 – -0.26**
	Wetlands	0.05	-0.18 – 0.29	0.01	-0.24 – 0.27	-0.04	-0.27 – 0.20
		R^2_{marg}=0.09 R^2_{cond}=0.38		R^2_{marg}=0.16 R^2_{cond}=0.46		R^2_{marg}=0.29 R^2_{cond}=0.54	
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	*Soy & corn	0.27	-0.03 – 0.57	**0.38**	**0.08 – 0.68**	**0.51**	**0.23 – 0.79**
Early season bees		R^2_{marg}=0.06 R^2_{cond}=0.28		R^2_{marg}=0.09 R^2_{cond}=0.29		R^2_{marg}=0.09 R^2_{cond}=0.25	
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	Semi-natural	-0.03	-0.18 – 0.12	-0.04	-0.18 – 0.09	-0.06	-0.19 – 0.08
	Bee crops	-0.03	-0.15 – 0.09	-0.05	-0.18 – 0.07	-0.05	-0.16 – 0.06
	Wetlands	-0.02	-0.14 – 0.10	-0.03	-0.15 – 0.08	0.03	-0.10 – 0.16
		R^2_{marg}=0.06 R^2_{cond}=0.26		R^2_{marg}=0.09 R^2_{cond}=0.28		R^2_{marg}=0.10 R^2_{cond}=0.29	
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	*Soy & corn	0.05	-0.09 – 0.18	0.08	-0.06 – 0.21	0.09	-0.05 – 0.22

continues

		1500 m		700 m		300 m	
Floral specialists		R^2_{marg}=0.05	R^2_{cond}=0.17	R^2_{marg}=0.05	R^2_{cond}=0.18	R^2_{marg}=0.10	R^2_{cond}=0.19
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	Semi-natural	0.09	-0.07 – 0.24	0.05	-0.10 – 0.19	0.04	-0.10 – 0.18
	Bee crops	-0.02	-0.16 – 0.12	0.06	-0.08 – 0.20	**0.14**	**0.01 – 0.27**
	Wetlands	-0.03	-0.17 – 0.11	0.00	-0.14 – 0.13	-0.03	-0.16 – 0.11
		R^2_{marg}=0.05	R^2_{cond}=0.18	R^2_{marg}=0.05	R^2_{cond}=0.18	R^2_{marg}=0.07	R^2_{cond}=019
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	*Soy & corn	-0.06	-0.21 – 0.09	-0.07	-0.22 – 0.08	-0.09	-0.24 – 0.06
Tongue length		R^2_{marg}=0.13	R^2_{cond}=0.27	R^2_{marg}=0.16	R^2_{cond}=0.27	R^2_{marg}=0.17	R^2_{cond}=0.29
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	Semi-natural	0.27	-0.38 – 0.92	0.08	-0.51 – 0.67	0.16	-0.45 – 0.76
	Bee crops	0.05	-0.53 – 0.64	0.47	-0.09 – 1.02	0.02	-0.51 – 0.56
	Wetlands	-0.23	-0.82 – 0.36	-0.14	-0.69 – 0.40	-0.5	-1.08 – 0.08
		R^2_{marg}=0.11	R^2_{cond}=0.22	R^2_{marg}=0.13	R^2_{cond}=0.26	R^2_{marg}=0.13	R^2_{cond}=0.26
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	*Soy & corn	-0.14	-0.74 – 0.46	-0.28	-0.89 – 0.34	-0.3	-0.92 – 0.33
Bee size		R^2_{marg}=0.12	R^2_{cond}=0.20	R^2_{marg}=0.16	R^2_{cond}=0.23	R^2_{marg}=0.20	R^2_{cond}=0.34
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	Semi-natural	0.03	-0.18 – 0.25	0	-0.20 – 0.21	0.14	-0.09 – 0.37
	Bee crops	0.04	-0.17 – 0.25	0.15	-0.04 – 0.35	-0.01	-0.21 – 0.19
	Wetlands	0.01	-0.21 – 0.24	0.05	-0.16 – 0.25	-0.15	-0.37 – 0.07
		R^2_{marg}=0.11	R^2_{cond}=0.17	R^2_{marg}=0.14	R^2_{cond}=0.21	R^2_{marg}=0.14	R^2_{cond}=0.22
		ß	*CI*	*ß*	*CI*	*ß*	*CI*
	*Soy & corn	-0.05	-0.25 – 0.15	-0.11	-0.31 – 0.10	-0.12	-0.33 – 0.09

Table 3-5. Bee traits and land-use. Estimates (***ß***) and 95% confidence intervals (*CI*) for effects of land-uses on community weighted trait means with land-use surrounding survey sites at 1500 m, 700 m, and 300 m from generalized linear mixed effects models including data from sweep netting collections. * Models for soy and corn were run separately due to collinearilty. All models are presented as standardized z-scores. Values in bold have 95% confidence intervals that do not include zero. Marginal and conditional R^2 values are provided for model evaluation**.**

		Honey bee success		Wild bee success			
Site	Year	Survival	Honey (kgs)	Abund.	Sp. rich.	expH'	*FDis*
1	2010	0.83	47	104	59	18.77	0.21
	2011	0.83	29	30	31	7.21	0.21
	2012	0.88	64	358	52	20.40	0.16
2	2010	0.79	46	218	69	19.45	0.24
	2011	0.75	27	113	56	12.76	0.23
	2012	0.71	52	291	63	23.32	0.19
3	2010	0.67	27	176	57	19.22	0.14
	2011	0.71	18	52	42	13.41	0.25
	2012	0.79	50	76	45	15.77	0.13
4	2010	0.83	31	77	42	16.88	0.08
	2011	0.75	37	29	26	14.11	0.14
	2012	0.75	36	208	49	22.38	0.08
5	2010	0.75	34	132	49	18.62	0.13
	2011	0.75	40	60	31	11.42	0.09
	2012	0.67	34	230	44	14.26	0.07
6	2010	0.5	12	89	50	17.16	0.17
	2011	0.5	17	34	26	3.36	0.11
	2012	0.71	45	215	43	14.91	0.11

Table 3-6. Bee success at six study sites. Proportion of honey bee colony survival, average annual kgs of honey production, wild bee abundance, species richness including sweep netting and bowl trap collections, exponential Shannon index (expH') and functional dispersion index (*FDis*), of bees caught using sweep nets at six study sites. Honey bee measures are from Smart et al. (2016b).

	Colony survival		**Honey production**	
	r	*P*	*r*	*P*
Abundance	0.21	0.40	**0.63**	**<0.01**
Species richness	0.20	0.44	0.35	0.15
Species diversity	0.32	0.19	**0.51**	**<0.05**
Functional diversity	0.16	0.53	-0.05	0.84

Table 3-7. Correlation of honey bee and wild bee measures of success. Pearson-moment correlations coefficients (*r*) and siginificance tests (*P*) for pair-wise corrleations of honey bee success measues (proportion of annual honey bee colony survival, average annual kgs of honey production) and wild bee success measures (abundance, species richness, species diversity as the exponential Shannon's entropy index, and functional diversity as functional dispersion).

	Site 1	**Site 2**	**Site 3**	**Site 4**	**Site 5**
Site2	0.25				
Site 3	0.20	0.45			
Site 4	0.32	**0.55**	0.11		
Site 5	0.14	0.39	0.11	0.30	
Site 6	0.29	**0.59**	0.05	0.09	0.25

Table 3-8. Proportion of total beta diversity explained by nestedness (*β*-ratio). Higher ratios indicate the importance of local species loss in beta diveristy differences among sites. Values > 0.5 indicate that nestedness is more important than species turnover.

Family	**Bee species**	**Nesting habit**	**Diet**	**Site 4**	**Site 6**
Colletidae	*Colletes rufocinctus*	Below	Oligo	-	-
	Hylaeus leptocephalus	Above	Oligo	+	-
Andrenidae	*Andrena accepta*	Below	Oligo	-	-
	Andrena canadensis	Below	Oligo	-	-
	Andrena chromotricha	Below	Oligo	-	-
	Andrena commoda	Below	Poly	+	-
	Andrena helianthi	Below	Oligo	-	+
	Andrena hirticincta	Below	Oligo	-	-
	Andrena illinoiensis	Below	Oligo	-	-
	Andrena lupinorum	Below	Poly	-	-
	Andrena medionitens	Below	Poly	-	-
	Andrena nubecula	Below	Oligo	-	+
	Andrena specularia	Below	Poly	-	-
	Andrena thaspii	Below	Poly	-	-
	Andrena virginiana	Below	Poly	-	-
	Perdita albipennis pallidipennis	Below	Oligo	-	-
	Perdita bruneri	Below	Oligo	-	-
	Perdita octomaculata	Below	Oligo	-	+
	Pseudopanurgus albitarsis	Below	Oligo	-	-
	Pseudopanurgus labrosus	Below	Oligo	-	-
	Pseudopanurgus nebrascensis	Below	Oligo	-	-
	Pseudopanurgus simulans	Below	Oligo	-	-
Halictidae	*Agapostemon texanus*	Below	Poly	+	-
	Dieunomia triangulifera	Below	Oligo	-	-
	Lasioglossum acuminatum	Below	Poly	-	-
	Lasioglossum macoupinense	Below	Poly	-	-
	Lasioglossum pectorale	Below	Poly	-	-
	Lasioglossum succinipenne	Below	Poly	-	+
	Lasioglossum zephyrum	Below	Poly	-	-
	Sphecodes cf. *atlantis*	Clepto	-	-	-
	Sphecodes coronus	Clepto	-	-	+
	Sphecodes nr. *cressonii*	Clepto	-	-	+
	Sphecodes sp. *ranunculii* group	Clepto	-	-	-
Apidae	*Bombus fervidus*	Above/Below	Poly	-	-
	Bombus rufocinctus	Above/Below	Poly	-	-
	Bombus vagans	Below	Poly	-	-
	Holcopasites heliopsis	Clepto	-	-	-
	Melissodes illatus	Ground	Oligo	-	-
	Melissodes subillatus	Ground	Oligo	+	-
	Nomada aquilarum	Clepto	-	-	+
	Triepeolus helianthi	Clepto	-	-	+
Megachilidae	*Heriades carinata*	Below	Poly	-	-
	Hoplitis pilosifrons	Below	Poly	+	-
	Hoplitis producta	Below	Poly	+	-
	Megachile inermis	Below	Poly	-	-
	Megachile latimanus	Below	Poly	-	+

Table 3-9. Bee species lost between Sites and their nesting and diet habits. Bee species present at Site 2 but absent from Sites 4 and 6, the sites showing the highest degree of nestedness. Below=Nesting below ground. Above=Nesting above ground. Clepto=Cleptoparasitic. Poly=Polylectic. Oligo=Oligolectic. - = Absent from Site. + = Present at Site.

Chapter 4.

Historic comparison of floral usage and species compostion of bees in agricultural lands in the prairie pothole region of North Dakota

Summary

This survey documented biodiversity of bee fauna within agricultural lands in eastern North Dakota from 2010-2012. The area surveyed overlapped with a broader scale bee survey by O.A. Stevens in the 1910s, when a significant portion of the region was in agricultural production, but there were more remnants of native plant communities. Past and present bee and floral visitation records were compared to reveal how bee communities and their interaction with the floral community have changed over the last century. Bees were collected in Griggs, Barnes, and Stutsman counties in North Dakota using three methods: sweep netting, bowl traps, and trap nesting in 2010, 2011, and 2012. All collection methods resulted in 14,947 bee specimens representing 166 species with 20 new state records for North Dakota. Historic bee-flower association records, which included 2,678 specimens and 161 bee species, were compared to current sweep netting collections, which included 2,521 bee specimens representing 134 species. First-order jack-knife estimation of species richness found a 16-30% loss of bee species richness between surveys. The bee genera *Lasioglossum*, *Mellisodes, Halictus,* and *Ceratina* increased in relative abundance more than 50% from 1910-1920 to 2010-2012 surveys, while the genera *Bombus, Megachile,* and *Colletes,* decreased in relative abundance more than 65% and the genus *Andrena* decreased in relative abundance by 47%. The most abundant species from the 1910-1920 survey was *Bombus terricola*, but *B. terricola* was represented by only a single specimen in the 2010-2012 survey. The plant genera that received the most bee visits (highest abundance) in the current survey were *Melilotus, Sonchus,* and *Cirsium,* and the plants with the highest number of bee species visiting them (species richness) were *Solidago, Cirsium*, and *Sonchus*. The plant genera *Zizia*, *Hydrophyllum*, and *Dalea* all received more visitation in the past, most likely due to higher abundance, and are good candidates for pollinator plantings in this region aimed at supporting bee diversity.

4.1 Introduction

The prairie pothole region of North Dakota is an area of biological interest because it encompasses range limits for many western and eastern species plant species and is a transition zone between northern and southern climatic zones (Upham 1892; Stevens 1920a). The bee fauna of North Dakota was previously studied by O.A. Stevens, a botany professor at the Agricultural College, University of North Dakota, Fargo, who surveyed bees throughout eastern North Dakota from the 1910s to the 1940s (Stevens 1917; Stevens 1919; Stevens 1920b; Stevens 1921; Stevens 1948a; Stevens 1950; Stevens 1951). Stevens recorded around 300 bee species, although it was assumed there were closer to 500 species present at that time (Stevens 1948a). There are no published studies of native bees in North Dakota since that time and few collection records, pointing to the importance of documenting the current bee fauna.

Historically this area was predominantly prairie grassland with many shallow wetlands, known as potholes, created by past glacial activity during the Wisconsin glaciation ~12,000 years ago (Euliss et al. 1999). Much of the prairie was converted to agricultural land use during colonization in the 1880s (Severson & Sieg 2006) and has remained in agricultural production since that time. More than half of the potholes have been drained and converted to agriculture, but the remaining potholes provide patches of relatively undisturbed land within the agricultural matrix. Although most land in this area has been in agricultural use for more than a hundred years, the nature of the agricultural land use has changed dramatically over the last century, and even over the last decade. The variety of commodities grown by North Dakota producers has steadily declined over the past century, with a dramatic increase in acreage dedicated to soy and corn since 2007 (Gascoigne et al. 2013). In addition, the amount of land held in North Dakota under the Conservation Reserve Program, a program paying rental fees or cost-sharing for land owners to set aside cropland in environmentally sensitive areas (U.S. Department of Agriculture 2015), decreased by 55% from peak enrollment of 1,370,000 hectares (3,389,000 acres) in 2007 to 620,000 hectares (1,528,000 acres) in 2015 (U.S. Department of Agriculture 2016). These declining land uses are known to support bee diversity (Chapter 2). It is assumed that loss of these land uses has contributed to shifts in the bee community. It is important to document the bee fauna in this area before these land-use changes result in species extirpations.

Bee communities are highly associated with plant communities, due to the dependence of bees on flowers for nutrition. Comparison of historic and present plant communities and plant usage by bees can help us understand the needs of current bee communities that are present in highly altered habitats. The pre-colonization (pre-1880) vegetation of eastern North Dakota was predominantly tall grass prairie including big-blue stem (*Andropogon gerardii*), porcupine grass (*Hesperostipa spartea*), and blue gramma (*Bouteloua gracilis*) grasses. Rivers were bordered by forested areas including box elder (*Acer negundo*), American elm (*Ulmus americana*), and plains cottonwood (*Populus deltoides*) (Severson & Sieg 2006). Shrub thickets including western snowberry (*Symphoricarpos occidentalis)* as well as roses (*Rosa* spp.), wild plums (*Prunus* spp.), and willow (*Salix* spp.) were also common near these wooded rivers. Fragments of these historic plant communities remain, but the change to a landscape dominated by agricultural fields has been drastic. An 1839 plant survey did not track abundance but noted the presence of a wide variety of bee preferred forage plants in this region (Upham 1892). Many introduced, weedy plants were already noted as commonly occurring in this region. *Melilotus* was noted as "becoming frequent," spreading abundantly particularly on roadsides. In 1920, Stevens noted high abundances of several introduced plants in North Dakota including *Cirsium arvense* and *Sonchus arvensis* (Stevens 1920a).

This chapter contains a survey of bees and other pollinators in agricultural lands in eastern North Dakota. The survey provides documentation of ranges of bee species in this understudied area, updates a study of bees in the same region a century ago, and will inform future studies about changes in the bee fauna. Floral visitation records were used to indicate the importance of particular plant species to current bee communities in eastern North Dakota, which can be used to inform new efforts to create pollinator habitat. Past and present bee and floral visitation records were compared to reveal how bee communities and their interactions with the floral community have changed over the last century. Plants that supported bee communities in the past, as indicated by high abundances and diversities of bee visitors, that are absent or rare in the current landscape could be candidates for inclusion in pollinator habitat efforts.

4.2 Methods

4.2.1 Study area

Survey locations were nested within six study sites in Stutsman, Barnes, and Griggs counties from latitude 46°57'13"N to 47°16'48" N and longitude 98°1'49" W to 98°56'3"W (Fig. 4-1). The average annual rainfall for the area is 47.5 cm. Total precipitation was above average in 2010 and 2011(59.2 cm and 56.7 cm respectively) and below average in 2012 (32.7 cm). Survey locations were chosen based on the presence of floral resources and land access. Most survey locations were along roadside ditches as that was predominantly where floral sources were located, but there are also survey locations within natural grasslands and ephemeral wetlands. All survey locations are noted in Appendix A.

4.2.2 Pollinator survey methods

Bees and other flower visitors were surveyed between May and September, once every three weeks in 2010, for a total of six collections, and once every four weeks in 2011 and 2012, for a total of five collections. In 2010, there were twelve survey locations, two at each of the six sites. In 2011, there were eighteen regularly sampled survey locations as well as twelve additional sweep net sampling sites (two at each of the six sites). The locations of these additional sweep net sampling sites changed with each visit as these sites were chosen for their abundance of flowering resources thought to be attractive to bees based on experience observing bees in the area. Collections were less frequent in 2011 and 2012 due to time constraints imposed by surveying additional sites. All sites were sampled within three to four days during each visit. Three different collection methods (sweep netting, bowl traps, and trap nests) were used to maximize the number of species caught and to compensate for variable performance of individual collection methods. Trap-nests are designed to only collect a subset of bee species, the cavity nesting bees, but they have been shown to collect bee species that are missed by other methods (Westphal et al. 2008). Overall, the survey included 96 unique collection locations and 20 collection events (3 to 4 day periods during which bees were collected) resulting in 325 unique collection events.

Regularly sampled survey locations were chosen so they were at least 1 km from each other. Each site was visited twice, once earlier and once later in the day, for sweep netting during each collection period of two to four days. The timing of “early” and “late” shifted with the season, with early ranging between 10 a.m. and 1 p.m. and late ranging between 1 p.m. and 6 p.m. Surveys took place when there was no precipitation and the temperature was greater than 15^{o} C. Timers were paused for retrieving insects out of nets, so that handling time was not included in sweep time. Only bees were collected from sweep nets. Other insects were released. Honey bees were counted and released as were queen bumble bees as both were readily identifiable. Although sweep nets are the most labor intensive of the three methods, they allowed for floral associations to be noted. Bee specimens collected from specific flowers were kept separate so that floral records could be attached to each specimen. In 2010, a total of 30 minutes of sweep time was spent at each survey site per visit, and focused on blooming flowers. Methods were similar in 2011 and 2012, but sampling at each site was reduced to 20 minutes, and sweep netting took place along a meandering transect. Observers walked at a consistent pace, covering approximately 100 m in 10 minutes, with the path of the transect varying over the season to encounter patches of flowers.

In 2011 and 2012, additional sweep net surveys took place at floral patches outside the bee survey locations. These additional sweep locations were chosen based on abundance of blooming bee-preferred forage. A total of twelve of these "best flower patches" collections were made during each visit. All bees found in a 25 m^{2} area within five minutes were collected, and floral species and their abundances were noted. This method was added to enhance the species richness of the survey, since the static survey locations did not always contain abundant floral resources.

In 2010, thirty-six bowl traps were set up at each survey location each collection period. The traps consisted of 200 ml plastic bowls painted either fluorescent blue, fluorescent yellow, or white. These bowls were attached to bamboo stakes so that the bowl was elevated slightly above vegetation height to ensure visibility. The bowls were placed along two orthogonal lines when possible, or along one straight line with 5 m between bowls. These lines were placed along roadside ditches or other open areas. Bowls were filled with a 2% soap solution (Dawn dish soap, Procter &Gamble, Cincinnati,OH) and left out for approximately twenty-four hours. Due to the increase in the number of survey locations, the number of bowls was reduced to twenty-four for 2011 and 2012 to enable timely processing of samples.

To survey cavity-nesting bees, trap nests were set up in early April and remained until September. In 2010 and 2011, trap nests were set up within 300 m of one bee survey location in the vicinity of each apiary for a total of six trap nests. In 2012, trap nests were set up within 300 m of each survey location for a total of eighteen. Wooden observation nest blocks were made and housed in shelters based on the design of Hallett (Hallett 2001) but scaled to 3/5 the given dimensions to hold 18 blocks each instead of 50 (Fig. 4-2). When possible, the shelter boxes were placed in dry ground with sparse vegetation, oriented to face east or southeast, with trees to the west to provide afternoon shade. Bundles of 50 to 60 bamboo sticks, 12 to 22 cm in length were held in a plastic pipe segments attached to the top of each shelter box. Over the winter, cocoons and prepupae were removed from nests, put in individual gelatin capsules, labeled, and stored at 4° C until spring, at which time they were kept at outdoor temperatures until emergence. Bees were collected as they emerged. Photographs taken of the nests before any bees were removed, combined with the individually labeled capsules, allowed accurate tracking of a specimen’s original position and nest construction, which aided in identification.

Bees were identified to species whenever possible using keys and comparisons with previously identified materials (Mitchell 1960; Laberge 1969; Gibbs 2010; Ascher & Pickering 2015). A subset of bees (5%) was sent to experts (Dr. John Ascher, Joel Gardner, Dr. Jason Gibbs, Dr. Mike Arduser, Sam Droege, Dr. Karen Wright) for creation of a synoptic set, confirmation of identifications, and identification of groups for which there were no available keys. Species level identification was not possible in all cases. Ten bee types were identified to species groups (1% of specimens) or as cf. species, meaning that either the species was not well documented from that part of the continent or there were potentially undescribed species that matched the characters of that specimen (14% of all specimens). Other insects from bowl traps and trap nests were identified to varying levels. Due to interest in syrphid flies both as pollinators and as beneficial insects (Robson 2008; Eckberg et al. 2014), flies belonging to the family Syrphidae were identified to species using keys and comparison with previously identified materials (Curran & Fluke 1926; Telford 1939; Miranda et al. 2013). Species identifications were not achieved for a small number of specimens in the genera *Syrphus* and *Neoscia*. Most specimens have been deposited in the University of Minnesota Insect Collection. A portion of specimens are located in the research collection at the University of Minnesota Bee Lab. All records were databased (Biota software) and will be shared with DiscoverLife and the USGS Pollinator Library.

4.2.3 Flower visitation

Flower visitation was summarized using two measures: the abundance of bee visitors and the number of bee species collected from flowers. These measures were summarized over all collections of the survey according to plant family, genus, and species. Correlation between these two measures was examined using simple linear regression in R version 3.2.1 (R Core Team 2015) with flower visitor abundance square root transformed to meet assumptions of normality and heteroscedasticity.

4.2.4 Blooming plant survey methods

Plants in bloom were assessed at 5 randomly chosen 1 m^2 quadrats along 100 m survey transects at each revisited sweep netting location during each collection period in 2011 and 2012. A total of 888 quadrats were assessed. The cover, number of stems, and number of blooms on three stems were recorded to estimate floral abundance. Plants were identified to species in most cases. Several plant-types were only identified to tribe or family.

4.2.5 Historic bee survey records

Historic bee survey records were obtained from bee collection records provided by the American Museum of Natural History (AMNH) through a cooperative agreement (Fig. 4-1). Identifications for theses records were verified by Dr. John Ascher. Records were limited to those within 150 km of the central point of the current survey and those from 1910-1920, predominantly collected by O.A. Stevens, who extensively collected bees from a wide range of flowering plants, predominantly in eastern North Dakota. The distance of 150 km was chosen to cover a similar geography and vegetation and to enable inclusion of a similar number of specimens and collection events to the current survey. These records were the result of 333 unique collection events. The limit to collections from 1910-1920 was chosen because this time period contained the majority (76%) of the historic records. Records were also limited to those collected between mid-May and mid-September to match with the seasonality of the current collections. Collections for the 1910-1920 survey may have occurred in a broader range of habitats. Collection locations for the 2010-2012 survey were limited to roadsides, grasslands, and agricultural fields due to constraints set by different research questions (Chapters 2 and 3). For both surveys, records were limited to those collected via sweep netting as noted in collection records from the AMNH. Comparisons of relative bee abundance were made at the generic and species level. Patterns were assumed to be reliable despite differences in sampling methods, particularly for genera that were commonly found at abundances greater than 2%. Differences in survey effort and random chance could have more influence on findings for species with small numbers of specimens per species. However rare species were included in parts of these analyses due to general interest in rare bee species.

4.2.6 Data analysis

The software EstimateS (Colwell 2013) was used to generate rarefaction curves to determine the sufficiency of sampling effort for 1) the current survey including all methods, 2) the current survey limited to collections by sweep netting, 3) the syrphid flies collected from bowl traps in the current survey, and 4) the historic bee collection survey. EstimateS was also used to generate 1st order jack-knife estimates of species richness and Shannon diversity indices to assess evenness using 100 iterations of random samples from the data sets. To compare the survey from 1910-1920 to the 2010- 2012 survey, data were summarized as relative abundance, or the number of individuals collected per species divided by the total collected. Two-tailed *z*-tests of equal proportions, following Colla and Packer (2008) were used to determine whether the relative abundance of each species differed significantly between the two time periods. The null hypothesis was that there was no change. To compare host plant usage by bees between the surveys, bee visitor data was summarized as relative abundance and relative species richness, the latter being the number of species collected from a plant genus divided by the total number of species collected in that survey. Two-tailed *z*-tests of equal proportions were also used to determine whether the relative abundance and species richness of bee visitors to plant genera differed between the two time periods.

4.3 Results

4.3.1 Bee survey from 2010-2012

All collection methods resulted in 14,947 bee specimens representing 166 species or species groups from 756 collection events (Table 4-1). The 1st order jack-knife estimate of species richness was 236.52 ± 10.7. The Shannon index of diversity was 3.27 ± 0.03. Inclusion of all sampling methods in a species accumulation curve with extrapolation to three times the number of collections showed that the survey accounted for 71% of expected species numbers (Fig. 4-3), indicating that sampling was sufficient to characterize the bee community. There were 50 species represented by a single specimen each, and 23 species represented by two specimens each. The ten most frequently collected species using all methods in descending order were: *Lasioglossum* cf. *novascotiae, L. pruinosum, Halictus confusus, L. albipenne, L. semicaeruleum, L. zonulum, Melissodes trinodis, Hylaeus leptocephalus, L. admirandum,* and *L. sagax*. There were 20 new state records for North Dakota. A complete catalog of species bee by collection is available in Appendix A.

Sweep netting collections, including both repeated transects and “best site” locations, resulted in 2,521 bee specimens representing 134 species or species groups from 260 collection events (Table 4-1). The 1st order jack-knife estimate of species richness was 164.85 ± 7.05. The Shannon index was 3.67 ± 0.01. Inclusion of sweep netting collections in a species accumulation curve with extrapolation to three times the number of collections showed that the survey accounted for 74% of expected species numbers (Fig. 4-4), indicating that sampling was sufficient to characterize the bee community. There were 48 species collected only by sweep netting. Sweep netting surveys at repeated transects resulted in 2,054 bee specimens representing 125 species with 37 of these only collected at repeated transect sites. Sweep netting at nearby "best site" locations at 25 m^2 flower patches resulted in 464 bee specimens representing 65 species or species groups with 7 of these only collected at “best site” locations. The ten most frequently collected species from sweep netting collections overall in descending order were: *Melissodes trinodis, Lasioglossum semicaeruleum, L.* cf. *novascotiae, Halictus confusus, L. albipenne, Ceratina mikmaqi, Hylaeus mesillae, Bombus griseocollis, L. sagax,* and *M. agilis*.

Bowl traps resulted in 11,440 specimens representing 115 species or species groups (Table 4-1). The 1^{st} order jack-knife estimate of species richness was 144.87 ± 6.51. The Shannon index was 2.24 ±0.01. There were 32 species collected only by this method. The ten most frequently collected species from bowl trap collections in descending order were: *Lasioglossum* cf. *novascotiae, L. pruinosum, Halictus confusus, L. albipenne, L. semicaeruleum, L. zonulum, Melissodes trinodis, L. admirandum, L. sagax,* and *L. paraforbesii*.

Trap nests resulted in 986 bee specimens representing 8 species (Table 4-1). There were 4 species collected only by this method. The eight species collected from trap nests in descending order of abundance were: *Hylaeus leptocephalus, Megachile relative, M. centuncularis, Heriades carinata, H. variolosa, Hoplitis spoliata, M. rotundata,* and *Coelioxys moesta*.

The vast majority of bees collected were native (162 species or species groups), but there were four introduced species: *Hylaeus leptocephalus, Andrena wilkella, Lasioglossum leucozonium,* and *Megachile rotundata*. These introduced species accounted for 4% of specimens collected by all methods, but 58% of specimens from trap nest collections. Introduced bee species accounted for 2% of specimens from sweep netting collections and <1% of bowl trap collections.

4.3.2 Non-bee collections from 2010-2012

Bowl traps resulted in 17,025 non-bee specimens representing 2 classes, 9 orders, and 81 families (Table 4-2). The dominant insect group was the dipteran family Anthomyiidae, with specimens comprising 63% of all non-bee arthropods. Nearly all anthomyiid specimens belonged to the genus *Delia* (99%). Only 4% were identified to species level and these were all *Delia platura*, seedcorn maggot, a common agricultural pest species. While the vast majority of the non-bee specimens from bowl traps were agricultural pests, beneficial insects such as lacewings (Chrysopidae), parasitic wasps (Ichneumonidae, Brachonidae, and the chalcid wasps Eupelmidae, Eurytomidae, and Torymidae), and syrphid flies (Syrphidae) were also collected in bowl traps.

Syrphidae were represented by 2,784 specimens representing 17 genera and 29 species (Table 4-3). Twelve species were represented by one specimen each. Three species were represented by two specimens. One species, *Toxomerus marginatus*, accounted for 74% of syrphid fly specimens. A species accumulation curve with extrapolation to three times the number of collections showed that the reference sample accounted for 60% of the expected species numbers, indicating that sampling was not sufficient to characterize the syrphid fly community (Fig. 4-5). The ten most frequently collected syrphid flies in descending order were: *Toxomerus marigantus, Helophilus fasciatus, Eristalis dimidiata, Syrphus* sp., *Lejops lineatus*, *Eupeodes americanus*, *Eristalis transversa*, *Helophilus obscurus*, *Eristalis bastardi*, and *Eristalis tenax*.

4.3.3 Comparison of current and historic bee surveys

Historic bee-flower association records included 2,678 bee specimens with collection notes indicating the flower from which the bee was collected from 323 collection events representing 161 bee species. The 1st order jack-knife estimate was 215.41 ± 11.51. Comparison with estimated richness from the current survey showed a 16 to 30% loss in species richness for the 2010-2012 survey when compared to the 1910-1920 survey. The Shannon diversity index in the 1910-1920 survey was 4.51 ± 0.01. A species accumulation curve extrapolated to three times the number of collections showed that the reference sample for the 1910-1920 survey accounted for 75% of the expected species numbers, indicating that sampling was sufficient to characterize the bee community (Fig. 4-4). When extrapolated to three times their original sample size, the 95% confidence intervals for estimates for species richness overlapped, indicating similarity in species richness between surveys.

There were several major shifts in relative abundances of bee genera between the two survey periods (Fig. 4-6). There were 24 bee genera found in both survey periods: 6 increased in abundance between the 1910-1920 and 2010-2012 surveys, 14 decreased in abundance, and 5 showed no change (Table 4-4). The genera *Lasioglossum*, *Mellisodes, Halictus,* and *Ceratina* increased in relative abundance more than 50% from the 1910-1920 to the 2010-2012 survey. The genera *Bombus, Megachile,* and *Colletes,* decreased in relative abundance by more than 65%. The genus *Andrena* decreased in relative abundance by 47%. Three genera were only found in the 1910-1920 survey period: *Macropis, Hesperapis,* and *Eupeoloides*. Five genera were only found in the 2010-2012 survey period: *Anthophora*, *Dieunomia, Dufourea, Eucera,* and *Svastra*.

The total number of bee species collected by both surveys combined was 238. There were 93 bee species found in both surveys: 16 of these increased in abundance, 38 decreased in abundance, and 39 showed no change (Table 4-5). There were 77 species found only in 1910-1920 survey and 47 species found only in the 2010-2012 survey (Table 4-6). Most newly found species in the 2010-2012 survey were *Lasioglossum* (65%) and *Andrena* (12%). Two out of the ten most abundant species were shared by the 1910-1920 and 2010-2012 survey: *Hyaleus* sp. *affinis* group and *Lasioglossum albipenne* (Fig. 4-7). Two species were among the most abundant in 2010-2012 but were not found in the 1910-1920 survey: *Lasioglossum* cf. *novascotiae* and *L. sagax*. *Megachile* had 4 of 5 species showing declines and 6 species present in the 1910-1920 survey but absent in the 2010-2012 survey. Only one out of three *Colletes* species shared between surveys declined, but there were 9 *Colletes* species absent from the current survey (Table 4-6).

The most abundant species from the 1910-1920 survey was *Bombus terricola* (122 individuals, 4% relative abundance), a bee of particular interest due to current conservation concerns (E. C. Evans et al. 2008). *B. terricola* was also found in the 2010-2012 survey but was represented only by a single specimen (<0.001% relatiive abundance) (Table 4-1). Overall, 6 of the 9 bumble bee species shared between surveys declined (*B. borealis, B. fervidus, B. rufocinctus*, *B. ternarius, B. terricola*, *B. vagans*) while one species increased in relative abundance (*B. griseocollis*) and two showed no differences (*B. bimaculatus, B. huntii*). There were 7 species of *Bombus* that were found in the 1910-1920 survey but were absent in the 2010-2012 survey (Table 4-6).

Several other species of particular conservation interest were found in the 1910-1920 survey but were absent from the 2010-2012 survey. *B. ashtoni*, a cleptoparasitic cuckoo bumble bee whose host is *B. terricola*, was historically present at 1.7% relative abundance (51 individuals). *Macropis nuda*, a bee specialized on oil collection from *Lysimachia* spp., was present at 1.3% relative abundance (39 individuals). *Epeoloides pilosulus*, a cleptoparasite of *Macropis*, was found at <1% relative abundance (2 individuals).

4.3.4 Flowering plant survey 2011-2012

The most abundant flowering plant found during plant surveys from 2010-2012 was *Melilotus officinalis*, including both white and yellow sweet clover (Table 4-7). *Erigeron annuus, Medicago sativa, Sonchus arvensis, Brassica rapa,* and *Cirsium arvense* were also abundant. Most of the highly abundant plants were of non-native origin. One hundred blooming plant species were found during plant surveys (Table 4-7, Appendix B.)

4.3.5 Flower visitation from 2010-2012 bee survey

During sweep netting collections, bees were collected from 63 plant species representing 52 genera and 21 families. Flower visitation was summarized using two measures: the abundance of bee visitors and the number of bee species collected from flowers (Table 4-8). The two measures were highly correlated (simple regression: $F= 761.2_{1,68}$, $p<0.001$, $R^2=0.92$). Collections from plant families Asteraceae, Fabaceae, and Brassicaceae yielded the greatest bee abundances and species numbers, with visitations to those three plant families accounting for 85% of bee abundance from sweep collections and 92% of bee species. The ten plant genera with the highest bee visitation in descending order were *Melilotus, Sonchus, Cirsium, Helianthus, Grindelia, Solidago,* *Salix, Taraxacum, Euphorbia,* and *Erigeron.* The greatest numbers of bee species were collected from these same plant genera but their rank order changed with the greatest number of bee species collected from *Solidago* followed by *Cirsium*, *Sonchus*, *Melilotus*, *Helianthus*, *Grindelia*, *Taraxacum*, *Euphorbia*, *Salix,* and *Erigeron*. Not all plants were identified to genus, so the categories of unidentified plants in the tribe Astereae and the family Brassicaceae were also highly visited. The ten plant species with the highest bee visitation in descending order were *Melilotus officinalis, Sonchus arvensis, Grindelia squarrosa, Taraxacum officinale, Cirsium arvense, Euphorbia esula, Cirsium vulgare*, *Erigeron annuus, Brassica rapa,* and *Helianthus annuus.* The greatest numbers of bee species were collected from *Sonchus arvensis, Melilotus officinalis, Grindelia squarrosa, Cirsium arvense, Taraxacom officinale, Euphorbia esula, Cirsium vulgare, Oligoneuron rigidum, Erigeron annuus,* and *Medicago sativa.*

4.3.6 Comparison of flower visitation from current and historic surveys

Historic collections occurred on a wider variety of plant species compared to the 2010-2012 survey. From 1910-1920, bees were collected from 136 plant species representing 97 genera and 32 families. Collections from the plant families Asteraceae, Fabaceae, and Apiaceae yielded the greatest bee abundances and species numbers, with visitations to those three plant families accounting for 80% of bee abundances and 89% of bee species. The ten plant genera with the highest bee visitation in descending order were *Grindelia, Zizia, Solidago, Helianthus, Melilotus, Symphyotrichum, Lactuca, Cirsium, Erigeron,* and *Taraxacum.* The greatest numbers of bee species were collected from *Grindelia*, *Solidago*, *Zizia*, *Helianthus*, *Melilotus*, *Symphyotrichum*, *Lactuca*, *Taraxacum*, *Dalea*, and *Hydrophyllum* in descending order. The ten plant species with the highest bee visitation in descending order were *Grindelia squarrosa*, *Zizia aurea*, *Solidago canadensis*, *Melilotus officinalis*, *Lactuca pulchella*, *Symphyotrichum lanceolatum*, *Cirsium undulatum*, *Erigeron philadelphicus*, *Helianthus maximiliani, Hydrophyllum virginianum,* and *Taraxacum officinale*. The greatest numbers of bee species were collected from *Grindelia squarrosa, Zizia aurea, Melilotus officinalis,* *Lactuca pulchella, Solidago canadensis, Symphyotrichum lanceolatum, Hydrophyllum virginianum, Taraxacum officinale, Cirsium undulatum,* and *Erigeron philadelphicus*.

There were 31 plant genera from which bees were collected during both surveys: 16 of these increased in abundance, 12 decreased in abundance, and 9 showed no change (Fig. 4-8, Table 4-9). The plant genera *Sisymbrium, Heliopsis, Thlaspi, Brassica, Salix, Melilotus, Sonchus*, and *Anemone* had over 70% increase in the relative abundance of bee visitors. The plant genera *Sisymbrium, Thlaspi, Sonchus, Anemone,* and *Cirsium* all had over 60% increase in the relative species richness of bee visitors. The plant genera *Trifolium*, *Hydrophyllum*, *Amorpha*, *Dracocephalum*, *Zizia*, *Ratibida*, and *Centaurea* had over 70% decrease in the relative abundance of bee visitors. *Centaurea, Ratibida, Zizia, Symphyotrichum,* and *Hydrophyllum* had over 50% reduction in relative species richness of bee visitors.

Two plant genera with visitation records in the 1910 to 1920 survey were completely absent from the current survey (*Lactuca* and *Dalea*) (Table 4-10). Several others plant genera received less than 2% visitation in the current survey, but received higher visitation in the 1910-1920 collection (*Zizia*, *Hydrophyllum*, and *Centaurea*). The native plants *Zizia aurea*, *Hydrophyllum virginianum*, and *Dalea purpurea* were all found during blooming flower surveys, though at very low overall cover. No plants in the genera *Lactuca* or *Centaurea* were found during 2010-2012 blooming plant surveys. The species of *Lactuca* from which all bee collections were made was *Lactuca pulchella*, a native plant.

4.4 Discussion

Although nearly all land formerly occupied by tall grass prairie in the prairie pothole region of North Dakota has been replaced by agricultural land, many native bee species are still present albeit with significant shifts in composition of the bee community. An estimated loss in species richness of 16% to 30% shows that a significant portion of bee diversity is likely to have been lost. Other studies globally have also found significant losses of bee biodiversity (Biesmeijer et al. 2006; Burkle et al. 2013; Senapathi et al. 2015). The decrease in the Shannon diversity index from 4.51 ± 0.01 to

3.67 ± 0.01, along with comparison of relative abundances of bees both at the generic and species level, shows that there has been homogenization of the bee community, with less evenness among bee genera and species. Fewer species are accounting for a larger proportion of overall abundance. In the 1910-1920 survey, the three most abundant species accounted for 10% of overall abundance. In the 2010-2012 survey, the three most abundant species accounted for 25% of overall abundance. Bee and pollinator conservation measures can only be effective in preserving biodiversity if a sufficient species pool still exists in a region. The collection of 166 species or species groups in this area, including habitat and diet specialist bees such as *Lasioglossum oenothera, Hylaeus nelumbonis,* species of conservation concern such as *Bombus terricola*, and cleptoparasitic bees such as *Stelis lateralis, Coelioxsys moesta,* and *Nomada aquilarum*, shows that despite loss of the majority of native habitat and loss of a significant portion of bee biodiversity, the bee community of the prairie pothole region in North Dakota still houses a rich species pool that includes bees with varying habitat and diet needs. To prevent further erosion in abundance and diversity of these important bee pollinators, habitat improvements should be made to enhance their floral resources and nesting requirements.

Sampling methods: The three different bee sampling methods utilized in the current survey complemented each other and were effective in characterizing the bee community. Although 30% of species in the current survey were represented by a single specimen, this is not unusual as other bee surveys in eastern North America have reported rates of singletons of 19-52% (Giles & Ascher 2006; Grundel et al. 2010; Richards et al. 2011; Cusser et al. 2015). The collection of 21 new state records indicates that despite significant historic collections, characterization of bee diversity in this region still needs attention. The two most effective methods were sweep netting and bowl traps. Although many species were collected by both sweep netting and bowl traps, 37 species (23% of total species collected) were only collected by sweep netting and 32 species (19%) were only collected by bowl traps. The inclusion of "best site" sweep netting survey locations in addition to repeated transects added an additional 7 species (4%). The addition of this method had a minimal contribution to species number, but could be a useful addition to survey methods when the goal is collection of a maximum number of species with little additional effort. Trap nests only yielded 8 bee species, but 4 of those 8 species were not collected by any of the other methods. A high proportion of the specimens in the trap nests were introduced bees, a finding that agrees with a recent study of trap nests in Toronto (MacIvor & Packer 2015). The deployment of trap nests requires little labor and maintenance during the season, but specimen processing can be labor intensive. The use of trap nests is an excellent tool for characterizing cavity nesting bee communities, but its utility in general surveys needs further examination.

Non-bee flower visitors: A large number of non-target organisms are caught in bowl traps because they lure insects by visually mimicking floral resources. In this study, there were 1.5 non-bee arthropods in bowl traps for every bee. The beneficial insects found in these traps, such as the parasitic wasps, may be of particular interest for integrated pest management of crops. As bowls are a common method for surveying bees, survey methods should include plans for by-catch from bowl traps as they could hold valuable information. Of flies in the family Syrphidae, one species, *Toxomerus marginatus,* dominated collections, accounting for nearly three-fourths of all syrphid flies. Other studies have found a similar dominance of *T. marginatus* in tall grass prairies and agricultural areas in the Northern Great Plains, with presence from early spring to late fall and visitation of a wide range of flowers (Robson 2008; Mogren et al. 2016). Despite their prevalence, their impact as pollinators is understudied. Future research on the impact of *T. marginatus* and other abundant pollinating insects on pollination networks would be beneficial.

Comparison of past and current bee communities: Examining changes in the relative abundance and species richness of bees between past and current surveys revealed several important changes. The increase in relative abundances of *Lasioglossum*, *Mellisodes, Halictus,* and *Ceratina* may indicate an ability of these bees to better adapt to human disturbance compared to other bee genera. *Lasioglossum, Mellisodes,* and *Halcitus* nest in the ground, and *Ceratina* nests in stems, the latter a habit possibly leading to habitat limitation due to lack of undisturbed standing vegetation. *Ceratina* and *Halictus* as well as most *Lasioglossum* are generalist foragers, but many *Mellisodes* are floral specialists to some degree, primarily on flowers in the family Asteraceae, a plant family that often maintains high abundances in disturbed landscapes and was highly represented in the current survey of blooming flowers. The abundance of Asteraceae may have enabled *Mellisodes* to meet their dietary needs despite the widespread alteration of the plant community. *Halictus* and *Ceratina* as well as most *Lasioglossum* species have long seasons of activity from May through September. Most *Mellisodes* species are active from July through September. For *Lasioglossum, Halictus,* and *Certina,* it is possible that their generalist diet and long season of activity are traits that enable these groups to survive in highly disturbed landscapes.

The decline in relative abundance of bumble bees and the loss of a high proportion of *Bombus* species is consistent with findings across the globe (Grixti et al. 2009; Cameron et al. 2011; Colla et al. 2012; Bartomeus et al. 2013; Goulson et al. 2015), pointing to the urgency of conservation efforts aimed at this group. The change from *Bombus terricola* being the most abundant bee species to being represented by only a single specimen demonstrates the dramatic level of decline some species in this group have experienced. Equally compelling is the case of *B. ashtoni* (*bohemicus*), a cuckoo bee specializing on two currently declining bumble bee species in eastern North America, *B. terricola* and *B. affinis*. Although found at only 1% relative abundance in the 1910-1920 survey, Stevens notes that *B. ashtoni* was the most common of the cuckoo bumble bees in North Dakota (Stevens 1948b). Interestingly, there were no cuckoo bumble bees found in the 2010-2012 collections.

Reductions in abundances of formerly common species clearly demonstrate declines. While declines in less common species are more difficult to demonstrate, as detection is less reliable, there were several less common groups with compelling evidence for decline. The declines in abundance and the high proportions of species loss for the genera *Megachile* and *Colletes* point to the importance of including a broad diversity of bees in conservation efforts. In addition, the window into the past provided by the 1910-1920 surveys shows a bee community that housed bees now considered to be extremely rare. *Epeoloides pilosulus* is a species that was never highly abundant but was once widespread throughout eastern North America. It was not captured for 60 years until recent finds in Nova Scotia and New England (Sheffield et al. 2004; Wagner & Ascher 2008). Although this species was not rediscovered in North Dakota during the current survey, its recent discovery in other areas points to the possibility of rare species remaining undetected for extended periods of time. The discovery of new state records for 21 species is additional evidence of the possibility that more rare bees could be discovered in this region.

Currently important plants: Flower visitation is an indirect measure of the nutritional impact a plant has on a bee, but visitation data are often collected because collection and analysis of pollen and nectar directly from bee specimens is often impractical. Both bee abundance and the number of bee species were highest on *Melilotus officinalis, Sonchus arvensis,* and *Grindellia squarrosa.* The high level of visitation to these plants may be due in part to the high abundance of these plants. As abundance and species richness were correlated, the high species numbers found visiting these plants does not necessarily indicate support for high overall bee diversity but could be a reflection of the abundance of these flowers. It is well known that floral choice by bees is not driven by floral abundance alone, as other characteristics including reward quality, also are influential on floral choice (Essenberg 2012). An example from this survey is the plant *Oligoneuron rigidum* which was also visited by a high number of bee species but was found at much lower abundance in the study area than these three other species.

Abundance and number of species visiting a plant are useful general indicators of plants that have the broadest impact on the bee community, but they do not indicate which flowers are of the most value to rare or declining bees. Some plants receiving fewer visits and visited by fewer species may be of great importance to declining bees, particularly if these bees are oligolectic, visiting a limited range of plant species. For example, the plant *Oenothera biennis*, the most abundant member of the family Onagraceae in the study area, was present at low cover and only one generalist bee, (*Lasioglossum succinipenne*) (Appendix A) was collected from *O. biennis* during the study, most likely due to a combination of low cover and flowers being most attractive in the evening (Stevens 1920b), outside of our normal collecting time. Several other bee species that are specialists on Onagraceae were recorded in the historical collection (*Lasioglossum lusorium, L. oenotherae,* and *L. texanum*), two of which were only collected by bowl traps in the current survey . It is assumed that as the most abundant plant in the region in that family, *Oenothera biennis* would be an important resource for these bee species, despite its low overall cover.

Comparison of past and current bee flower visitation: Comparisons of flower visitation between the 1910-1920 and 2010-2012 survey should be interpreted with caution. Differences in plant visitation between time periods could be due to changes in the plant and/or the bee communities, or they could be due to sampling differences between the surveys. There were large differences in the number of plant species from which bees were collected between the surveys. It is assumed that one of O.A. Steven's goals as a botanist was to record plant-bee interactions, whereas the main goal of the collections for the 2010-2012 survey was to assess the impact of varying land uses on bee communities, so collections were limited to areas within these land uses. The differences seen in the diversity of plants visited by bees could be due to changes in the landscape over the last 100 years, differences in collecting goals, or, most likely, the combined effect of a changing landscape and different collecting goals. Regardless of the origin of these differences, an examination of what plants were most commonly being used by bees was warranted.

Shifts in plant use by bees between survey periods were seen at the family level. The plant family Apiaceae was in the top three plant families for bee abundance and species richness along with Asteraceae and Fabaceae in the 1910-1920 survey. In contrast, Brassicaceae was in the top three plant families for the 2010-2012 survey. Most of the plants with high decreases in bee visitation were native in origin: *Hydrophyllum*, *Amorpha*, *Dracocephalum (parvefolium)*, *Zizia*, and *Ratibida*. In the 2010-2012 survey, these genera were present at low cover and few bees were collected from them. Most of the plants with high increases in bee visitation were non-native, with the exception of *Heliopsis*, *Salix*, and *Anemone*. While non-native flowers form the base of the diet of most bees in the region currently, awareness of the importance of particular native plants species in terms of both current and past use can guide restoration efforts.

Non-native plants have been a common element of the landscape in this region for over 120 years (Upham 1892; Stevens 1920a; Severson & Sieg 2006), but native plants have become increasingly rare. Changes in the plant community are reflected in changes in bees' plant usage compared to ~100 years ago. The native plants *Zizia aurea*, *Hydrophyllum virginianum*, *Dalea candida, D. purpurea, D. villosa,* and *Lactuca pulchella* were all much less frequently visited or not visited at all in the current survey. Due to the high level of visitation they received in the past, it is assumed that these plants were of value to the bee community and that the current low rate of visitation is a reflection of low plant abundance rather than a change in bee preference. Including these plants in plantings could benefit conservation of the native bee community. Including plants that support oligolectic bees, a group thought to be at greater risk of decline due specialized habitat needs, could also benefit native bee communities. The majority of the specialists collected in this study specialize on plants in the family Asteraceae (Chapter 2). Other plant groups supporting specialists found in this study include Salicaceae and Onagraceae. Efforts to include these plant families in plantings could help support specialist bees.

The collections of O.A. Stevens from the 1910's are the earliest bee collections in this region, but some indication of the earlier flowering plant community for bees in this region can be garnered from plants collected by Charles A. Geyer along the James River during an expedition in 1839. The following are some the forbs commonly found during that survey that are known to be utilized by bees and were not commonly found in the current survey: *Anemone patens*, *Ranunculus* spp., *Viola canadensis*, *Hypericum ellipticum*, *Linum perenne*, *Sphaeralcea coccinea*, *Vicia americana*, *Amorpha canescens*, *Dalea* spp., *Astragalus caryocarpus*, *Desmodium canadense*, *Potentilla* spp., *Rosa blanda*, *Epilobium* spp., *Liatris punctata*, *Eupatorium purpureum*, *Campanula rotundifolia*, *Gentiana* spp., *Monarda fistulosa*, *Agastache foeniculum*, *Physalis lanceolata*, *Mimulus* spp., *Veronia scitellata*, *Gerardia purpurea*, and *Verbena urticifolia* (Upham 1892). These are additional plant species that could benefit the remaining native bee community.

Although the native bee community in the prairie pothole region of eastern North Dakota has experienced a decline in biodiversity and major shifts in community structure, the community remains rich in the number of species present. Major shifts in plant communities, in addition to loss of nesting habitat, are likely causes of these shifts, although pests and parasites, pesticides, and changing climate can also have strong impacts on bee communities (Kearns & Oliveras 2009; Potts et al. 2010; Scheper et al.

2014; Goulson et al. 2015). Although the landscape has been highly altered for more than a century, dramatic land-use changes over the last decade may be a significant contributor to the observed declines. Inclusion of the native plants *Zizia aurea*, *Hydrophyllum virginianum*, *Dalea candida, D. purpurea, D. villosa,* and *Lactuca pulchella* in restoration efforts in this area could help to restore native bee/plant interactions. In addition, the value of non-native plants in supporting native bee communities should not be discounted. *Melilotus officinalis* and *Sonchus arvensis* were the two flowers from which the majority of bees and bee species were collected. Their ubiquitous presence in the agricultural landscape in this region provides important resources to support diverse native bee communities. Extremely low populations of once common bees points to the urgency of enacting conservation measures. The fact that these now rare bees are still present in this highly altered landscape gives hope to broad-scale pollinator habitat efforts to provide for these struggling remnants from the bee community of the last century.

4.5 Figures

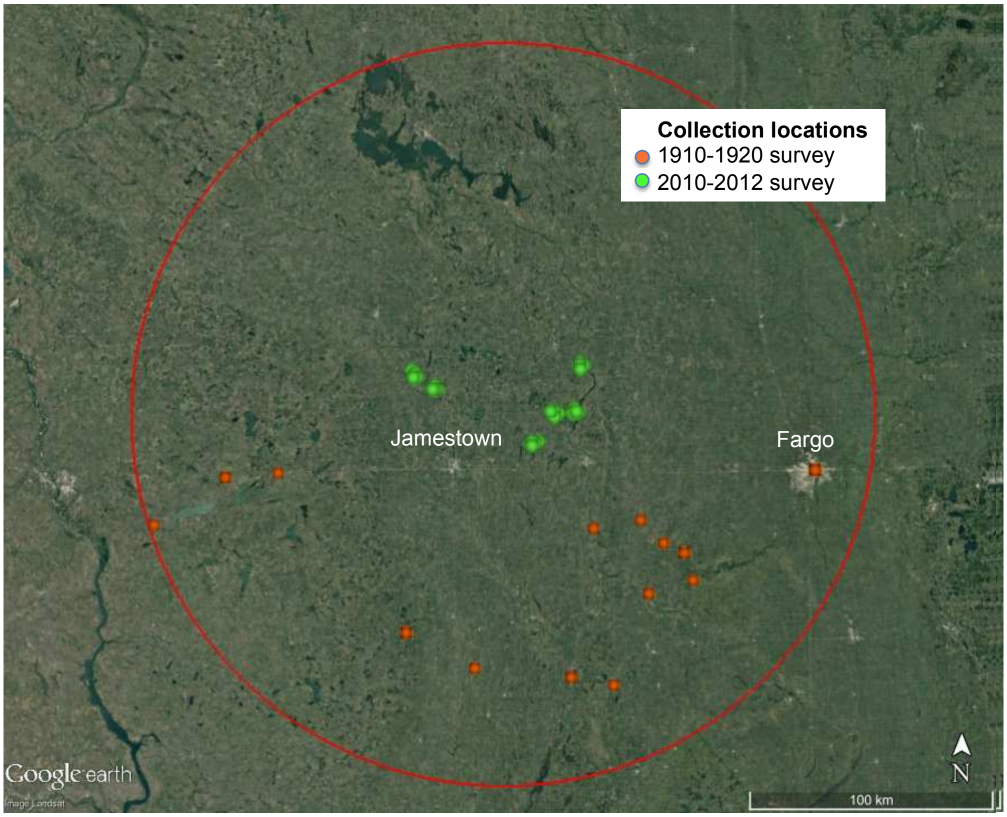

Figure 4-1. Collection locations for 1910-1020 and 2010-2012 surveys on North Dakota, USA.

Figure 4-2. **Trap nest array consisting of wooden observation nest blocks and a bundle of bamboo stems.**

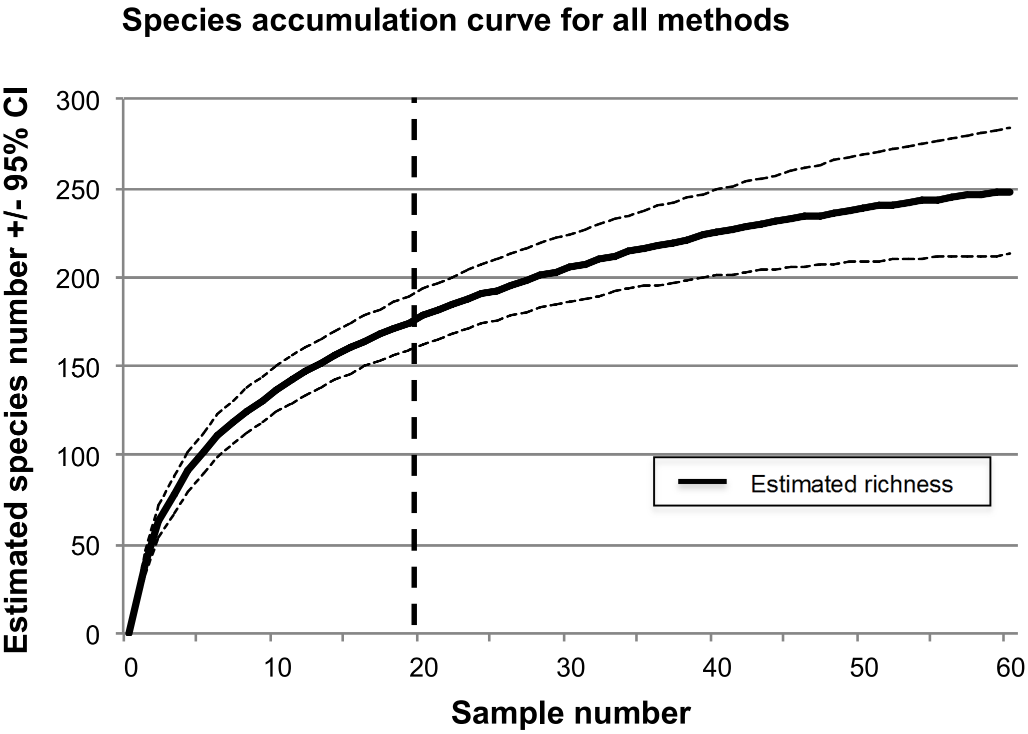

Figure 4-3. Sample based rarefaction curve for bee species richness over all sites and methods for 2010-2012 survey. Data points beyond the vertical dashed line (reference sample) were extrapolated to three times the reference sample using non-parametric methods (Colwell et al. 2012). The reference sample accounted for 72% of the extrapolated species richness.

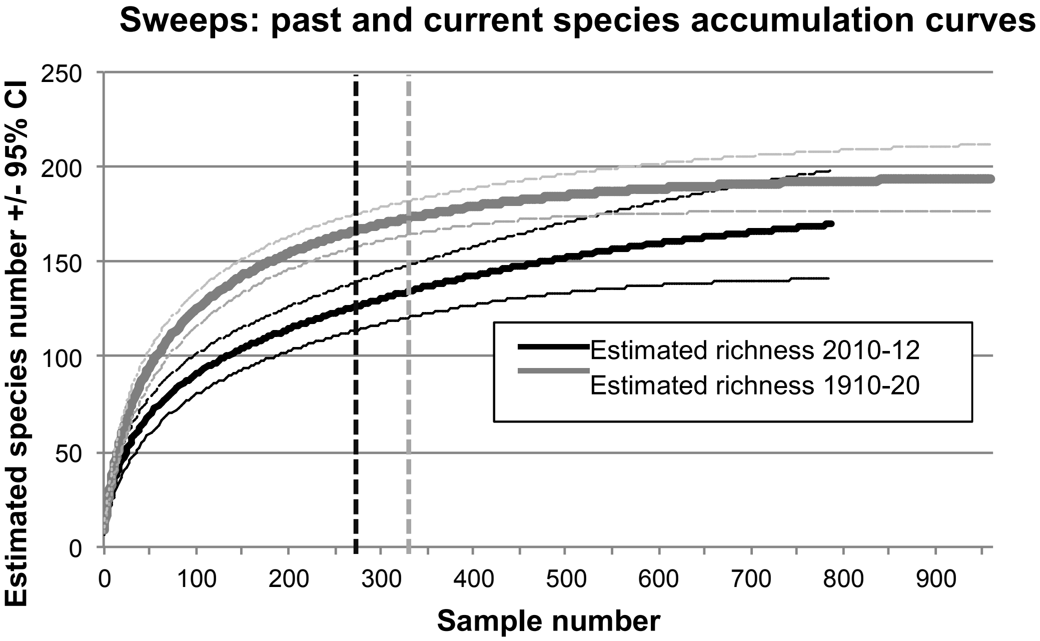

Figure 4-4. Sample based rarefaction curve for bee species richness over for all sweep netting collections for 1910-1920 and 2010-2012 surveys. Data points beyond the vertical dashed lines (reference samples) were extrapolated to three times the reference sample using non-parametric methods (Colwell et al., 2012).

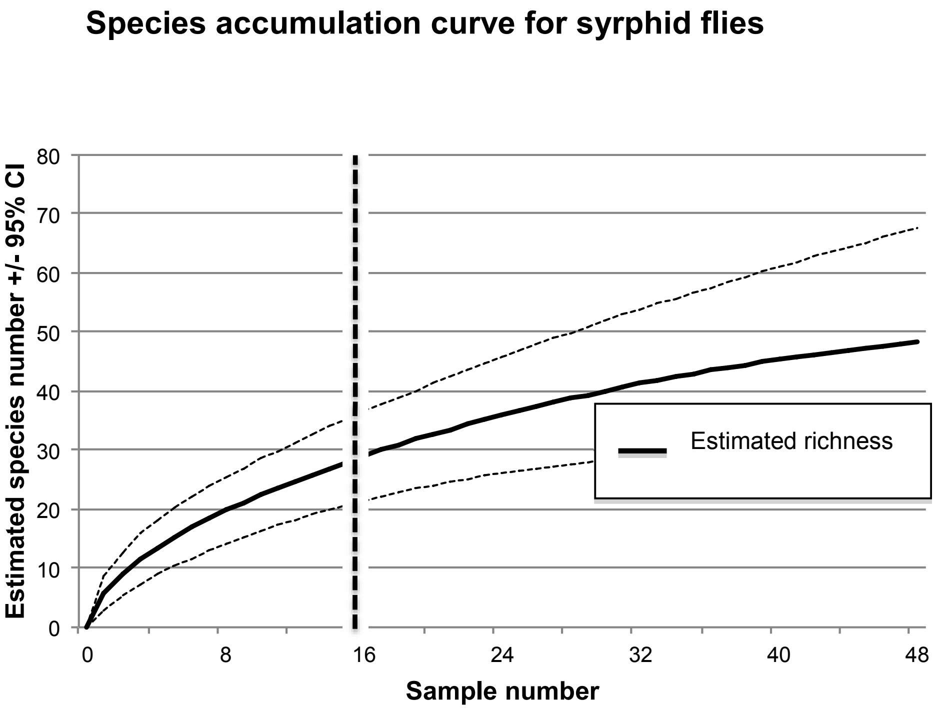

Figure 4-5. Sample based rarefaction curve for syrphid fly species richness over all sites and methods. Data points beyond the vertical dashed line (reference sample) were extrapolated to three times the reference sample using non-parametric methods Colwell et al., 2012). The reference sample accounted for 60% of the extrapolated species richness.

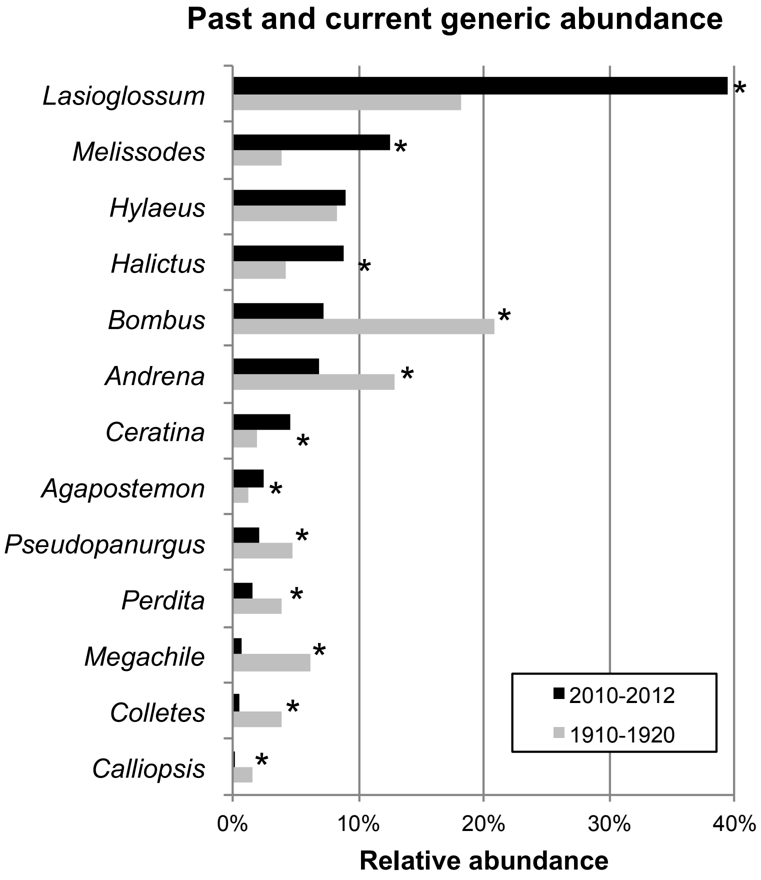

Figure 4-6. Relative abundance of bee genera from surveys from 1910 to 1920 compared to 2010 to 2012. Only genera comprising more that 2% relative abundance in either survey are included. For the 2010 to 2012 survey, only sweep netting collections were included, as that was the primary collection method for the 1910 to 1920 survey. Records from 1910 to 1920 surveys were limited to those within 150 km of the center of the 2010 to 2012 survey and from the same seasonal collection period (mid-May to mid-September).* denotes significance at <0.01 for *z*-test of equal proportion.

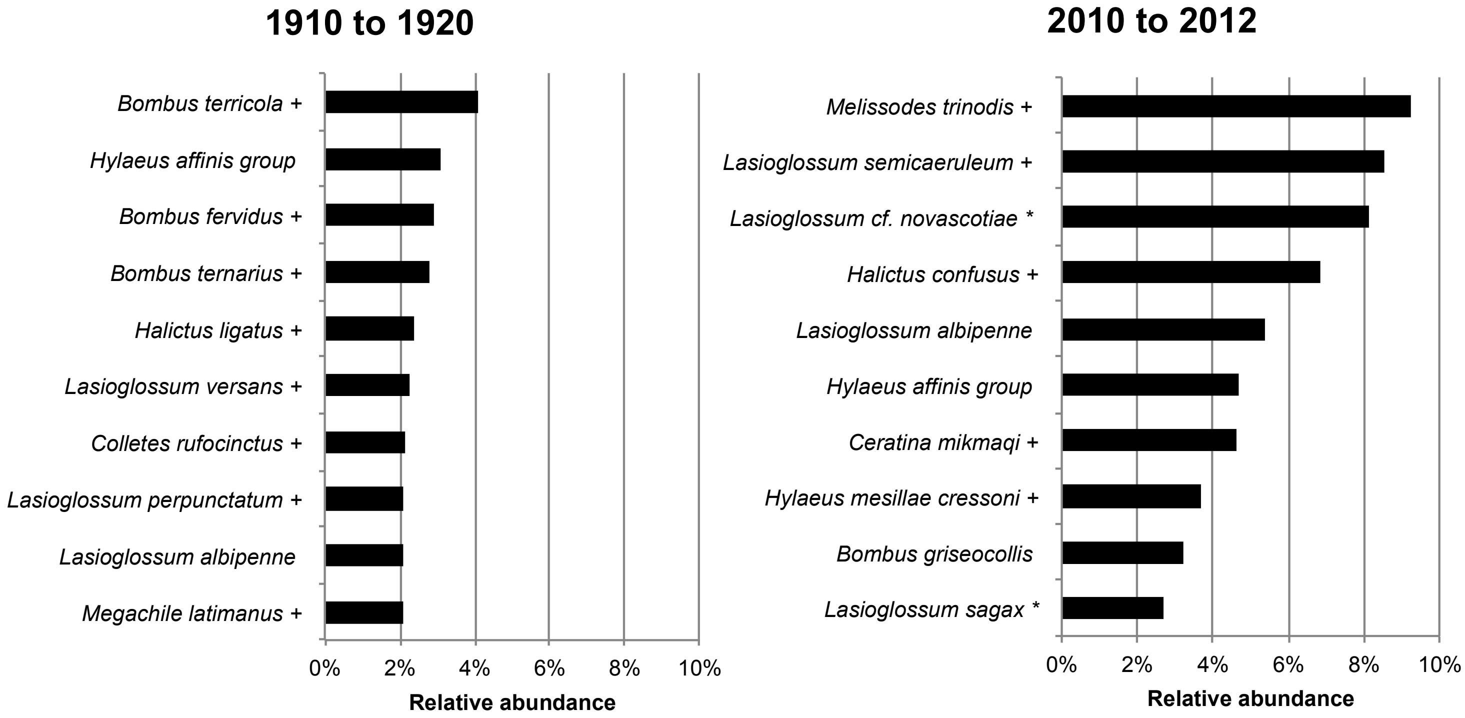

Figure 4-7. Relative abundance of common bee species from surveys from 1910 to 1920 compared to 2010 to 2012. Only the ten most abundant species are shown. For the 2010 to 2012 survey, only sweep netting collections were included, as that was the primary collection method for the 1910 to 1920 survey. Records from 1910 to 1920 surveys were limited to those within 150 km of the center of the 2010 to 2012 survey and from the same seasonal collection period (mid-May to mid-September).* = species that were present in one survey and not the other. + = species that were present in both surveys but below 2% abundance in the other survey.

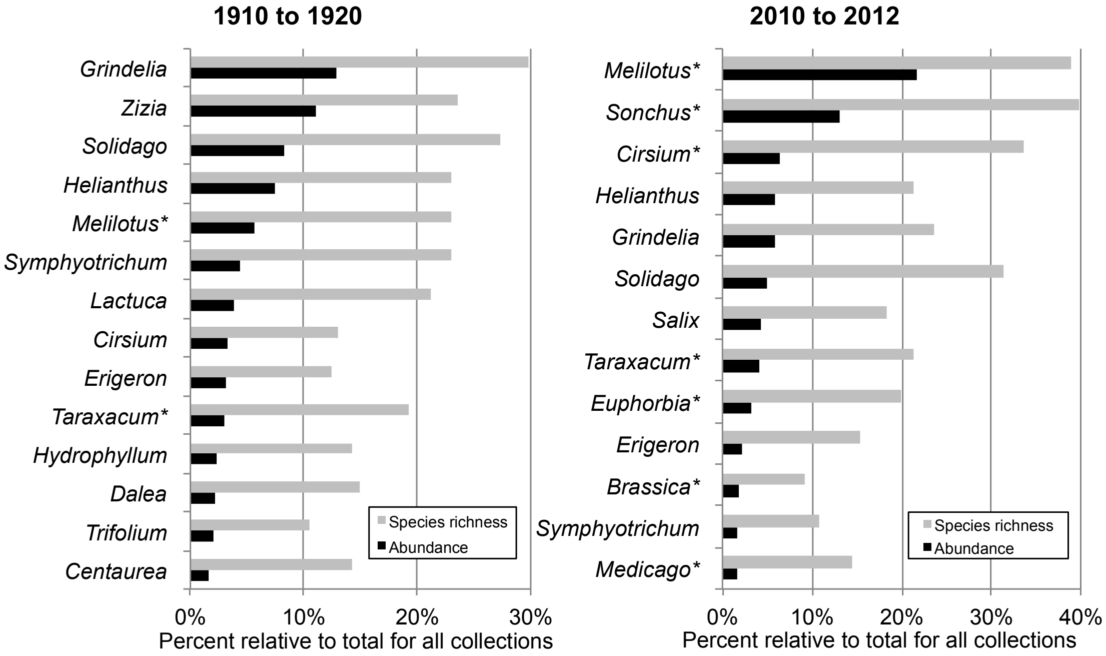

Figure 4-8. Change in relative abundance and relative species richness of bee visitors to plant genera from 1910-1920 to 2010-2012. Bee and plant records from 1910 to 1920 records were limited to those within 150 km of current collecting sites from the same seasonal collection window (mid-May to mid-September). Collections for both time periods were summarized as relative measures. Plant genera with bee visitors comprising less than 2% of total abundance for either time period were excluded. * introduced plants.

4.6 Tables

Bee family	Bee species	Total netting (transect, 25m^2)	Bowl trap	Trap nest	Grand Total
	Number spp. unique to method	47 (33,7)	32	4	
Coll		237 (222, 15)	68	565	870
	Colletes brevicornis	-	2	-	2
	Colletes kincaidii	9 (7, 2)	1	-	10
	Colletes lutzi lutzi	1 (1, 0)	-	-	1
	Colletes rufocinctus	1 (1, 0)	-	-	1
	Hylaeus affinis	59 (55, 4)	23	-	82
	Hylaeus affinis or *modestus*	58 (54, 4)	33	-	91
	Hylaeus leptocephalus *	8 (7, 1)	1	565	574
	Hylaeus mesillae	93 (90, 3)	4	-	97
	Hylaeus mesillae cressonii	4 (3, 1)	-	-	4
	Hylaeus modestus	-	2	-	2
	Hylaeus modestus or sp. A (Arduser)	2 (2, 0)	1	-	3
	Hylaeus nelumbonis +	-	1	-	1
	Hylaeus rudbeckiae	2 (2, 0)	-	-	2
And		270 (201, 69)	93	-	363
	Andrena accepta	3 (2, 1)	-	-	3
	Andrena barbilabris	3 (1, 2)	1	-	4
	Andrena canadensis	4 (4, 0)	1	-	5
	Andrena chromotricha	13 (13, 0)	6	-	19
	Andrena commoda	13 (11, 2)	11	-	24
	Andrena erythrogaster	2 (0, 2)	-	-	2
	Andrena forbesii	2 (0, 2)	-	-	2
	Andrena helianthi	11 (10, 1)	3	-	14
	Andrena hippotes	2 (1, 1)	1	-	3
	Andrena hirticincta	5 (5, 0)	-	-	5
	Andrena illinoiensis	3 (2, 1)	-	-	3
	Andrena lupinorum	8 (7, 1)	10	-	18
	Andrena macoupinensis+	1 (0, 1)	-	-	1
	Andrena mariae	-	1	-	1
	Andrena medionitens	40 (2, 38)	4	-	44
	Andrena nivalis	3 (2, 1)	3	-	6
	Andrena nubecula	14 (13, 1)	1	-	15
	Andrena quintilis	1 (1, 0)	-	-	1
	Andrena robervalensis	-	1	-	1
	Andrena rugosa	1 (0, 1)	-	-	1
	Andrena salictaria	1 (1, 0)	-	-	1
	Andrena specularia	2 (2, 0)	-	-	2
	Andrena thaspii	16 (14, 2)	9	-	25
	Andrena virginiana	1 (1, 0)	-	-	1
	Andrena w-scripta	2 (0, 2)	-	-	2
	Andrena wilkella *	17 (10, 7)	3	-	20
	Andrena ziziae	1 (1, 0)	-	-	1

continues

Bee family	**Bee species**	**Total netting (transect, 25m^2)**	**Bowl trap**	**Trap nest**	**Grand Total**
contd.	*Andrena* sp.	3 (1, 2)	1	-	4
	Calliopsis andreniformis	-	1	-	1
	Calliopsis coloradensis	2 (2, 0)	-	-	2
	Calliopsis nebraskensis	1 (1, 0)	-	-	1
	Perdita albipennis pallidipennis	1 (1, 0)	-	-	1
	Perdita bruneri	3 (3, 0)	1	-	4
	Perdita octomaculata	36 (36, 0)	-	-	36
	Pseudopanurgus aestivalis	4 (4, 0)	1	-	5
	Pseudopanurgus albitarsis$^+$	9 (9, 0)	6	-	15
	Pseudopanurgus dakotensis	1 (1, 0)	-	-	1
	Pseudopanurgus labrosus	1 (1, 0)	-	-	1
	Pseudopanurgus piercei	-	1	-	1
	Pseudopanurgus renimaculatus	9 (9, 0)	-	-	9
	Pseudopanurgus sp. *rudbeckiae* group	7 (7, 0)	1	-	8
	Pseudopanurgus simulans	24 (23, 1)	26	-	50
Hal		1342 (1056, 286)	9938	-	11280
	Agapostemon femoratus	1 (0, 1)	-	-	1
	Agapostemon texanus	23 (9, 14)	275	-	298
	Agapostemon virescens	39 (31, 8)	258	-	297
	Augochlorella aurata	-	15	-	15
	Dieunomia triangulifera	2 (2, 0)	1	-	3
	Dufourea marginata	43 (35, 8)	65	-	108
	Dufourea maura	-	1	-	1
	Halictus confusus	172 (153, 19)	1358	-	1530
	Halictus ligatus	35 (28, 7)	30	-	65
	Halictus parallelus	2 (1, 1)	2	-	4
	Halictus rubicundus	15 (15, 0)	91	-	106
	Holcopasites heliopsis	2 (2, 0)	-	-	2
	Lasioglossum aberrans	-	1	-	1
	Lasioglossum acuminatum$^+$	3 (3, 0)	16	-	19
	Lasioglossum admirandum	60 (46, 14)	461	-	521
	Lasioglossum albipenne	135 (116, 19)	1136	-	1271
	Lasioglossum cf. *novascotiae*	204 (154, 50)	1592	-	1796
	Lasioglossum cinctipes	2 (2, 0)	1	-	3
	Lasioglossum cressonii	-	2	-	2
	Lasioglossum cf. *ellisiae*	16 (14, 2)	48	-	64
	Lasioglossum cf. *ephialtum*	22 (17, 5)	93	-	115
	Lasioglossum foxii	1 (1, 0)	1	-	2
	Lasioglossum imitatum	11 (2, 9)	2	-	13
	Lasioglossum incompletum$^+$	-	2	-	2
	Lasioglossum laevissimum	4 (3, 1)	3	-	7

continues

Bee family	Bee species	Total netting (transect, $25m^2$)	Bowl trap	Trap nest	Grand Total
contd.	*Lasioglossum leucozonium* $^{*+}$	13 (12, 1)	46	-	59
	Lasioglossum lineatulum	16 (8, 8)	14	-	30
	Lasioglossum lusorium	-	4	-	4
	Lasioglossum macoupinense	4 (4, 0)	2	-	6
	Lasioglossum novascotiae^{+}	12 (12, 0)	7	-	19
	Lasioglossum occidentale	5 (5, 0)	24	-	29
	Lasioglossum packeri	5 (5, 0)	2	-	7
	Lasioglossum paraforbesii	33 (28, 5)	399	-	432
	Lasioglossum pectorale	15 (14, 1)	38	-	53
	Lasioglossum cf. *perdifficile*	1 (1, 0)	-	-	1
	Lasioglossum perpunctatum	35 (27, 8)	48	-	83
	Lasioglossum pictum	-	2	-	2
	Lasioglossum nr. *pictum*	-	1	-	1
	Lasioglossum pruinosum	56 (42, 14)	1528	-	1584
	Lasioglossum sagax^{+}	68 (53, 15)	441	-	509
	Lasioglossum semicaeruleum	214 (153, 61)	871	-	1085
	Lasioglossum succinipenne	5 (4, 1)	93	-	98
	Lasioglossum texanum	-	1	-	1
	Lasioglossum truncatum	4 (3, 1)	5	-	9
	Lasioglossum versans	13 (12, 1)	30	-	43
	Lasioglossum viridatum^{+}	3 (3, 0)	18	-	21
	Lasioglossum zephyrum	11 (3, 8)	2	-	13
	Lasioglossum zonulum	14 (13, 1)	865	-	879
	Lasioglossum (*Dialictus*) sp.	7 (7, 0)	29	-	36
	Sphecodes cf. *atlantis*	3 (3, 0)	-	-	3
	Sphecodes confertus	1 (1, 0)	-	-	1
	Sphecodes coronus^{+}	4 (4, 0)	11	-	15
	Sphecodes cressonii	1 (1, 0)	-	-	1
	Sphecodes dichrous	3 (1, 2)	-	-	3
	Sphecodes nr. *coronus*	-	2	-	2
	Sphecodes nr. *cressonii*	1 (1, 0)	-	-	1
	Sphecodes prosphorus^{+}	2 (1, 1)	-	-	2
	Sphecodes sp. *ranunculi* group	2 (2, 0)	-	-	2
	Sphecodes sp. *cressonii* group	1 (1, 0)	-	-	1
	Sphecodes sp.	-	1	-	1
Meg		34 (33, 1)	73	421	528
	Ashmeadiella bucconis	1 (1, 0)	-	-	1
	Coelioxys moestus	-	-	1	1
	Heriades carinata	3 (2, 1)	-	38	41
	Heriades variolosa	-	-	32	32
	Hoplitis pilosifrons	7 (7, 0)	34	-	41
	Hoplitis producta	5 (5, 0)	22	-	27
	Hoplitis spoliata	-	-	2	2

continues

Bee family	**Bee species**	**Total netting (transect, 25m^2)**	**Bowl trap**	**Trap nest**	**Grand Total**
contd.	*Megachile brevis brevis*	5 (5, 0)	2	-	7
	Megachile centuncularis	1 (1, 0)	-	169	170
	Megachile inermis	3 (3, 0)	4	-	7
	Megachile latimanus	7 (7, 0)	5	-	12
	Megachile relativa	1 (1, 0)	1	177	179
	Megachile rotundata *	-	-	2	2
	Osmia cyaneonitens +	-	2	-	2
	Osmia illinoensis	-	1	-	1
	Stelis lateralis	1 (1, 0)	2	-	3
Api		638 (542, 96)	1,268	-	1,906
	Anthophora bomboides	-	1	-	1
	Anthophora terminalis	-	4	-	4
	Anthophora walshii	2 (0, 2)	1	-	3
	Bombus bimaculatus	12 (11, 1)	4	-	16
	Bombus borealis	12 (11, 1)	17	-	29
	Bombus fervidus	9 (8, 1)	48	-	57
	Bombus griseocollis	83 (78, 5)	28	-	111
	Bombus huntii	17 (17, 0)	8	-	25
	Bombus rufocinctus	6 (5, 1)	3	-	9
	Bombus ternarius	35 (32, 3)	18	-	53
	Bombus terricola	1 (1, 0)	-	-	1
	Bombus vagans	11 (11, 0)	2	-	13
	Ceratina calcarata	-	2	-	2
	Ceratina mikmaqi	116 (96, 20)	189	-	305
	Eucera hamata+	-	1	-	1
	Melissodes agilis	63 (50, 13)	381	-	444
	Melissodes bimaculatus	1 (1, 0)	6	-	7
	Melissodes confusus	1 (1, 0)	-	-	1
	Melissodes coreopsis	-	2	-	2
	Melissodes druriellus	1 (1, 0)	-	-	1
	Melissodes nr. *druriellus*	-	1	-	1
	Melissodes illatus+	4 (4, 0)	3	-	7
	Melissodes menuachus	-	1	-	1
	Melissodes niveus+	-	1	-	1
	Melissodes perlusus	-	2	-	2
	Melissodes rivalis	1 (1, 0)	8	-	9
	Melissodes subillatus	8 (8, 0)	11	-	19
	Melissodes trinodis	232 (187, 45)	506	-	738
	Melissodes sp.	3 (3, 0)	1	-	4
	Melissodes sp. 1 (Arduser)	-	1	-	1
	Nomada aquilarum +	2 (2, 0)	-	-	2
	Nomada articulata	1 (1, 0)	8	-	9
	Nomada bethunei	1 (0, 1)	-	-	1
	Nomada sp. bidentate group	-	1	-	1

Bee family	Bee species	Total netting (transect, 25m^2)	Bowl trap	Trap nest	Grand Total
contd.	*Nomada cuneata*	2 (2, 0)	1	-	3
	Nomada denticulata[+]	-	1	-	1
	Nomada vincta	-	7	-	7
	Nomada sp.	3 (2, 1)	-	-	3
	Svastra obliqua obliqua	1 (1, 0)	-	-	1
	Triepeolus helianthi	8 (6, 2)	-	-	8
Grand Total		**2,521 (2054, 467)**	**11,440**	**986**	**14,947**

Table 4-1 Species and species groups found in Griggs, Stutsman, and Barnes counties ND, 2010 to 2012. * non-native species. + new state records for ND. Col=Colletidae, And=Andrenidae, Hal=Halictidae, Meg=Megachilidae, Api=Apidae

Phylum	Class	Order	Family	Abundance
Arthropoda				17,025
	Arachnida	Arachnida total		13
		Araneae total		
		Araneae	Lycosidae	5
			Salticidae	8
	Insecta	Insecta total abundance (non-bee)		17,012
		Coleoptera total		190
			Anthicidae	2
			Anthribidae	20
			Cantharidae	8
			Carabidae	10
			Cerambycidae	1
			Chrysomelidae	14
			Cleridae	2
			Coccinelidae	7
			Curculionidae	10
			Elateridae	5
			Empididae	32
			Erotylidae	1
			Lampyridae	11
			Melloidae	2
			Mordelidae	9
			Nitidulidae	37
			Scarabaeidae	3
			Staphalynidae	13
			Tenebrionidae	3
		Diptera total		15,315
			Anthomyiidae	10,639
			Asilidae	10
			Bombyliidae	7
			Calliphoridae	529
			Chironomidae	15
			Chloropidae	2
			Culicidae	30
			Dolichopodidae	179
			Lauxaniidae	19
			Muscidae	56
			Phoridae	10
			Sarcophagidae	593
			Scathophagidae	76
			Sepsidae	3
			Stratiomyidae	223
			Syrphidae	2,785
			Tabanidae	30
			Tachinidae	105
			Tephritidae	4
		Hemiptera total		262
			Cicadellidae	123
			Delphacidae	2
			Membracidae	17
			Miridae	28
			Nabidae	6
			Reduviidae	86
				continues

Phyllum	Class	Order	Family	Abundance
contd.	contd.	Hymenoptera total (non-bee)		605
			Argidae	10
			Bethylidae	1
			Brachonidae	5
			Chrysididae	8
			Cimbicidae	1
			Crabonidae	25
			Diapriidae	5
			Figitidae	4
			Eumenidae	7
			Eupelmidae	2
			Eurytomidae	20
			Formicidae	415
			Ichneumonidae	24
			Netelia	1
			Pompilidae	29
			Tenthredinidae	40
			Torymidae	5
			Vespidae	2
		Lepidoptera total		483
			Cercopidae	1
			Crambidae	11
			Geometridae	1
			Hesperidae	81
			Lycaenidae	62
			Lymantriidae	1
			Noctuidae	55
			Nymphalidae	3
			Pieridae	265
			Pyralidae	2
			Tortricidae	1
		Neuroptera total		93
			Chrysopidae	93
		Odonata total		5
			Libellulidae	5
		Orthoptera total		59
			Acrididae	39
			Gryllidae	5
			Tettigoniidae	15

Table 4-2. Abundances of non-bee arthropods captured in bowl traps in Griggs, Stutsman, and Barnes counties ND, 2010 to 2012.

Family	Subfamily	Species	Abundance
Syrphidae			2,784
	Eristalinae		600
		Eristalis anthophorina	1
		Eristalis bastardi	11
		Eristalis dimidiata	117
		Eristalis tenax	9
		Eristalis transversa	31
		Helophilus fasciatus	341
		Helophilus lapponicus	1
		Helophilus latifrons	6
		Helophilus obscurus/ hybridus	20
		Lejops chrysostomus	1
		Lejops curvipes	1
		Lejops fasciatus	8
		Lejops lineatus	44
		Mallota posticata	4
		Neoascia sp.	1
		Pterallastes thoracicus	1
		Syritta pipiens	1
		Tropidia quadrata	2
	Syrphinae		2,184
		Epistrophe grossulariae	1
		Eupeodes americanus	32
		Melanostoma pictipes	2
		Paragus bicolor	1
		Parhelophilus sp.	3
		Platycheirus quadratus	1
		Sphaerophoria contingua	4
		Sphaerophoria philanthus	5
		Sphaerophoria sp.	1
		Syrphus sp.	76
		Toxomerus marginatus	2,057
		Toxomerus politus	1

Table 4-3. Flies of family Syrphidae captured in bowl traps in Griggs, Stutsman, and Barnes counties ND, 2010 to 2012.

Family	Genus	*z* score	*p* value	Direction
Colletidae	*Colletes*	8.37	<0.01	-
	Hylaeus	-0.86	0.39	=
Andrenidae	*Andrena*	7.50	<0.01	-
	Calliopsis	5.62	<0.01	-
	Perdita	5.15	<0.01	-
	Pseudopanurgus	5.05	<0.01	-
Halictidae	*Agapostemon*	-3.36	<0.01	+
	Augochlorella	4.80	<0.01	-
	Halictus	-7.09	<0.01	+
	Lasioglossum	-17.46	<0.01	+
Megachilidae	*Ashmeadiella*	0.44	0.66	=
	Coelioxys	4.71	<0.01	-
	Heriades	3.41	<0.01	-
	Holcopasites	2.69	<0.01	-
	Hoplitis	3.32	<0.01	-
Megachilidae	*Ashmeadiella*	0.44	0.66	=
	Coelioxys	4.71	<0.01	-
	Megachile	10.74	<0.01	=
	Osmia	2.61	<0.01	-
	Stelis	3.68	<0.01	-
Apidae	*Bombus*	14.35	<0.01	-
	Ceratina	-5.42	<0.01	+
	Melissodes	-11.83	<0.01	+
	Nomada	0.28	0.780	=
	Triepeolus	-0.85	0.40	=

Table 4-4. Change in relative abundance of bee genera from 1910-1920 survey to 2010-2012 survey. Z-tests of equal proportions were run for the relative abundances of each bee genus present in both survey periods. The null hypothesis was that the proportion for each genus was equal during both time periods. + = an increase in 2010-2012 survey, - = a decrease in 2010-2012 survey, and = = no change between surveys.

Family	**Species**	***z* score**	***p* value**	**Direction**
Colletidae	*Colletes brevicornis*	1.66	0.10	=
	Colletes kincaidii	1.46	0.14	=
	Colletes rufocinctus	7.16	<0.001	-
	Hylaeus sp. *affinis* group	-2.02	0.04	+
	Hylaeus leptocephalus	5.24	<0.001	-
	Hylaeus mesillae	-6.15	<0.001	+
	Hylaeus rudbeckiae	-0.72	0.47	=
Andrenidae	*Andrena barbilabris*	-1.17	0.24	=
	Andrena canadensis	0.37	0.71	=
	Andrena chromotricha	3.23	<0.01	-
	Andrena commoda	0.44	0.66	=
	Andrena erythrogaster	1.43	0.15	=
	Andrena forbesii	0.62	0.54	=
	Andrena helianthi	2.10	0.04	-
	Andrena hippotes	2.97	<0.01	-
	Andrena hirticinta	3.66	<0.001	-
	Andrena lupinorum	-0.85	0.40	=
	Andrena mariae	1.05	0.30	=
	Andrena nivalis	1.45	0.15	=
	Andrena nubecula	3.44	<0.01	-
	Andrena quintilis	0.44	0.66	=
	Andrena runcinatae	3.47	<0.01	-
	Andrena thaspii	-3.36	<0.01	+
	Andrena virginiana	0.44	0.66	=
	Andrena ziziae	6.40	<0.001	-
	Calliopsis andreniformis	1.05	0.30	=
	Calliopsis coloradensis	4.52	<0.001	-
	Calliopsis nebraskensis	3.05	<0.01	-
	Perdita bruneri	6.53	<0.001	-
	Pseudopanurgus piercei	3.60	<0.001	-
	Pseudopanurgus renimaculatus	4.25	<0.001	-
	Pseudopanurgus simulans	-0.17	0.87	=
Halictidae	*Agapostemon texanus*	-4.11	<0.001	+
	Agapostemon virescens	-3.74	<0.001	+
	Augochlorella aurata	4.73	<0.001	-
	Halictus confusus	-14.14	<0.001	+
	Halictus ligatus	2.61	<0.01	-
	Halictus rubicundus	3.89	<0.001	-
	Lasioglossum admirandum	-7.05	<0.001	+
	Lasioglossum albipenne	-6.50	<0.001	+

continues

Family	**Species**	***z* score**	***p* value**	**Direction**
Halictidae contd.	*Lasioglossum foxii*	1.68	0.09	=
	Lasioglossum imitatum	1.72	0.09	=
	Lasioglossum laevissimum	6.00	<0.001	-
	Lasioglossum leucozonium	-1.03	0.30	=
	Lasioglossum lineatulum	-2.53	<0.01	+
	Lasioglossum paraforbesii	-0.67	0.51	=
	Lasioglossum pectorale	2.88	<0.01	-
	Lasioglossum perpunctatum	1.95	0.05	=
	Lasioglossum pruinosum	-6.07	<0.001	+
	Lasioglossum semicaeruleum	-12.08	<0.001	+
	Lasioglossum succinipenne	1.88	0.06	=
	Lasioglossum versans	5.36	<0.001	-
	Lasioglossum zephyrum	4.31	<0.001	-
	Sphecodes dichrous	-1.17	0.24	=
	Sphecodes sp. *ranunculi* group	-0.17	0.87	=
Megachilidae	*Ashmeadiella bucconis*	0.44	0.66	=
	Coelioxys moesta	2.10	<0.05	-
	Heriades carinata	3.29	<0.01	-
	Heriades variolosus	0.58	0.56	=
	Hoplitis pilosifrons	0.60	0.55	=
	Hoplitis producta	3.56	<0.001	-
	Hoplitis spoliata	0.58	0.56	=
	Megachile brevis brevis	2.47	<0.05	-
	Megachile centuncularis	4.22	<0.001	-
	Megachile inermis	0.16	0.87	=
	Megachile latimanus	5.93	<0.001	-
	Megachile relativa	6.92	<0.001	-
	Stelis lateralis	2.92	<0.01	-
Apidae	*Bombus bimaculatus*	-1.27	0.20	=
	Bombus borealis	4.86	<0.001	-
	Bombus fervidus	7.55	<0.001	-
	Bombus griseocollis	-3.24	<0.01	+
	Bombus huntii	-1.79	0.07	=
	Bombus rufocinctus	4.49	<0.001	-
	Bombus ternarius	3.69	<0.001	-
	Bombus terricola	10.15	<0.001	-
	Bombus vagans	4.72	<0.001	-
	Ceratina calcarata	2.64	<0.01	-
	Ceratina mikmaqi	-6.21	<0.001	+

continues

Family	Species	z score	p value	Direction
Apidae contd.	*Holcopasites heliopsis*	1.19	0.24	=
	Melissodes agilis	-7.46	<0.001	+
	Melissodes confusus	0.44	0.66	=
	Melissodes coreopsis	1.89	0.06	=
	Melissodes druriellus	4.11	<0.001	-
	Melissodes menuachus	1.38	0.17	=
	Melissodes perlusus	1.66	0.10	=
	Melissodes rivalis	2.77	<0.01	-
	Melissodes subillatus	-2.59	<0.01	+
	Melissodes trinodis	-16.81	<0.001	+
	Nomada articulata	1.16	0.25	=
	Nomada vincta	1.38	0.17	=
	Triepeolus helianthi	-1.79	0.07	=

Table 4-5. Change in relative abundance of bee species from 1910-1920 survey to 2010-2012 survey. *Z*-tests of equal proportions were run for the relative abundances of each bee species present in both survey periods. The null hypothesis is that the proportion for each species is equal during both time periods. + = an increase in 2010-2012 survey, - = a decrease in 2010-2012 survey, and = = no change between surveys.

Species present only 1910-1920 (abundance)		**Species present only in 2010-2012 (abundance)**	
Col.	*Colletes aberrans* (3)	Col.	*Colletes lutzi lutzi* (1)
	Colletes americanus (4)	And.	*Andrena accepta* (3)
	Colletes hyalinus hyalinus (1)		*Andrena illinoiensis* (3)
	Colletes impunctatus lacustris (1)		*Andrena macoupinensis* (1)
	Colletes latitarsis (1)		*Andrena medionitens* (40)
	Colletes phaceliae (6)		*Andrena rugosa* (1)
	Colletes robertsonii (1)		*Andrena salictaria* (1)
	Colletes simulans armatus (3)		*Andrena specularia* (2)
	Colletes simulans simulans (5)		*Andrena w-scripta* (2)
	Colletes willistoni (2)		*Andrena wilkella* (17)
	Hylaeus annulatus (31)		*Perdita albipennis pallidipennis* (1)
	Hylaeus basalis (10)		*Perdita octomaculata* (36)
	Hylaeus verticalis (25)		*Pseudopanurgus albitarsis* (9)
And.	*Andrena asteris* (1)		*Pseudopanurgus dakotensis* (1)
	Andrena brevipalpis (6)		*Pseudopanurgus labrosiformis* (1)
	Andrena crataegi (1)		*Pseudopanurgus labrosus* (1)
	Andrena cressonii cressonii (1)		*Pseudopanurgus nebrascensis* (4)
	Andrena dunningi (1)	Hal.	*Agapostemon femoratus* (1)
	Andrena fragilis (1)		*Dieunomia triangulifera* (2)
	Andrena frigida (2)		*Dufourea marginata* (43)
	Andrena geranii (20)		*Halictus parallelus* (2)
	Andrena haynesi (5)		*Lasioglossum acuminatum* (3)
	Andrena milwaukeensis (2)		*Lasioglossum cinctipes* (2)
	Andrena miranda (49)		*Lasioglossum* cf. *ellisiae* (15)
	Andrena nigrae (4)		*Lasioglossum* cf. *ephialtum* (20)
	Andrena wheeleri (7)		*Lasioglossum macoupinense* (4)
	Perdita laticincta (10)		*Lasioglossum novascotiae* (12)
	Perdita perpallida (9)		*Lasioglossum* cf. *novascotiae* (204)
	Perdita swenki (27)		*Lasioglossum occidentale* (5)
	Perdita tridentata (11)		*Lasioglossum packeri* (5)
	Pseudopanurgus aestivalis (23)		*Lasioglossum perdifficile* (1)
	Pseudopanurgus andrenoides (19)		*Lasioglossum sagax* (68)
	Pseudopanurgus parvus (11)		*Lasioglossum truncatum* (3)
Hal.	*Agapostemon sericeus* (8)		*Lasioglossum viridatum* (3)
	Agapostemon splendens (10)		*Lasioglossum zonulum* (14)
	Lasioglossum coriaceum (7)		*Sphecodes* cf. *atlantis* (3)
	Lasioglossum divergens (18)		*Sphecodes confertus* (1)
	Lasioglossum swenki (19)		*Sphecodes coronus* (4)
	Sphecodes davisii (1)		*Sphecodes cressonii* (1)
Meg.	*Coelioxys funeraria* (3)		*Sphecodes* near *cressonii* (1)
	Coelioxys rufitarsis (17)		*Sphecodes prosphorus* (2)
	Megachile frigida (3)	Api.	*Anthophora walshii* (2)
	Megachile melanophaea (2)		*Melissodes bimaculatus* (1)
	Megachile mendica (2)		*Melissodes illatus* (4)
	Megachile montivaga (1)		*Nomada aquilarum* (2)

Species present only in 1910-1920		Species present only in 2010-2012	
Meg. contd.	*Megachile pugnata pugnata* (5)	Api. contd.	*Nomada cuneata* (2)
	Megachile texana (1)		*Svastra obliqua* (1)
	Osmia simillima (8)		
	Stelis coarctatus (4)		
	Stelis labiata (2)		
Mel.	*Macropis nuda* (39)		
	Hesperapis carinata (19)		
Api.	*Bombus affinis* (2)		
	Bombus ashtoni (51)		
	Bombus citrinus (25)		
	Bombus nevadensis (2)		
	Bombus pensylvanicus (21)		
	Bombus perplexus (2)		
	Bombus variabilis (1)		
	Epeoloides pilosulus (2)		
	Holcopasites pulchellus (5)		
	Holcopasites stevensi (3)		
	Melissodes bidentis (9)		
	Melissodes communis communis (1)		
	Melissodes denticulatus (23)		
	Melissodes desponsus (8)		
	Melissodes grindeliae (1)		
	Melissodes lutulentus (1)		
	Melissodes pallidisignatus (1)		
	Melissodes snowii (1)		
	Melissodes subagilis (6)		
	Melissodes vernoniae (1)		
	Melissodes wheeleri (5)		
	Nomada subrubi (2)		
	Nomada vegana (1)		
	Nomada vicina stevensi (2)		
	Triepeolus cressonii (3)		

Table 4-6. Species present only in either survey. Col=Colletidae, And=Andrenidae, Hal=Halictidae, Meg=Megachilidae, Api=Apidae

Plant species	**Percent cover**
*Melilotus officinalis**	1.4
Erigeron annuus	0.6
*Medicago sativa**	0.6
*Sonchus arvensis**	0.5
*Brassica rapa**	0.4
*Cirsium arvense**	0.4
*Taraxacum officinale**	0.3
Symphoricarpos occidentalis	0.2
Anemone canadensis	0.1
Solidago canadensis	0.1
*Euphorbia esula**	0.1
Grindelia squarrosa	0.1
*Cirsium vulgare**	0.1
*Artemesia absinthium**	0.1
Helianthus maximilliani	0.1
Helianthus annuus	0.1

Table 4-7. Percent cover of commonly occurring blooming plant species in transects in study area in 2012-2012 survey. Blooming plant species occupying more than 0.1% of overall cover in descending order of abundance. Transects were primarily in areas where bee collections occurred, primarily in roadsides. * = introduced species.

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Plant family	**Plant**	**Abundance**	**Bee species**
Apiaceae total		19	5
	Zizia aptera	3	3
	Zizia sp.	16	3
Apocynaceae total		26	12
	Apocynum cannabinum	20	11
	Asclepias speciosa	1	1
	Asclepias verticilata	1	1
	Asclepias sp.	4	1
Asteraceae total		1271	101
	*Artemisia absinthium**	5	1
	Artemisia ludoviciana	14	8
	*Centaurea cyanus**	1	1
	*Cichorium intybus**	5	4
	*Cirsium arvense**	95	31
	*Cirsium vulgare**	63	25
	Erigeron strigosus	52	20
	Grindelia squarrosa	144	31
	Helianthus annuus	45	10
	Helianthus maxamiliani	1	1
	Helianthus petiolaris	2	1
	Helianthus sp.	98	24
	Helianthus tuberosus	4	2
	Heliopsis helianthoides	32	8
	Heterotheca villosa	22	7
	Oligoneuron rigidum	29	23
	Ratibida columnifera	1	1
	Solidago canadensis	12	7
	Solidago sp.	85	28
	*Sonchus arvensis**	325	52
	Symphyotrichum ericoides	41	14
	*Taraxacum officinale**	102	28
	*Tragopogon dubius**	2	2
	Astereae	91	31
Brassicaeae total		255	37
	*Berteroa incana**	32	10
	*Brassica rapa**	46	12
	Descurainia pinnata	7	3
	Hesperis matronalis	27	2
	Thlaspi arvense	29	15
	*Sinapis arvensis **	1	1
	*Sisymbrium altissimum**	14	9
	*Sisymbrium officinale **	2	2
	Brassicaceae	97	24
Caprifoliaceae total		15	12
	*Lonicera tattarica **	1	1
	Symphoricarpos occidentalis	14	12
Chenopodiaceae total		1	1
	Chenopodium simplex	1	1
Convolvulaceae total		1	1
	*Convolvulus arvensis **	1	1

continues

Plant family	Plant	Abundance	Bee species
Euphorbiaceae total		79	26
	Euphorbia esula *	79	26
Fabaceae total		594	55
	Amorpha canescens	2	2
	Caragana arborescens *	8	4
	Medicago sativa *	39	19
	Melilotus officinalis	532	50
	Pediomelum argophyllum	1	1
	Trifolium arvense *	1	1
	Trifolium pratense *	10	5
	Trifolium repens *	1	1
Hydrophyllaceae total		13	9
	Hydrophyllum virginianum	13	9
Iridaceae total		3	2
	Sisyrinchium angustifolium	3	2
Lamiaceae total		10	7
	Dracocephalum parviflorum	1	1
	Stachys palustris *	9	6
Liliaceae total		5	3
	Maianthemum racemosum	1	1
	Maianthemum stellatum	4	2
Oleaceae total		2	2
	Syringa vulgaris *	2	2
Onagraceae total		1	1
	Oenothera biennis	1	1
Poaceae total		2	2
	Poaceae	2	2
Polygonaceae total		12	7
	Fagopyrum esculentum *	4	3
	Polygonum amphibium	8	6
Ranunculaceae total		18	12
	Anemone canadensis	18	12
Rosaceae total		17	8
	Fragaria virginiana	2	2
	Argentina anserina	4	2
	Rosa arkansana	11	5
Salicaceae total		106	23
	Salix sp.	106	23
Scrophulariaceae total		17	8
	Linaria vulgaris *	17	8
Solonaceae total		4	2

Table 4-8. Abundance and species of bees collected from plants. Abundance was total of all bee species collected from a plant species or species group. Bee species was the total number of bee species collected from a plant species or species group. * plant of non-native origin.

Host plants		Bee abundance			Bee species numbers		
Host family	**Host genus**	***z* score**	***p* value**	**Direction**	***z* score**	***p* value**	**Direction**
Apiaceae	*Zizia*	15.34	<0.001	-	4.75	<0.001	-
Apocynaceae	*Apocynum*	0.31	0.76	=	-1.18	0.24	=
	Asclepias	0.37	0.71	=	1.39	0.17	=
Asteraceae	*Centaurea*	5.99	<0.001	-	4.18	<0.001	-
	Cirsium	-5.16	<0.001	+	-4.20	<0.001	+
	Erigeron	2.26	<0.05	-	-0.70	0.48	=
	Grindelia	8.57	<0.001	-	1.18	0.24	=
	Helianthus	2.21	<0.05	-	0.33	0.74	=
	Heliopsis	-4.51	<0.001	+	-1.24	0.22	=
	Ratibida	5.51	<0.001	-	2.60	<0.05	-
	Solidago	4.78	<0.001	-	-0.74	0.46	=
	Sonchus	-18.29	<0.001	+	-7.30	<0.001	+
	Symphyotrichu	5.52	<0.001	-	2.75	<0.05	-
	Taraxacum	-2.20	<0.05	+	-0.45	0.65	=
Boraginaceae	*Hydrophyllum*	5.32	<0.001	-	2.02	0.05	=
Brassicaceae	*Brassica*	-5.53	<0.001	+	-1.92	0.06	=
	Sinapis	1.24	0.21	=	0.80	0.42	=
	Sisymbrium	-3.83	<0.001	+	-3.13	<0.001	+
	Thlaspi	-5.12	<0.001	+	-3.71	<0.001	+
Caprifoliaceae	*Symphoricarpos*	0.12	0.90	=	-0.95	0.34	=
Fabaceae	*Amorpha*	2.67	<0.05	-	1.15	0.25	=
	Medicago	-1.22	0.22	=	-1.75	0.08	=
	Melilotus	-16.91	<0.001	+	-2.95	<0.001	+
	Trifolium	4.84	<0.001	-	1.61	0.11	=
Lamiaceae	*Dracocephalum*	2.90	<0.001	-	1.87	0.06	=
	Stachys	0.45	0.65	=	-0.66	0.51	=
Onagraceae	*Oenothera*	1.78	0.08	=	1.40	0.16	=
Ranunculacea	*Anemone*	-3.20	<0.001	+	-2.81	<0.05	+
Rosaceae	*Fragaria*	-0.66	0.51	=	-0.76	0.45	=
	Rosa	1.67	0.10	=	1.32	0.19	=
Salicaceae	*Salix*	-7.69	<0.001	+	-2.43	<0.05	+

Table 4-9. Change in relative abundance and species richness of bees collected from plant genera from 1910-1920 survey to 2010-2012 survey. Z-tests of equal proportions were run for the relative abundances and species richness of bee visitors to host plants present in both survey periods. The null hypothesis is that the proportion for each species is equal during both time periods. + = an increase in 2010-2012 survey, - = a decrease in 2010-2012 survey, and = = no change between surveys.

Plants with bee visitors		Bee relative abundance, abundance	
Family	**Species**	**1910-1920**	**2010-2012**
Apiaceae	*Zizia aurea*	11%, 294	-
Asteraceae	*Centaurea jacea**	1%, 36	-
	Chrysopsis sp.	2%, 41	-
	*Cirsium arvense**	-	4%, 95
	Cirsium undulatum	3%, 88	-
	*Cirsium vulgare**	-	3%, 63
	Erigeron philadelphicus	3%, 84	-
	Heliopsis helianthoides	-	1%, 32
	Lactuca pulchella	4%, 104	-
	Solidago gigantea	1%, 32	-
	Symphotrichum lanceolatum	1%, 28	-
	Vernonia fasciculata	1%, 35	-
Brassicaceae	*Berteroa incana**	-	1%, 32
	*Brassica rapa**	-	2%, 46
	*Hesperis matronalis**	-	1%, 27
Euphorbiaceae	*Euphorbia esula**	-	3%, 79
Fabaceae	*Dalea villosa*	1%, 27	-
Lamiaceae	*Physostegia parviflora*	1%, 31	-
Solanaceae	*Physalis philadelphica**	1%, 27	-
Verbenaceae	*Verbena hastata*	1%, 26	-

Table 4-10. Bee visited plants recorded only from either 1910-1920 or 2010-2012. Bee and plant records from 1910-1920 records were limited to those within 150 km of current collecting sites from the same seasonal collection window (mid-May to mid-September). * =introduced species. Example: in the 1910-1920 survey there were 294 individuals recorded visiting *Zizia aurea*, representing 11% of total bee abundance.

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Appendix A.
Catalog of bees collected in Griggs, Stutsman, and Barnes counties in North Dakota in 2010, 2011, and 2012.

Family
Species
State, County: Survey location, Latitude, Longitude, elevation, date, Number and sex (Collected by)
Bees collected using trap nests have no date, but rather say 2010 season, 2011 season, or 2012 season.

Colletidae

Colletes brevicornis
North Dakota, Barnes Co.: 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 12-Jul-2011, 1 ♀ (M. Spivak, J. Castro), Stutsman Co.: 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak)

Colletes kincaidii
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 4 km NE of Rogers; 47.09595, -98.15716, 435 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 10-Aug-2011, 1 ♂ (J. Castro, R. Rudd), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 4 km E of Edmunds; 47.235483, -98.911533, 474 m, 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 14-Jul-2011, 1 ♂ (E. Evans, J. Gardner, M. Spivak); 12-Jul-2012, 2 ♀ (E. Evans & party); 12-Aug-2012, 1 ♀ (E. Evans); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 12-Jul-2012, 1 ♀ (E. Evans & party)

Colletes lutzi lutzi
North Dakota, Barnes Co.: 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 13-Jul-2012, 1 ♀ (E. Evans, D. Morrison, K. Pouliquen)

Colletes rufocinctus
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 10-Sep-2010, 1 ♀ (E. Evans, K. Lee)

Hylaeus affinis
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 14-Jun-2012, 2 ♂ (E. Evans & party); 15-Jun-2012, 1 ♂ (E. Evans & party); 12-Jul-2012, 2 ♂ (E. Evans & party); 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 15-Jun-2012, 1 ♂ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 15-Jun-2010, 1 ♂ (E. Evans, K. Knuth); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 13-Jun-2011, 2 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.99384,

-98.25588, 438 m, 15-Jun-2010, 4 ♂ (E. Evans, J. Gardner, K. Knuth); 46.9945, -98.257, 439 m, 14-Jun-2012, 2 ♂ (R. Rudd, K. Lee, J. Castro); 13-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 15-Aug-2010, 1 ♀ (E. Evans & party); 46.98536, -98.27707, 441 m, 14-Jun-2012, 1 ♂ (R. Rudd, K. Lee, J. Castro); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 15-Jun-2012, 1 ♂ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 15 ♂ (E. Evans & party); 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 16-Jun-2010, 2 ♂ (E. Evans & party); 11-Sep-2010, 1 ♂ (E. Evans, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2011, 1 ♂ (E. Evans & party); 11-Aug-2011, 1 ♂ (E. Evans & party); 14-Jun-2012, 6 ♂ (E. Evans & party); 47.2698, -98.03332, 427 m, 16-Jun-2010, 6 ♂ (E. Evans & party); 6-Jul-2010, 1 ♂ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 4 ♂ (E. Evans & party); Karnak; 47.27607, -98.06752, 430 m, 14-Jun-2012, 1 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Jun-2010, 3 ♀, 6 ♂ (J. Gardner, M. Smart); 2-Aug-2010, 1 ♂ (J. Gardner, R. Borba); 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 47.2258, -98.9217, 481 m, 13-Jun-2011, 1 ♂ (E. Evans, M. Spivak); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 12-Jul-2012, 1 ♂ (E. Evans & party); 47.18348, -98.82031, 459 m, 15-Jun-2010, 2 ♂ (J. Gardner, M. Smart); 3-Aug-2010, 1 ♂ (E. Evans & party); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 1 ♂ (E. Evans, J. Gardner, M. Spivak); 47.20049, -98.80618, 464 m, 15-Jun-2010, 1 ♀, 2 ♂ (J. Gardner, M. Smart)

Hylaeus leptocephalus
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 15-Jun-2012, 1 ♂ (E. Evans & party); 3 km N of Rogers; 47.10332, -98.19166, 431 m, 2012 season, 1 ♀ (Joel Gardner); 3 km NE of Rogers; 47.08977, -98.17058, 433 m, 2012 season, 2 ♂ (Joel Gardner); 7 km NW of Sanborn; 46.9945, -98.29863, 440 m, 2012 season, 2 ♀, 2 ♂ (Joel Gardner); 8 km E of Pingree; 47.09491, -98.04014, 426 m, 2012 season, 1 ♀ (Joel Gardner), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2012, 2 ♂ (E. Evans & party); 2 km SE of Karnak; 47.26966, -98.03912, 428 m, 2010 season, 1 ♀, 1 ♂ (Joel Gardner); 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 4 km SE of Karnak; 47.25573, -98.03462, 430 m, 2012 season, 23 ♀, 14 ♂ (Joel Gardner), Stutsman Co.: 3 km E of Edmunds; 47.24681, -98.93201, 473 m, 2012 season, 7 ♀, 6 ♂ (Joel Gardner); 4 km SE of Edmunds; 47.22327, -98.93243, 487 m, 2012 season, 4 ♀, 4 ♂ (Joel Gardner); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 10-Sep-2010, 1 ♂ (E. Evans, K. Lee); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 3-Aug-2010, 1 ♂ (E. Evans & party); 6 km NE of Pingree; 47.18253, -98.82094, 458 m, 2012 season, 31 ♀, 27 ♂ (Joel Gardner); 2010 season, 1 ♀, 1 ♂ (Joel Gardner)

Hylaeus mesillae
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 20-May-2012, 1 ♂ (E. Evans, J. Gardner); 15-Jun-2012, 2 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 14-Jun-2012, 2 ♂ (R. Rudd, K. Lee, J. Castro); 13-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 16-Aug-2012, 1 ♂ (E. Evans & party); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Aug-2012, 1 ♀, 2 ♂ (E. Evans, K. Holzenthal); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 15-Jun-2012, 1 ♀, 1 ♂ (E. Evans & party); 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2012, 2 ♀, 1 ♂ (E. Evans & party); 14-Aug-2012, 7 ♀, 1 ♂ (J. Gardner, J. Castro); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 18-May-2012, 4 ♂ (E. Evans & party); 14-Jun-2012, 23 ♀, 6 ♂ (E. Evans & party); 14-Aug-2012, 9 ♀ (J. Gardner, J. Castro); 47.2698, -98.03332, 427 m, 16-Jun-2010, 2 ♀, 1 ♂ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 18-May-2012, 3 ♂ (E. Evans & party); 14-Jun-2012, 6 ♀, 5 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 15-Jun-2010, 1 ♂ (J. Gardner, M. Smart); 4 km SE of Edmunds; 47.225949, -98.917008, 481 m, 13-Jun-2011, 1 ♂ (E. Evans, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 18-May-2012, 3 ♂ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 1 ♂ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♂ (E. Evans & party); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 2 ♂ (E. Evans, J. Gardner, M. Spivak); 14-Jul-2011, 2 ♂ (E. Evans, J. Gardner, M. Spivak); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 14-Jun-2012, 1 ♀ (E. Evans & party)

Hylaeus mesillae cressonii
North Dakota, Barnes Co.: 9 km NE of Rogers; 47.09551, -98.03784, 426 m, 16-Aug-2012, 1 ♀ (E. Evans & party), Griggs Co.: 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen)

Hylaeus modestus
North Dakota, Stutsman Co.: 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 6-Jul-2010, 1 ♂ (E. Evans, M. Spivak, K. Lee); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart)

Hylaeus nelumbonis
North Dakota, Griggs Co.: 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd)
Hylaeus rudbeckiae North Dakota, Stutsman Co.: 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 1 ♂ (E. Evans, J. Gardner, M. Spivak); 14-Jul-2011, 1 ♂ (E. Evans, J. Gardner, M. Spivak)

Andrenidae

Andrena accepta
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Aug-2012, 2 ♂ (E. Evans, K. Holzenthal); 47.25491, -98.92525, 477 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal)

Andrena barbilabris
North Dakota, Barnes Co.: 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 26-May-2010, 1 ♂ (J. Gardner, K. Lee); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 20-May-2012, 1 ♀ (M. Spivak, J. Castro); Griggs Co.: 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 18-May-2011, 2 ♂ (E. Evans)

Andrena canadensis
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 15-Aug-2010, 1 ♀ (J. Gardner, M. Spivak, C. Carlson); Griggs Co.: 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 15-Aug-2010, 1 ♀ (E. Evans & party); Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 47.2258, -98.9217, 481 m, 14-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 6 km SE of Edmunds, 47.2259, -98.901, 489 m, 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan)

Andrena chromotricha
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 5-Jul-2010, 1 ♀ (J. Gardner, R. Borba); Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 3-Aug-2010, 2 ♀ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 15-Aug-2010, 2 ♀, 1 ♂ (E. Evans & party); Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Aug-2012, 2 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Aug-2010, 4 ♀ (E. Evans, K. Knuth); 47.2258, -98.9217, 481 m, 11-Aug-2011, 1 ♂ (E. Evans, J. Castro); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 14-Jul-2011, 1 ♂ (E. Evans, J. Gardner, M. Spivak); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 16-Aug-2012, 1 ♂ (E. Evans & party)

Andrena commoda
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 16-Jun-2010, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 15-Jun-2012, 1 ♀ (E. Evans & party); 2 km NE of Rogers; 47.0823, -98.1718, 433 m, 14-Jun-2012, 3 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09598, -98.17888, 433 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 14-Jun-2012, 3 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 14-Jun-2012, 3 ♀ (E. Evans & party); Stutsman Co.: 4 km E of Edmunds; 47.235483, -98.911533, 474 m, 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Jun-2010, 1 ♂ (J. Gardner, M. Smart); 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 47.2258, -98.9217, 481 m, 14-Jun-2012, 2 ♂ (E. Evans & party); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 1 ♂

(E. Evans, M. Spivak); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 6-Jul-2010, 2 ♀ (E. Evans, M. Spivak, K. Lee); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart)

Andrena erythrogaster
North Dakota, Griggs Co.: 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 2 ♂ (E. Evans & party)

Andrena forbesii
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 18-May-2011, 1 ♂ (E. Evans & party), Griggs Co.: 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 1 ♂ (E. Evans & party)

Andrena helianthi
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.0823, -98.1718, 433 m, 13-Aug-2012, 1 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 3-Aug-2010, 1 ♀ (E. Evans & party); 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 3-Aug-2010, 1 ♀ (E. Evans & party); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 16-Aug-2012, 1 ♂ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 3-Aug-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 1 ♂ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); I km S of Karnak; 47.26996, -98.06083, 430 m, 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 2 ♀, 1 ♂ (E. Evans, K. Knuth); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth)

Andrena hippotes
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.0823, -98.1718, 433 m, 13-Jun-2011, 1 ♀ (E. Evans & party), Griggs Co.: 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 1 ♂ (E. Evans & party), Stutsman Co.: 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak)

Andrena hirticincta
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 15-Aug-2010, 1 ♂ (J. Gardner, M. Spivak, C. Carlson), Griggs Co.: 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 15-Aug-2010, 1 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee)

Andrena illinoiensis
North Dakota, Griggs Co.: 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 1 ♂ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.2258,

-98.9217, 481 m, 18-May-2012, 1 ♂ (E. Evans, M. Spivak)

Andrena lupinorum
North Dakota, Barnes Co.: 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 5-Jul-2010, 2 ♀ (J. Gardner, R. Borba); 3-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 6-Jul-2010, 1 ♂ (E. Evans & party); 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 1 ♂ (E. Evans & party); 47.2698, -98.03332, 427 m, 6-Jul-2010, 1 ♀, 2 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 5-Jul-2010, 1 ♂ (E. Evans, M. Spivak, K. Lee); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 5-Jul-2010, 1 ♀, 2 ♂ (E. Evans, M. Spivak, K. Lee); 47.2258, -98.9217, 481 m, 13-Jun-2011, 1 ♂ (E. Evans, M. Spivak); 12-Jul-2012, 1 ♂ (E. Evans, M. Smart, K. Pouliquen); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 6-Jul-2010, 2 ♀, 1 ♂ (E. Evans, M. Spivak, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak)

Andrena macoupinensis
North Dakota, Griggs Co.: 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 18-May-2011, 1 ♂ (E. Evans)

Andrena mariae
North Dakota, Griggs Co.: 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party)

Andrena medionitens
North Dakota, Griggs Co.: 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party); Karnak; 47.2759, -98.06754, 437 m, 14-Jun-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 4 km SE of Edmunds; 47.225949, -98.917008, 481 m, 13-Jun-2011, 37 ♂ (E. Evans, M. Spivak); 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 13-Jun-2011, 1 ♂ (E. Evans, M. Spivak); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 2 ♂ (E. Evans, M. Spivak); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 1 ♀ (E. Evans, K. Lee)

Andrena nivalis
North Dakota, Griggs Co.: 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 1 ♂ (E. Evans & party); 47.2697, -98.0353, 427 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 6-Jul-2010, 1 ♂ (E. Evans & party), Stutsman Co.: 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Jun-2010, 1 ♂ (J. Gardner, M. Smart); 6-Jul-2010, 2 ♀ (E. Evans, M. Spivak, K. Lee)

Andrena nubecula
North Dakota, Barnes Co.: 8 km NW of Sanborn; 46.994, -98.293, 439 m, 16-Aug-2012, 1 ♂ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 15-Aug-2010, 1 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819,

-98.93286, 472 m, 2-Aug-2010, 1 ♂ (J. Gardner, R. Borba); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 3 ♀ (E. Evans, K. Knuth); 47.2258, -98.9217, 481 m, 14-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 3-Aug-2010, 2 ♀ (E. Evans & party); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 10-Aug-2011, 2 ♀ (E. Evans, J. Gardner); 16-Aug-2012, 1 ♀ (E. Evans & party); 9 km NE of Pingree; 47.17975, -98.78927, 450 m, 16-Aug-2012, 1 ♀ (E. Evans & party); 47.1816, -98.7945, 454 m, 16-Aug-2012, 1 ♀ (E. Evans & party)

Andrena quintilis
North Dakota, Stutsman Co.: 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 12-Jul-2012, 1 ♂ (E. Evans & party)

Andrena rugosa
North Dakota, Griggs Co.: 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 1 ♂ (E. Evans & party)

Andrena runcinatae
North Dakota, Stutsman Co.: 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jul-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak)

Andrena salictaria
North Dakota, Stutsman Co.: 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak)

Andrena specularia
North Dakota, Stutsman Co.: 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 7-Sep-2011, 1 ♀ (E. Evans, B. Finnegan)

Andrena thaspii
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 15-Jun-2010, 2 ♀ (E. Evans, K. Knuth), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 47.28403, -98.04595, 429 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 6-Jul-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 5-Jul-2010, 1 ♀, 1 ♂ (E. Evans, M. Spivak, K. Lee); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 5-Jul-2010, 2 ♀, 1 ♂ (E. Evans, M. Spivak, K. Lee); 2-Aug-2010, 2 ♀ (J. Gardner, R. Borba); 47.2258, -98.9217, 481 m, 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Jun-2010, 2 ♀, 7 ♂ (J. Gardner, M. Smart); 6-Jul-2010, 2 ♀ (E. Evans, M. Spivak, K. Lee)

Andrena virginiana
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal)

Andrena w-scripta
North Dakota, Stutsman Co.: 4 km SE of Edmunds; 47.225949, -98.917008, 481 m, 13-Jun-2011, 2 ♂ (E. Evans, M. Spivak)

Andrena wilkella
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 14-Jun-2012, 2 ♂ (E. Evans & party); 15-Jun-2012, 2 ♂ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 1 ♂ (J. Gardner, K. Lee); 15-Jun-2010, 2 ♀ (E. Evans, K. Knuth); 47.0823, -98.1718, 433 m, 20-May-2012, 2 ♂ (E. Evans & party); 4 km NE of Rogers; 47.09598, -98.17888, 433 m, 14-Jun-2012, 4 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 15-Jun-2010, 1 ♀ (E. Evans, J. Gardner, K. Knuth), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 1 ♂ (E. Evans & party); Karnak; 47.2759, -98.06754, 437 m, 14-Jun-2012, 1 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak)

Andrena ziziae
North Dakota, Stutsman Co.: 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 1 ♂ (E. Evans, J. Gardner, M. Spivak)

Calliopsis andreniformis
North Dakota, Griggs Co.: 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 15-Aug-2010, 1 ♀ (E. Evans & party)

Calliopsis coloradensis
North Dakota, Griggs Co.: 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Aug-2012, 2 ♂ (J. Gardner, J. Castro)

Calliopsis nebraskensis
North Dakota, Stutsman Co.: 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 16-Aug-2012, 1 ♂ (E. Evans & party)

Perdita albipennis pallidipennis
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 11-Aug-2011, 1 ♂ (E. Evans, J. Castro)

Perdita bruneri
North Dakota, Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 15-Aug-2010, 2 ♂ (E. Evans, K. Knuth); 47.2258, -98.9217, 481 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal)

Perdita octomaculata
North Dakota, Barnes Co.: 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 15-Aug-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 2-Aug-2010, 3 ♀ (J. Gardner, R. Borba); 15-Aug-2010, 1 ♀, 11 ♂ (E. Evans, K. Knuth); 47.2258, -98.9217, 481 m, 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 14-Aug-2012, 17 ♀, 1 ♂ (E. Evans, K. Holzenthal)

Pseudopanurgus albitarsis
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.11018, -98.07701, 431 m, 3-Aug-2010, 1 ♂ (E. Evans, M. Spivak, R. Rudd); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 15-Aug-2010, 1 ♀ (J. Gardner, M. Spivak, C. Carlson); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 10-Aug-2011, 1 ♀ (J. Castro, R. Rudd); 7-Sep-2011, 1 ♂ (J. Castro, R. Rudd), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 15-Aug-2010, 1 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 11-Aug-2011, 1 ♂ (E. Evans, J. Castro); 14-Aug-2012, 2 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 10-Aug-2011, 2 ♂ (E. Evans, J. Gardner); 47.20049, -98.80618, 464 m, 3-Aug-2010, 1 ♂ (E. Evans & party); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 10-Aug-2011, 1 ♂ (E. Evans, J. Gardner)

Pseudopanurgus dakotensis
North Dakota, Stutsman Co.: 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 12-Jul-2012, 1 ♂ (E. Evans & party)

Pseudopanurgus labrosus
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 11-Aug-2011, 1 ♂ (E. Evans, J. Castro)

Pseudopanurgus nebrascensis
North Dakota, Griggs Co.: 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 11-Aug-2011, 1 ♀ (E. Evans & party); 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 11-Aug-2011, 3 ♂ (E. Evans, J. Castro)

Pseudopanurgus piercei
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 2-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd)

Pseudopanurgus renimaculatus
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 16-Aug-2012, 2 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 11-Sep-2012, 1 ♀ (E. Evans & party); 4 km NE of

Rogers; 47.09591, -98.15093, 434 m, 15-Aug-2010, 1 ♀ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 15-Aug-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth)

Pseudopanurgus simulans
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.11018, -98.07701, 431 m, 3-Aug-2010, 4 ♀, 6 ♂ (E. Evans, M. Spivak, R. Rudd); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 3-Aug-2010, 4 ♀ (E. Evans, M. Spivak, R. Rudd); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 2-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 1 ♀ (J. Gardner, M. Spivak, C. Carlson); 47.0823, -98.1718, 433 m, 13-Aug-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 10-Aug-2011, 1 ♂ (J. Castro, R. Rudd); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 2-Aug-2010, 2 ♀ (E. Evans, M. Smart, R. Rudd); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 15-Aug-2010, 1 ♀ (E. Evans & party); 46.99417, -98.25027, 439 m, 13-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 3-Aug-2010, 1 ♀ (E. Evans & party), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 3-Aug-2010, 2 ♂ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 11-Aug-2011, 2 ♂ (E. Evans, J. Castro); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 2-Aug-2010, 3 ♂ (J. Gardner, R. Borba); 15-Aug-2010, 1 ♀, 1 ♂ (E. Evans, K. Knuth); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 3-Aug-2010, 1 ♀, 2 ♂ (E. Evans & party); 15-Aug-2010, 4 ♀, 3 ♂ (E. Evans, K. Knuth); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 10-Aug-2011, 1 ♂ (E. Evans, J. Gardner); 47.20049, -98.80618, 464 m, 3-Aug-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 1 ♀, 1 ♂ (E. Evans, K. Knuth); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 10-Aug-2011, 1 ♂ (E. Evans, J. Gardner)

Halictidae

Agapostemon femoratus
North Dakota, Griggs Co.: 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd)

Agapostemon texanus
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 20-May-2012, 3 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 25-May-2010, 3 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 1 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 6-Jul-2010, 1 ♀ (J. Gardner, R. Borba, M. Spivak); 11-Sep-2010, 2 ♀, 1 ♂ (E. Evans & party); 47.11298, -98.06702, 430 m, 6-Sep-2011, 1 ♂ (J. Castro, R. Rudd); 20-May-2012, 1 ♀ (E. Evans, J. Gardner); 14-Jun-

2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 3 ♀ (E. Evans & party); 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 11 ♀ (J. Gardner, K. Lee); 5-Jul-2010, 2 ♀ (J. Gardner, R. Borba); 2-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 1 ♀, 4 ♂ (E. Evans & party); 47.0823, -98.1718, 433 m, 13-Jun-2011, 3 ♀ (E. Evans & party); 20-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 13-Aug-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 2 ♀, 1 ♂ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 18-May-2011, 1 ♀ (E. Evans & party); 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 7-Sep-2011, 1 ♂ (J. Castro, R. Rudd); 14-Jun-2012, 2 ♀ (E. Evans & party); 13-Aug-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 2 ♂ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, K. Knuth); 47.09616, -98.1509, 434 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 13-Aug-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀, 1 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 20-May-2012, 3 ♀ (M. Spivak , J. Castro); 14-Jun-2012, 3 ♀ (R. Rudd, K. Lee, J. Castro); 13-Aug-2012, 1 ♀, 1 ♂ (E. Evans, K. Holzenthal); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 14-Jun-2012, 6 ♀ (R. Rudd, K. Lee, J. Castro); 11-Sep-2012, 2 ♂ (E. Evans, K. Foord); 46.97964, -98.28512, 443 m, 26-May-2010, 8 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, J. Gardner, K. Knuth); 6-Jul-2010, 2 ♀ (E. Evans & party); 12-Sep-2010, 3 ♀ (E. Evans, J. Gardner, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 46.99628, -98.27705, 439 m, 11-Sep-2012, 1 ♂ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 15-Jun-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♂ (E. Evans & party); 10-Sep-2012, 2 ♀, 1 ♂ (J. Gardner, K. Foord) , Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 2 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd), Stutsman Co.: 2 km NE of Edmunds; 47.25482, -98.94766, 426 m, 10-Sep-2012, 8 ♂ (E. Evans, R. Rudd); 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 5-Jul-2010, 2 ♀ (E. Evans, M. Spivak, K. Lee); 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 47.25226, -98.9328, 477 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 7 ♀ (E. Evans & party); 12-Jul-2012, 5 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 4 km E of Edmunds; 47.24218, -98.91154, 422 m, 10-Sep-2012, 3 ♂ (E. Evans, R. Rudd); 5 km E of Edmunds; 47.25488, -98.9019, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 12 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth); 11-Sep-2010, 2 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 9 ♀ (J. Gardner, M. Spivak); 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 14-Jun-2012, 4 ♀ (E. Evans & party); 14-Aug-2012, 7 ♀ (E. Evans, K. Holzenthal); 10-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 47.254, -98.92969, 471 m, 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 2 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 4 ♀ (J. Gardner, M. Spivak); 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 18-

May-2012, 5 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 6 ♀ (E. Evans & party); 14-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 5 ♀ (E. Evans, J. Gardner, M. Spivak); 47.18348, -98.82031, 459 m, 27-May-2010, 7 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 5 ♀ (J. Gardner, M. Smart); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 3 ♀ (E. Evans, J. Gardner, M. Spivak); 13-Jul-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 2 ♀ (E. Evans & party); 16-Aug-2012, 2 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 27-May-2010, 8 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 19 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 5 ♀ (E. Evans, K. Lee); 10-Sep-2010, 7 ♀, 1 ♂ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 8 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 16 ♀ (E. Evans, M. Spivak)

Agapostemon virescens
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 13-Jun-2011, 4 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 9 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 6 ♀ (E. Evans & party); 10-Sep-2012, 2 ♀, 1 ♂ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 16-Jun-2010, 2 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀ (J. Gardner, R. Borba, M. Spivak); 15-Aug-2010, 1 ♂ (E. Evans & party); 11-Sep-2010, 4 ♀, 3 ♂ (E. Evans & party); 47.0956, -98.08625, 434 m, 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 47.11298, -98.06702, 430 m, 12-Jul-2011, 2 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 4 ♀ (E. Evans & party); 12-Jul-2012, 5 ♀ (E. Evans & party); 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 3 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 3 ♀ (E. Evans, K. Knuth); 5-Jul-2010, 3 ♀ (J. Gardner, R. Borba); 11-Sep-2010, 2 ♀, 12 ♂ (E. Evans & party); 47.0823, -98.1718, 433 m, 10-Aug-2011, 2 ♀ (J. Castro, R. Rudd); 20-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 16 ♀ (E. Evans & party); 12-Jul-2012, 6 ♀ (E. Evans & party); 13-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 4 ♀, 9 ♂ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 13-Aug-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 10 ♀ (E. Evans & party); 3 km NE of Rogers; 47.0962, -98.17216, 434 m, 11-Sep-2012, 2 ♀, 3 ♂ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 15-Jun-2010, 2 ♀ (E. Evans, K. Knuth); 5-Jul-2010, 5 ♀ (J. Gardner, R. Borba); 11-Sep-2010, 1 ♂ (E. Evans & party); 47.09616, -98.1509, 434 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀, 4 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 6-Jul-2010, 3 ♀ (E. Evans & party); 12-Sep-2010, 1 ♂ (E. Evans, J. Gardner, R. Rudd); 46.9945, -98.257, 439 m, 13-Jul-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 14-Jun-2012, 2 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 4 ♀ (E. Evans, D. Morrison, K. Pouliquen); 11-Sep-2012, 7 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 14-Jun-2012, 5 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 1 ♀ (E. Evans, D. Morrison, K. Pouliquen); 11-Sep-2012, 2 ♀, 2 ♂ (E. Evans, K. Foord); 46.97964, -98.28512, 443 m, 26-May-2010, 3 ♀ (J. Gardner, K. Lee); 12-Sep-2010, 1 ♀, 1 ♂ (E. Evans, J. Gardner, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jul-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 1 ♀ (M. Spivak, J. Castro); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 3 ♀ (M. Spivak, J.

Castro); 15-Jun-2012, 4 ♀ (E. Evans & party); 12-Jul-2012, 4 ♀ (E. Evans & party); 10-Sep-2012, 5 ♀, 3 ♂ (J. Gardner, K. Foord); 11-Sep-2012, 1 ♂ (J. Gardner, R. Rudd); 47.0963, -98.03685, 425 m, 10-Sep-2012, 2 ♂ (J. Gardner, K. Foord), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 2 ♀ (E. Evans & party); 12-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 2 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2012, 3 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 16-Jun-2010, 4 ♀ (E. Evans & party); 6-Jul-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 2 ♂ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 3 ♀ (E. Evans & party); 12-Sep-2012, 2 ♀, 2 ♂ (E. Evans, R. Rudd), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 47.25226, -98.9328, 477 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 14-Aug-2012, 4 ♀, 1 ♂ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 5-Jul-2010, 2 ♀ (E. Evans, M. Spivak, K. Lee); 11-Sep-2010, 1 ♂ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 14-Aug-2012, 1 ♀, 1 ♂ (E. Evans, K. Holzenthal); 10-Sep-2012, 1 ♀, 4 ♂ (E. Evans, R. Rudd); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 14-Jun-2012, 4 ♀ (E. Evans & party); 14-Aug-2012, 1 ♀, 1 ♂ (E. Evans, K. Holzenthal); 10-Sep-2012, 1 ♀, 2 ♂ (E. Evans, R. Rudd); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 7 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 7 ♀ (E. Evans, M. Spivak, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jul-2011, 9 ♀ (E. Evans, J. Gardner, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 2 ♂ (E. Evans & party); 47.20049, -98.80618, 464 m, 15-Jun-2010, 2 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 1 ♀ (E. Evans, K. Lee); 10-Sep-2010, 1 ♀, 1 ♂ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 6 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 8 ♀ (E. Evans, M. Spivak); 16-Aug-2012, 1 ♂ (E. Evans & party)

Augochlorella aurata
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 14-Jun-2012, 2 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 3 ♀ (J. Gardner, K. Lee); 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09616, -98.1509, 434 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 46.97964, -98.28512, 443 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee), Griggs Co.: 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee)

Dieunomia triangulifera
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Aug-2012, 2 ♀, 1 ♂ (E. Evans, K. Holzenthal)

Dufourea marginata

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.11018, -98.07701, 431 m, 6-Jul-2010, 1 ♀ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 12 ♀, 7 ♂ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 2 ♀, 1 ♂ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 3-Aug-2010, 2 ♀ (E. Evans, M. Spivak, R. Rudd); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 2-Aug-2010, 2 ♀ (E. Evans, M. Smart, R. Rudd); 3-Aug-2010, 1 ♂ (E. Evans, M. Smart, R. Rudd); 47.0823, -98.1718, 433 m, 13-Aug-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 7-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 14-Jun-2012, 1 ♀ (E. Evans & party); 3 km NE of Rogers; 47.09623, -98.17216, 434 m, 13-Aug-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 2-Aug-2010, 9 ♀, 4 ♂ (E. Evans, M. Smart, R. Rudd); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 3-Aug-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans & party); 46.99417, -98.25027, 439 m, 13-Aug-2012, 2 ♀ (E. Evans, K. Holzenthal); 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 3-Aug-2010, 4 ♀ (E. Evans & party); 12-Sep-2010, 1 ♀ (E. Evans, J. Gardner, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 16-Aug-2012, 1 ♀ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 11-Aug-2011, 1 ♀ (E. Evans & party); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 3-Aug-2010, 2 ♀, 1 ♂ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 11-Aug-2011, 1 ♀ (E. Evans & party); 14-Aug-2012, 1 ♀, 1 ♂ (J. Gardner, J. Castro), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Aug-2012, 3 ♀, 1 ♂ (E. Evans, K. Holzenthal); 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 47.25491, -98.92525, 477 m, 14-Aug-2012, 2 ♀ (E. Evans, K. Holzenthal); 4 km E of Edmunds; 47.25108, -98.91161, 477 m, 14-Aug-2012, 2 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 2-Aug-2010, 1 ♀, 3 ♂ (J. Gardner, R. Borba); 15-Aug-2010, 2 ♂ (E. Evans, K. Knuth); 47.2258, -98.9217, 481 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 10-Aug-2011, 3 ♀, 5 ♂ (E. Evans, J. Gardner); 47.18348, -98.82031, 459 m, 3-Aug-2010, 5 ♀, 3 ♂ (E. Evans & party); 15-Aug-2010, 1 ♀, 1 ♂ (E. Evans, K. Knuth); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 10-Aug-2011, 1 ♂ (E. Evans, J. Gardner); 47.20049, -98.80618, 464 m, 3-Aug-2010, 4 ♀, 2 ♂ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 9 km NE of Pingree; 47.17958, -98.78922, 460 m, 10-Aug-2011, 1 ♂ (E. Evans, J. Gardner); 47.1816, -98.7945, 454 m, 10-Aug-2011, 1 ♂ (E. Evans, J. Gardner)

Dufourea maura

North Dakota, Stutsman Co.: 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 18-May-2012, 1 ♂ (E. Evans, M. Spivak)

Halictus confusus

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 12-Jul-2011, 2 ♀ (M. Spivak, J. Castro); 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 2 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀ (E. Evans & party); 10-Sep-2012, 5 ♀ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 25-May-2010, 9 ♀ (J. Gardner, K. Lee); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 16 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀

(J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 3 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 2 ♀, 2 ♂ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.09568, -98.06634, 427 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 15-Jun-2012, 2 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 2 ♂ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 153 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 7 ♀ (E. Evans, K. Knuth); 2-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 13-Jun-2011, 2 ♀ (E. Evans & party); 7-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 20-May-2012, 8 ♀ (E. Evans & party); 14-Jun-2012, 3 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 13-Jun-2011, 3 ♀ (E. Evans & party); 20-May-2012, 8 ♀ (E. Evans & party); 14-Jun-2012, 6 ♀ (E. Evans & party); 12-Jul-2012, 6 ♀ (E. Evans & party); 13-Aug-2012, 2 ♂ (E. Evans & party); 11-Sep-2012, 2 ♀, 2 ♂ (E. Evans & party); 3 km NE of Rogers; 47.08977, -98.17058, 433 m, 14-Jun-2012, 7 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09569, -98.15723, 433 m, 20-May-2012, 1 ♀ (E. Evans, J. Gardner); 47.09591, -98.15093, 434 m, 26-May-2010, 65 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 5 ♀ (E. Evans, K. Knuth); 2-Aug-2010, 3 ♀ (E. Evans, M. Smart, R. Rudd); 3-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 2 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 18-May-2011, 14 ♀ (E. Evans & party); 13-Jun-2011, 10 ♀ (E. Evans & party); 12-Jul-2011, 4 ♀ (E. Evans, M. Spivak, J. Castro); 10-Aug-2011, 4 ♀ (J. Castro, R. Rudd); 7-Sep-2011, 2 ♂ (J. Castro, R. Rudd); 20-May-2012, 12 ♀ (E. Evans & party); 14-Jun-2012, 17 ♀ (E. Evans & party); 11-Sep-2012, 2 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 27 ♀ (J. Gardner, K. Lee); 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 2 ♀ (E. Evans, J. Gardner, K. Knuth); 15-Aug-2010, 1 ♀ (E. Evans & party); 46.9945, -98.257, 439 m, 13-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 11-Sep-2012, 2 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 17-May-2011, 1 ♀ (E. Evans); 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 4 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 5 ♀ (R. Rudd, K. Lee, J. Castro); 16-Aug-2012, 2 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀, 1 ♂ (E. Evans, K. Foord); 46.97964, -98.28512, 443 m, 26-May-2010, 275 ♀, 1 ♂ (J. Gardner, K. Lee); 15-Jun-2010, 5 ♀ (E. Evans, J. Gardner, K. Knuth); 6-Jul-2010, 3 ♀ (E. Evans & party); 15-Aug-2010, 1 ♂ (E. Evans & party); 12-Sep-2010, 6 ♀, 2 ♂ (E. Evans, J. Gardner, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 20-May-2012, 22 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 7 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 1 ♀ (E. Evans, D. Morrison, K. Pouliquen); 16-Aug-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀, 4 ♂ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 20-May-2012, 1 ♀ (E. Evans, J. Gardner); 10-Sep-2012, 1 ♀, 1 ♂ (J. Gardner, K. Foord); 11-Sep-2012, 1 ♀ (J. Gardner, R. Rudd); 47.0965, -98.03688, 425 m, 16-Aug-2012, 1 ♀ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 18-May-2011, 1 ♀ (E. Evans); 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 18-May-2012, 1 ♀ (E. Evans & party); 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 93 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 3 ♀ (E. Evans & party); 3-Aug-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 2 ♀ (E. Evans & party); 11-Sep-2010, 4 ♀, 4 ♂ (E. Evans, K. Lee); 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 2 ♀ (E. Evans & party); 47.2697, -98.0353, 427 m, 14-Jun-2011, 2 ♀ (E. Evans & party); 18-May-2012, 6 ♀ (E. Evans & party); 14-Jun-2012, 4 ♀ (E. Evans & party); 14-Aug-2012, 4 ♂ (J.

Gardner, J. Castro); 47.2698, -98.03332, 427 m, 27-May-2010, 42 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 3 ♀ (E. Evans & party); 6-Jul-2010, 2 ♀ (E. Evans & party); 3-Aug-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 2 ♀, 1 ♂ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 18-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 3 ♀ (E. Evans & party); Karnak; 47.2759, -98.06754, 437 m, 14-Jun-2012, 2 ♀ (E. Evans & party); 47.27607, -98.06752, 430 m, 14-Jun-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 2 km NE of Edmunds; 47.25482, -98.94766, 426 m, 10-Sep-2012, 2 ♂ (E. Evans, R. Rudd); 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 34 ♀ (J. Gardner, K. Lee); 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 2-Aug-2010, 1 ♂ (J. Gardner, R. Borba); 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 11-Sep-2010, 2 ♀ (E. Evans, K. Lee); 47.25226, -98.9328, 477 m, 13-Jun-2011, 10 ♀ (E. Evans, M. Spivak); 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 18-May-2012, 4 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 5 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 50 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 7 ♀ (J. Gardner, M. Smart); 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 11-Sep-2010, 2 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 17-May-2011, 1 ♀ (E. Evans); 13-Jun-2011, 2 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 7 ♀ (J. Gardner, M. Spivak); 18-May-2012, 2 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 2 ♀ (E. Evans & party); 10-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 17-May-2011, 4 ♀ (E. Evans); 13-Jun-2011, 5 ♀ (E. Evans, M. Spivak); 18-May-2012, 4 ♀ (E. Evans, M. Spivak); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 22-Apr-2012, 1 ♀ (E. Evans); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 9 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 12-Aug-2012, 1 ♂ (E. Evans); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 47.18348, -98.82031, 459 m, 27-May-2010, 128 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 65 ♀ (J. Gardner, M. Smart); 3-Aug-2010, 2 ♀, 16 ♂ (E. Evans & party); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 47.20049, -98.80618, 464 m, 27-May-2010, 110 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 35 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 3 ♀ (E. Evans, K. Lee); 3-Aug-2010, 3 ♀ (E. Evans & party); 15-Aug-2010, 3 ♂ (E. Evans, K. Knuth); 10-Sep-2010, 3 ♀ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 4 ♀ (E. Evans, J. Gardner, M. Spivak); 10-Aug-2011, 1 ♀ (E. Evans, J. Gardner); 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 18-May-2012, 4 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 48.17974, -98.78921, 458 m, 14-Jun-2012, 1 ♀ (E. Evans & party)

Halictus ligatus
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 6-Jul-2010, 1 ♀ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 47.11298, -98.06702, 430 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♂ (E. Evans & party); 10-Sep-2012, 2 ♂ (J. Gardner, K. Foord); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 2-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 12-Jul-2012, 1 ♂ (E. Evans & party); 11-Sep-2012,

1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 47.09616, -98.1509, 434 m, 11-Sep-2012, 1 ♂ (E. Evans & party); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 20-May-2012, 2 ♀ (M. Spivak, J. Castro); 13-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 16-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♂ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 47.0965, -98.03688, 425 m, 16-Aug-2012, 1 ♀ (E. Evans & party), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Aug-2012, 4 ♀, 4 ♂ (J. Gardner, J. Castro); 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 12-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 2 ♀, 3 ♂ (E. Evans, R. Rudd), Stutsman Co.: 2 km NE of Edmunds; 47.25482, -98.94766, 426 m, 10-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 10-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 4 ♀ (J. Gardner, K. Lee); 11-Sep-2010, 1 ♂ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 1 ♀, 1 ♂ (E. Evans, K. Holzenthal); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 3 ♀ (J. Gardner, M. Smart); 10-Sep-2010, 1 ♂ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 11-Sep-2012, 1 ♂ (E. Evans & party)

Halictus parallelus
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.11018, -98.07701, 431 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 8 km NW of Sanborn; 46.99628, -98.27705, 439 m, 11-Sep-2012, 1 ♂ (E. Evans, K. Foord), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Jun-2012, 1 ♀ (E. Evans & party)

Halictus rubicundus
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 18-May-2011, 1 ♀ (E. Evans & party); 20-May-2012, 2 ♀ (E. Evans, J. Gardner); 12-Jul-2012, 1 ♀ (E. Evans & party); 47.11018, -98.07701, 431 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 2 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 1 ♂ (E. Evans & party); 11-Sep-2010, 1 ♂ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 4 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, K. Knuth); 5-Jul-2010, 1 ♀ (J. Gardner, R. Borba); 47.0823, -98.1718, 433 m, 20-May-2012, 8 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 7-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 20-May-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 11-Sep-2010, 1 ♂ (E. Evans & party); 47.09616, -98.1509, 434 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 7 km NW of Sanborn; 46.9794,

-98.2916, 442 m, 17-May-2011, 2 ♀ (E. Evans); 20-May-2012, 1 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 46.97964, -98.28512, 443 m, 26-May-2010, 3 ♀ (J. Gardner, K. Lee); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 20-May-2012, 2 ♀ (M. Spivak, J. Castro); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 15-Jun-2012, 1 ♀ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 18-May-2011, 1 ♀ (E. Evans); 14-Jun-2011, 1 ♀ (E. Evans & party); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 2 ♀ (J. Gardner, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 18-May-2011, 2 ♀ (E. Evans); 18-May-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 2 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 5 ♀ (J. Gardner, K. Lee); 47.2258, -98.9217, 481 m, 18-May-2012, 2 ♀ (E. Evans, M. Spivak); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 17-May-2011, 3 ♀ (E. Evans); 13-Jun-2011, 4 ♀ (E. Evans, M. Spivak); 18-May-2012, 2 ♀ (E. Evans, M. Spivak); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 22-Apr-2012, 5 ♀ (E. Evans); 47.18348, -98.82031, 459 m, 27-May-2010, 12 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 2 ♀ (E. Evans, M. Spivak, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 2 ♀ (E. Evans, J. Gardner, M. Spivak); 47.20049, -98.80618, 464 m, 27-May-2010, 4 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 4 ♀ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 2 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 2 ♀ (E. Evans, M. Spivak)

Lasioglossum aberrans
North Dakota, Barnes Co.: 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 6-Jul-2010, 1 ♀ (E. Evans & party)

Lasioglossum acuminatum
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.0823, -98.1718, 433 m, 20-May-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 14-Jun-2012, 6 ♀ (R. Rudd, K. Lee, J. Castro); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 46.97964, -98.28512, 443 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 15-Jun-2012, 1 ♀ (E. Evans & party); Griggs Co.: 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 12-Jul-2012, 1 ♂ (E. Evans, M. Smart, K. Pouliquen); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 1 ♀, 1 ♂ (J. Gardner, K. Lee); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 10-Sep-2010, 1 ♂ (E. Evans, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 16-Aug-2012, 1 ♂ (E. Evans & party)

Lasioglossum admirandum

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 11-Aug-2011, 2 ♀ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 5 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 19 ♀ (E. Evans & party); 16-Aug-2012, 1 ♂ (E. Evans & party); 10-Sep-2012, 10 ♂ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 25-May-2010, 91 ♀ (J. Gardner, K. Lee); 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 11-Sep-2010, 1 ♂ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 4 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 8 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 1 ♀ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.0956, -98.08625, 434 m, 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 47.11298, -98.06702, 430 m, 13-Jun-2011, 1 ♀ (E. Evans & party); , 14 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 36 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 28 ♀ (E. Evans & party); 15-Jun-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♂ (E. Evans & party); 10-Sep-2012, 2 ♀ (J. Gardner, K. Foord); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 8 ♀ (J. Gardner, K. Lee); 2-Aug-2010, 2 ♀ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 1 ♂ (E. Evans & party); 47.0823, -98.1718, 433 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 20-May-2012, 10 ♀ (E. Evans & party); 14-Jun-2012, 5 ♀ (E. Evans & party); 11-Sep-2012, 1 ♂ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 13-Jun-2011, 8 ♀ (E. Evans & party); 10-Aug-2011, 3 ♀ (J. Castro, R. Rudd); 20-May-2012, 20 ♀ (E. Evans & party); 14-Jun-2012, 19 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀, 1 ♂ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 23 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 3 ♀ (E. Evans, K. Knuth); 2-Aug-2010, 2 ♀ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.09598, -98.17888, 433 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 18-May-2011, 1 ♀ (E. Evans & party); 13-Jun-2011, 2 ♀ (E. Evans & party); 20-May-2012, 5 ♀ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 11-Sep-2012, 2 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 30 ♀ (J. Gardner, K. Lee); 46.9945, -98.257, 439 m, 13-Jun-2011, 3 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 9 ♀ (M. Spivak , J. Castro); , 3 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 13 ♀ (R. Rudd, K. Lee, J. Castro); 13-Aug-2012, 3 ♀ (E. Evans, K. Holzenthal); 11-Sep-2012, 2 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 1 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 46.97964, -98.28512, 443 m, 26-May-2010, 15 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 2 ♀ (E. Evans, J. Gardner, K. Knuth); 12-Sep-2010, 1 ♀ (E. Evans, J. Gardner, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 13 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 7 ♀ (R. Rudd, K. Lee, J. Castro); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 15-Jun-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 3 ♂ (E. Evans & party); 10-Sep-2012, 2 ♀, 1 ♂ (J. Gardner, K. Foord); Griggs Co.: 1 km S of Karnak; 47.26995, -98.06468, 426 m, 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 2 ♀ (E. Evans & party); 14-Jun-2012, 10 ♀ (E. Evans & party); 14-Aug-2012, 2 ♂ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968,

-98.04474, 428 m, 27-May-2010, 5 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 1 ♀ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2011, 2 ♀ (E. Evans & party); 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 4 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 6-Jul-2010, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 18-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 14-Aug-2012, 2 ♀ (J. Gardner, J. Castro); I km S of Karnak; 47.26996, -98.06083, 430 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 47.25226, -98.9328, 477 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 11-Aug-2011, 2 ♀ (E. Evans, J. Castro); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 17-May-2011, 1 ♀ (E. Evans); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 47.20049, -98.80618, 464 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 2 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 1 ♀ (E. Evans, K. Lee); 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth)

Lasioglossum albipenne
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 3 ♀ (M. Spivak, J. Castro); 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 3 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 19 ♀ (E. Evans & party); 16-Aug-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀, 1 ♂ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 25-May-2010, 14 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 5 ♀ (E. Evans & party); 15-Aug-2010, 1 ♂ (E. Evans & party); 11-Sep-2010, 2 ♂ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 4 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 1 ♀ (E. Evans & party); 6-Jul-2010, 10 ♀ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 4 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 2 ♀, 5 ♂ (E. Evans & party); 11-Sep-2010, 4 ♀, 2 ♂ (E. Evans & party); 47.09568, -98.06634, 427 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 13-Jun-2011, 3 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 3 ♀ (M. Spivak, J. Castro); 11-Aug-2011, 2 ♀ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 11 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 33 ♀ (E. Evans & party); 15-Jun-2012, 3 ♀ (E. Evans & party); 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 18 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 13 ♀ (E. Evans, K. Knuth); 5-Jul-2010, 8 ♀ (J. Gardner, R. Borba); 2-Aug-2010, 1 ♀, 2 ♂ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 2 ♂ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 13-Jun-2011, 4 ♀ (E. Evans & party); 20-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 15 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 13-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀, 1 ♂ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 13-Jun-2011, 19 ♀ (E. Evans & party); 12-Jul-2011, 4 ♀ (E. Evans, M. Spivak, J. Castro); 10-Aug-2011, 3 ♀ (J. Castro, R. Rudd); 20-May-2012, 16 ♀ (E. Evans & party); 14-Jun-2012, 38 ♀ (E. Evans & party); 13-Aug-2012, 4 ♀ (E. Evans & party); 11-Sep-2012, 2 ♀, 1 ♂ (E. Evans & party); 3 km NE of Rogers; 47.096, -98.172, 435 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 31 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 6 ♀ (E. Evans,

K. Knuth); 5-Jul-2010, 4 ♀ (J. Gardner, R. Borba); 3-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 3 ♀, 1 ♂ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 4 ♀, 2 ♂ (E. Evans & party); 47.09616, -98.1509, 434 m, 13-Jun-2011, 11 ♀ (E. Evans & party); 10-Aug-2011, 1 ♀ (J. Castro, R. Rudd); 7-Sep-2011, 1 ♀, 2 ♂ (J. Castro, R. Rudd); 20-May-2012, 11 ♀ (E. Evans & party); 14-Jun-2012, 6 ♀ (E. Evans & party); 13-Aug-2012, 1 ♀, 2 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 49 ♀ (J. Gardner, K. Lee); 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 2 ♀ (E. Evans & party); 3-Aug-2010, 3 ♀ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans & party); 46.9945, -98.257, 439 m, 13-Jun-2011, 11 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 2 ♀ (M. Spivak , J. Castro); 14-Jun-2012, 10 ♀ (R. Rudd, K. Lee, J. Castro); 16-Aug-2012, 1 ♂ (E. Evans & party); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 17-May-2011, 1 ♀ (E. Evans); 13-Jun-2011, 21 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 1 ♀, 1 ♂ (M. Spivak, J. Castro); 14-Jun-2012, 40 ♀, 1 ♂ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 1 ♀ (E. Evans, D. Morrison, K. Pouliquen); 16-Aug-2012, 1 ♂ (E. Evans & party); 46.97964, -98.28512, 443 m, 26-May-2010, 73 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 3 ♀ (E. Evans, J. Gardner, K. Knuth); 6-Jul-2010, 8 ♀ (E. Evans & party); 3-Aug-2010, 2 ♀ (E. Evans & party); 15-Aug-2010, 4 ♀, 1 ♂ (E. Evans & party); 12-Sep-2010, 5 ♀ (E. Evans, J. Gardner, R. Rudd); 46.9943, -98.27637, 439 m, 11-Sep-2012, 1 ♂ (E. Evans, K. Foord); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 15 ♀ (J. Castro, K. Knuth, R. Rudd); 13-Jul-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Aug-2011, 2 ♂ (J. Gardner, R. Borba, R. Rudd); 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 20-May-2012, 4 ♀, 1 ♂ (M. Spivak, J. Castro); 14-Jun-2012, 9 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 2 ♀ (E. Evans, D. Morrison, K. Pouliquen); 11-Sep-2012, 6 ♀, 3 ♂ (E. Evans, K. Foord); 46.99628, -98.27705, 439 m, 11-Sep-2012, 1 ♂ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 13-Jun-2011, 6 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 1 ♀ (M. Spivak, J. Castro); 15-Jun-2012, 6 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♀, 1 ♂ (E. Evans & party); 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord); 47.0963, -98.03685, 425 m, 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord); 47.0965, -98.03688, 425 m, 16-Aug-2012, 1 ♂ (E. Evans & party); Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 12-Jul-2011, 3 ♀ (E. Evans, M. Spivak, J. Castro); 14-Jun-2012, 17 ♀ (E. Evans & party); 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 3 ♀ (E. Evans & party); 3-Aug-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2011, 3 ♀ (E. Evans & party); 12-Jul-2011, 2 ♀ (E. Evans, M. Spivak, J. Castro); 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 5 ♀ (E. Evans & party); 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); 10-Sep-2012, 1 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 27-May-2010, 4 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 2 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 6 ♀ (E. Evans & party); 18-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 12 ♀ (E. Evans & party); 14-Aug-2012, 2 ♂ (J. Gardner, J. Castro); Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 8 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 4 ♀ (J. Gardner, M. Smart); 5-Jul-2010, 3 ♀ (E. Evans, M. Spivak, K. Lee); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 47.25226, -98.9328, 477 m, 13-Jun-2011, 16 ♀ (E. Evans, M. Spivak); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 6 ♀ (E. Evans & party);

4 km E of Edmunds; 47.235483, -98.911533, 474 m, 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 5 km E of Edmunds; 47.25488, -98.9019, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 20 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 10 ♀ (J. Gardner, M. Smart); 5-Jul-2010, 4 ♀ (E. Evans, M. Spivak, K. Lee); 11-Sep-2010, 2 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 13-Jun-2011, 3 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 8 ♀ (J. Gardner, M. Spivak); 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 18-May-2012, 4 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party); 14-Aug-2012, 3 ♀, 1 ♂ (E. Evans, K. Holzenthal); 10-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 4 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 14-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 10-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 7 km NE of Pingree; 47.1824, -98.80691, 391 m, 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 47.18306, -98.81944, 456 m, 13-Jun-2011, 37 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 40 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀ (E. Evans & party); 16-Aug-2012, 2 ♂ (E. Evans & party); 11-Sep-2012, 5 ♀ (E. Evans, K. Foord); 47.18348, -98.82031, 459 m, 27-May-2010, 18 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 74 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 22 ♀ (E. Evans, M. Spivak, K. Lee); 3-Aug-2010, 3 ♀, 17 ♂ (E. Evans & party); 15-Aug-2010, 8 ♀, 15 ♂ (E. Evans, K. Knuth); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 11 ♀ (E. Evans, J. Gardner, M. Spivak); 13-Jul-2011, 4 ♀ (E. Evans, J. Gardner, M. Spivak); 14-Jul-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 14-Jun-2012, 7 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀ (E. Evans & party); 16-Aug-2012, 1 ♀, 1 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 27-May-2010, 4 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 10 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 8 ♀ (E. Evans, K. Lee); 15-Aug-2010, 2 ♀, 1 ♂ (E. Evans, K. Knuth); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 9 km NE of Pingree; 47.17958, -98.78922, 460 m, 10-Aug-2011, 1 ♂ (E. Evans, J. Gardner); 47.17975, -98.78927, 450 m, 16-Aug-2012, 2 ♀ (E. Evans & party); 47.1816, -98.7945, 454 m, 13-Jun-2011, 8 ♀ (E. Evans, J. Gardner, M. Spivak); 10-Aug-2011, 2 ♀, 1 ♂ (E. Evans, J. Gardner); 18-May-2012, 73 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 5 ♀ (E. Evans & party); 12-Jul-2012, 4 ♀ (E. Evans & party); 16-Aug-2012, 2 ♂ (E. Evans & party)

Lasioglossum cinctipes
North Dakota, Griggs Co.: 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); Stutsman Co.: 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak)

Lasioglossum cressonii
North Dakota, Barnes Co.: 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee)

Lasioglossum ellisiae
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee)

Lasioglossum foxii

North Dakota, Stutsman Co.: 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 14-Jun-2012, 1 ♀ (E. Evans & party)

Lasioglossum imitatum

North Dakota, Barnes Co.: 8 km NW of Sanborn; 46.994, -98.293, 439 m, 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); Griggs Co.: 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 8 ♀ (E. Evans, R. Rudd); Stutsman Co.: 4 km E of Edmunds; 47.22575, -98.90397, 470 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 3-Aug-2010, 2 ♀ (E. Evans & party)

Lasioglossum incompletum

North Dakota, Barnes Co.: 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee); Stutsman Co.: 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak)

Lasioglossum laevissimum

North Dakota, Barnes Co.: 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); Griggs Co.: 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2012, 2 ♀ (E. Evans & party); 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 16-Jun-2010, 1 ♀ (E. Evans & party); 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd)

Lasioglossum leucozonium

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 47.11018, -98.07701, 431 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 3-Aug-2010, 1 ♂ (E. Evans, M. Spivak, R. Rudd); 11-Sep-2010, 1 ♂ (E. Evans & party); 47.11298, -98.06702, 430 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 14-Jun-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♂ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 11-Sep-2010, 1 ♂ (E. Evans & party); 47.0823, -98.1718, 433 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 10-Aug-2011, 1 ♀ (J. Castro, R. Rudd); 14-Jun-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 15-Jun-2010, 4 ♀ (E. Evans, K. Knuth); 11-Sep-2010, 1 ♂ (E. Evans & party); 47.09616, -98.1509, 434 m, 12-Jul-2011, 5 ♀ (E. Evans, M. Spivak, J. Castro); 13-Aug-2012, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 3-Aug-2010, 1 ♂ (E. Evans & party); 46.9945, -98.257, 439 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 46.97964, -98.28512, 443 m, 6-Jul-2010, 1 ♀ (E. Evans & party); 8 km NW of Sanborn; 46.994,

-98.293, 439 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 16-Aug-2012, 1 ♂ (E. Evans & party); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♂ (E. Evans & party); 47.0965, -98.03688, 425 m, 16-Aug-2012, 1 ♂ (E. Evans & party); Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 12-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 18-May-2011, 1 ♀ (E. Evans); 14-Jun-2011, 1 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 11-Sep-2010, 1 ♂ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro); Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 47.25226, -98.9328, 477 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 14-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 11-Sep-2010, 1 ♂ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 10-Sep-2012, 2 ♀ (E. Evans, R. Rudd); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 14-Jun-2012, 4 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 2 ♀ (E. Evans, J. Gardner, M. Spivak); 11-Sep-2012, 1 ♀, 1 ♂ (E. Evans, K. Foord)

Lasioglossum lineatulum
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 2-Aug-2010, 1 ♂ (E. Evans, M. Smart, R. Rudd); 47.0823, -98.1718, 433 m, 20-May-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 17-May-2011, 1 ♀ (E. Evans); 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 9 km NE of Rogers; 47.09545, -98.06052, 425 m, 20-May-2012, 1 ♀ (E. Evans, J. Gardner); 47.0962, -98.07721, 432 m, 11-Sep-2012, 1 ♂ (J. Gardner, R. Rudd); Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 6-Jul-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 2 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 6-Jul-2010, 1 ♀ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 2 ♀, 1 ♂ (E. Evans, R. Rudd); Karnak; 47.27607, -98.06752, 430 m, 14-Jun-2012, 2 ♂ (E. Evans & party); Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 47.25226, -98.9328, 477 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Jun-2010, 2 ♀ (J. Gardner, M. Smart); 10-Sep-2010, 1 ♂ (E. Evans, K. Lee)

Lasioglossum lusorium

North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 5-Jul-2010, 1 ♀ (J. Gardner, R. Borba); 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 6-Jul-2010, 1 ♀ (E. Evans & party); Stutsman Co.: 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak)

Lasioglossum macoupinense
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 2 ♀ (J. Gardner, K. Lee); 47.2258, -98.9217, 481 m, 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 10-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal)

Lasioglossum novascotiae
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.11018, -98.07701, 431 m, 11-Sep-2010, 5 ♂ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 11-Sep-2010, 1 ♂ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 11-Sep-2010, 12 ♂ (E. Evans & party); Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 10-Sep-2010, 1 ♂ (E. Evans, K. Lee)

Lasioglossum occidentale
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 15-Jun-2012, 1 ♀ (E. Evans & party); 47.11018, -98.07701, 431 m, 25-May-2010, 6 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 4 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 7 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 2 ♀ (E. Evans & party); 6-Jul-2010, 1 ♀ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 2 ♀ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans & party); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 15-Jun-2012, 3 ♀ (E. Evans & party)

Lasioglossum packeri
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 15-Jun-2012, 4 ♀ (E. Evans & party); Stutsman Co.: 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak)

Lasioglossum paraforbesii
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 25-May-2010, 8 ♀ (J. Gardner, K. Lee); 11-Sep-2010, 1 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 6-Jul-2010, 2 ♀ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 1 ♀ (E. Evans & party); 11-Sep-2010, 4 ♀ (E. Evans & party); 47.09571, -98.06639, 429 m, 6-Sep-2011, 2 ♀ (J. Castro, R.

Rudd); 47.11298, -98.06702, 430 m, 14-Jun-2012, 3 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 7 ♀ (J. Gardner, K. Lee); 5-Jul-2010, 1 ♀ (J. Gardner, R. Borba); 2-Aug-2010, 2 ♀ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 7 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 13-Jun-2011, 4 ♀ (E. Evans & party); 20-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 13-Aug-2012, 2 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 20-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♂ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, K. Knuth); 15-Aug-2010, 1 ♀ (J. Gardner, M. Spivak, C. Carlson); 47.09616, -98.1509, 434 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 20-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 13-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.986, -98.234, 438 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 46.99384, -98.25588, 438 m, 25-May-2010, 4 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 2 ♀ (E. Evans, J. Gardner, K. Knuth); 46.9945, -98.257, 439 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 2 ♀ (M. Spivak , J. Castro); 14-Jun-2012, 5 ♀ (R. Rudd, K. Lee, J. Castro); 16-Aug-2012, 1 ♀ (E. Evans & party); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 13-Jun-2011, 3 ♀ (J. Castro, K. Knuth, R. Rudd); 22-Apr-2012, 1 ♀ (E. Evans); 20-May-2012, 1 ♀, 1 ♂ (M. Spivak, J. Castro); 14-Jun-2012, 7 ♀ (R. Rudd, K. Lee, J. Castro); 46.97964, -98.28512, 443 m, 26-May-2010, 40 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 7 ♀ (E. Evans, J. Gardner, K. Knuth); 6-Jul-2010, 4 ♀ (E. Evans & party); 12-Sep-2010, 3 ♀, 1 ♂ (E. Evans, J. Gardner, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 20-May-2012, 3 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 3 ♀ (R. Rudd, K. Lee, J. Castro); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 20-May-2012, 1 ♀ (E. Evans, J. Gardner); Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 4 ♀ (E. Evans & party); 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 14-Jun-2012, 4 ♀ (E. Evans & party); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 5 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 1 ♀ (E. Evans & party); 6-Jul-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 18-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀ (E. Evans & party); 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 27-May-2010, 4 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 3 ♀ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 7 ♀ (E. Evans & party); 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 9 ♀ (E. Evans & party); Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 22 ♀ (J. Gardner, K. Lee); 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 11-Sep-2010, 2 ♀ (E. Evans, K. Lee); 47.25226, -98.9328, 477 m, 13-Jun-2011, 13 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 11-Aug-2011, 1 ♂ (E. Evans, J. Castro); 18-May-2012, 5 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 3 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 4 km E of Edmunds; 47.235483, -98.911533, 474 m, 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 9 ♀ (J. Gardner, K. Lee); 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 11-Sep-2010, 2 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 17-

May-2011, 1 ♀ (E. Evans); 13-Jun-2011, 4 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 6 ♀ (J. Gardner, M. Spivak); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 9 ♀ (E. Evans, M. Spivak); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 4 ♀ (E. Evans & party); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 9 ♀ (E. Evans, J. Gardner, M. Spivak); 14-Jul-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 4 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 3 ♀ (E. Evans & party); 47.18348, -98.82031, 459 m, 27-May-2010, 12 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 22 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 6 ♀ (E. Evans, M. Spivak, K. Lee); 10-Sep-2010, 3 ♀ (E. Evans, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 4 ♀ (E. Evans, J. Gardner, M. Spivak); 13-Jul-2011, 4 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 2 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 6 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 27-May-2010, 14 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 8 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 5 ♀ (E. Evans, K. Lee); 10-Sep-2010, 11 ♀, 1 ♂ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 15 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀ (E. Evans & party); 11-Sep-2012, 2 ♀ (E. Evans & party); 48.17974, -98.78921, 458 m, 14-Jun-2012, 1 ♀ (E. Evans & party)

Lasioglossum pectorale
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 15-Jun-2010, 2 ♀ (E. Evans, K. Knuth); Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 16-Jun-2010, 1 ♀ (E. Evans & party); 6-Jul-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 1 ♂ (E. Evans & party)
, Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 11 ♀ (J. Gardner, M. Smart); 5-Jul-2010, 3 ♀ (E. Evans, M. Spivak, K. Lee); 47.2258, -98.9217, 481 m, 13-Jul-2011, 3 ♀ (J. Gardner, M. Spivak); 14-Jun-2012, 3 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 47.254, -98.92969, 471 m, 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jul-2011, 2 ♀ (J. Gardner, M. Spivak); 14-Jun-2012, 5 ♀ (E. Evans & party); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Jun-2010, 4 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 1 ♀ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 10-Aug-2011, 1 ♂ (E. Evans, J. Gardner); 18-May-2012, 5 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party)

Lasioglossum cf. *perdifficile*
North Dakota, Barnes Co.: 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 15-Aug-2010, 1 ♀ (J. Gardner, M. Spivak, C. Carlson)

Lasioglossum perpunctatum
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 15-Jun-2012, 1 ♀ (E. Evans & party); 47.11018, -98.07701, 431 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 1 ♀

(J. Gardner, K. Lee); 15-Aug-2010, 1 ♂ (E. Evans & party); 47.11298, -98.06702, 430 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 15-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, K. Knuth); 5-Jul-2010, 1 ♀ (J. Gardner, R. Borba); 47.0823, -98.1718, 433 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 20-May-2012, 1 ♀ (E. Evans & party); 3 km NE of Rogers; 47.096, -98.172, 435 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 15-Aug-2010, 1 ♀ (J. Gardner, M. Spivak, C. Carlson); 47.09616, -98.1509, 434 m, 20-May-2012, 4 ♀ (E. Evans & party); 11-Sep-2012, 1 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 46.9945, -98.257, 439 m, 20-May-2012, 1 ♀ (M. Spivak, J. Castro); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 13-Jul-2012, 1 ♀, 1 ♂ (E. Evans, D. Morrison, K. Pouliquen); 46.97964, -98.28512, 443 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 20-May-2012, 1 ♀ (M. Spivak, J. Castro); 9 km NE of Rogers; 47.09545, -98.06052, 425 m, 20-May-2012, 2 ♀ (E. Evans, J. Gardner); 47.0965, -98.03688, 425 m, 16-Aug-2012, 1 ♂ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2012, 2 ♀ (E. Evans & party); 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); 47.2698, -98.03332, 427 m, 27-May-2010, 2 ♀ (J. Gardner, K. Lee); 3-Aug-2010, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); Karnak; 47.27607, -98.06752, 430 m, 14-Jun-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 2 ♀ (J. Gardner, K. Lee); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 4 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 2 ♀ (E. Evans, M. Spivak); 18-May-2012, 2 ♀ (E. Evans, M. Spivak); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 2 ♀ (E. Evans, J. Gardner, M. Spivak); 47.18348, -98.82031, 459 m, 27-May-2010, 5 ♀ (J. Gardner, K. Lee); 3-Aug-2010, 1 ♂ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 27-May-2010, 2 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 9 ♀ (J. Gardner, M. Smart)

Lasioglossum pictum
North Dakota, Barnes Co.: 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd), Stutsman Co.: 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak)

Lasioglossum pruinosum

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 13-Jun-2011, 6 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 4 ♀ (M. Spivak, J. Castro); 11-Aug-2011, 1 ♀, 1 ♂ (J. Gardner, R. Borba, R. Rudd); 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 20-May-2012, 12 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 16 ♀ (E. Evans & party); 15-Jun-2012, 4 ♀ (E. Evans & party); 12-Jul-2012, 10 ♀ (E. Evans & party); 16-Aug-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 2 ♀ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 25-May-2010, 31 ♀ (J. Gardner, K. Lee); 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 7 ♀ (E. Evans & party); 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 11-Sep-2010, 8 ♀, 1 ♂ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 18 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 3 ♀ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 9 ♀ (E. Evans, M. Spivak, R. Rudd); 11-Sep-2010, 10 ♀, 1 ♂ (E. Evans & party); 47.09568, -98.06634, 427 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 11 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 14 ♀ (E. Evans & party); 15-Jun-2012, 2 ♀ (E. Evans & party); 12-Jul-2012, 14 ♀ (E. Evans & party); 16-Aug-2012, 6 ♀ (E. Evans & party); 10-Sep-2012, 2 ♀, 4 ♂ (J. Gardner, K. Foord); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 308 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 11 ♀ (E. Evans, K. Knuth); 5-Jul-2010, 4 ♀ (J. Gardner, R. Borba); 2-Aug-2010, 6 ♀ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 2 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 13-Jun-2011, 62 ♀ (E. Evans & party); 10-Aug-2011, 1 ♀ (J. Castro, R. Rudd); 7-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 20-May-2012, 130 ♀ (E. Evans & party); 14-Jun-2012, 15 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 5 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 10-Aug-2011, 1 ♀ (J. Castro, R. Rudd); 7-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 20-May-2012, 8 ♀ (E. Evans & party); 14-Jun-2012, 20 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 13-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 5 ♀ (E. Evans & party); 3 km NE of Rogers; 47.096, -98.172, 435 m, 13-Jun-2011, 2 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 38 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 4 ♀ (E. Evans, K. Knuth); 5-Jul-2010, 2 ♀ (J. Gardner, R. Borba); 2-Aug-2010, 2 ♀ (E. Evans, M. Smart, R. Rudd); 47.09598, -98.17888, 433 m, 14-Jun-2012, 2 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 13-Jun-2011, 8 ♀ (E. Evans & party); 20-May-2012, 12 ♀ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀ (E. Evans & party); 13-Aug-2012, 2 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 20 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, J. Gardner, K. Knuth); 46.9945, -98.257, 439 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Aug-2011, 4 ♀ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 11 ♀ (M. Spivak , J. Castro); 14-Jun-2012, 13 ♀ (R. Rudd, K. Lee, J. Castro); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 17-May-2011, 1 ♀ (E. Evans); 13-Jun-2011, 13 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Aug-2011, 3 ♀ (J. Gardner, R. Borba, R. Rudd); 22-Apr-2012, 3 ♀ (E. Evans); 20-May-2012, 8 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 26 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 6 ♀ (E. Evans, D. Morrison, K. Pouliquen); 16-Aug-2012, 2 ♀ (E. Evans & party); 46.97963, -98.27595, 441 m, 13-Jul-2012, 1 ♂ (E. Evans, D. Morrison, K. Pouliquen); 46.97964,

-98.28512, 443 m, 26-May-2010, 142 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 4 ♀ (E. Evans, J. Gardner, K. Knuth); 6-Jul-2010, 2 ♀ (E. Evans & party); 3-Aug-2010, 5 ♀ (E. Evans & party); 15-Aug-2010, 2 ♀ (E. Evans & party); 12-Sep-2010, 5 ♀, 1 ♂ (E. Evans, J. Gardner, R. Rudd); 46.98536, -98.27707, 441 m, 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 18 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 22 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 18 ♀ (E. Evans, D. Morrison, K. Pouliquen); 13-Aug-2012, 4 ♀ (E. Evans, K. Holzenthal); 16-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 7 ♀, 1 ♂ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0959, -98.08627, 425 m, 20-May-2012, 1 ♀ (E. Evans, J. Gardner); 47.0962, -98.07721, 432 m, 13-Jun-2011, 9 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 5 ♀ (E. Evans, J. Gardner); 15-Jun-2012, 18 ♀ (E. Evans & party); 12-Jul-2012, 3 ♀ (E. Evans & party); 10-Sep-2012, 3 ♀ (J. Gardner, K. Foord); 47.0965, -98.03688, 425 m, 16-Aug-2012, 2 ♂ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 18-May-2011, 1 ♀ (E. Evans); 14-Jun-2011, 5 ♀ (E. Evans & party); 11-Aug-2011, 2 ♀ (E. Evans & party); 18-May-2012, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 2 ♀ (E. Evans & party); 47.2697, -98.0353, 427 m, 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 4 ♀ (E. Evans & party); 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 12 ♀ (E. Evans & party); 4 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 1 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 6 ♀ (J. Gardner, K. Lee); 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 47.25226, -98.9328, 477 m, 13-Jun-2011, 26 ♀ (E. Evans, M. Spivak); 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 18-May-2012, 18 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 21 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 2 ♀ (J. Gardner, M. Smart); 2-Aug-2010, 3 ♀ (J. Gardner, R. Borba); 47.2258, -98.9217, 481 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 18-May-2012, 11 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 4 ♀ (E. Evans & party); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 6 ♀ (E. Evans, M. Spivak); 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 18-May-2012, 4 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 20 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 11-Sep-2012, 3 ♀ (E. Evans, K. Foord); 47.18348, -98.82031, 459 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 3-Aug-2010, 1 ♀, 1 ♂ (E. Evans & party); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 2 ♀ (E. Evans & party); 12-Jul-2012, 3 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 27-May-2010, 32 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 36 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 24 ♀ (E. Evans, K. Lee); 3-Aug-2010, 5 ♀ (E. Evans & party); 15-Aug-2010, 4 ♀ (E. Evans, K. Knuth); 10-Sep-2010, 10 ♀, 1 ♂ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 18 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 20 ♀ (E. Evans, M. Spivak); 12-Jul-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♂ (E. Evans & party)

Lasioglossum sagax
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 18-May-2011, 3 ♀ (E. Evans & party); 20-May-2012, 1 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 10 ♀ (E. Evans & party); 15-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀, 1 ♂ (E. Evans & party); 10-Sep-2012, 2 ♀, 1 ♂ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 25-May-2010, 12 ♀ (J. Gardner, K. Lee); 26-May-2010, 3 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 4 ♀ (E. Evans & party); 11-Sep-2010, 2 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 16-Jun-2010, 2 ♀ (E. Evans & party); 6-Jul-2010, 3 ♀ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 8 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 3 ♀, 1 ♂ (E. Evans & party); 11-Sep-2010, 5 ♀, 1 ♂ (E. Evans & party); 47.09568, -98.06634, 427 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 4 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 2 ♀ (E. Evans & party); 15-Jun-2012, 5 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 14 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, K. Knuth); 2-Aug-2010, 5 ♀ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 20-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 13-Aug-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 18-May-2011, 1 ♀ (E. Evans & party); 13-Jun-2011, 3 ♀ (E. Evans & party); 20-May-2012, 10 ♀ (E. Evans & party); 14-Jun-2012, 8 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 36 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 4 ♀ (E. Evans, K. Knuth); 2-Aug-2010, 10 ♀ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 1 ♂ (J. Gardner, M. Spivak, C. Carlson); 47.09598, -98.17888, 433 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 13-Jun-2011, 6 ♀ (E. Evans & party); 20-May-2012, 3 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 3 ♀ (E. Evans & party); 13-Aug-2012, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 11 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 3 ♀ (E. Evans, J. Gardner, K. Knuth); 15-Aug-2010, 1 ♀ (E. Evans & party); 46.99414, -98.26698, 440 m, 20-May-2012, 1 ♀ (M. Spivak , J. Castro); 46.9945, -98.257, 439 m, 13-Jun-2011, 4 ♀ (J. Castro, K. Knuth, R. Rudd); 14-Jun-2012, 3 ♀ (R. Rudd, K. Lee, J. Castro); 16-Aug-2012, 1 ♀ (E. Evans & party); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 17-May-2011, 2 ♀ (E. Evans); 13-Jun-2011, 3 ♀ (J. Castro, K. Knuth, R. Rudd); 13-Jul-2012, 1 ♀ (E. Evans, D. Morrison, K. Pouliquen); 46.97964, -98.28512, 443 m, 26-May-2010, 70 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 2 ♀ (E. Evans, J. Gardner, K. Knuth); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 17-May-2011, 1 ♀ (E. Evans); 13-Jun-2011, 5 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 47 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 15 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 3 ♀ (E. Evans, D. Morrison, K. Pouliquen); 13-Aug-2012, 1 ♀, 1 ♂ (E. Evans, K. Holzenthal); 11-Sep-2012, 3 ♀ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 15-Jun-2012, 2 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀ (E. Evans & party); 47.0965, -98.03688, 425 m, 16-Aug-2012, 1 ♂ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 4 ♀ (E. Evans & party); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 8 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 6 ♀ (E. Evans & party); 11-Sep-2010, 1 ♀ (E.

Evans, K. Lee); 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 1 ♀ (E. Evans & party); 47.2697, -98.0353, 427 m, 18-May-2011, 1 ♀ (E. Evans); 14-Jun-2011, 1 ♀ (E. Evans & party); 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 7 ♀ (E. Evans & party); 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 27-May-2010, 10 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♂ (E. Evans & party); 3-Aug-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 11 ♀ (E. Evans & party); 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 3 ♀ (E. Evans, R. Rudd); Karnak; 47.2759, -98.06754, 437 m, 14-Jun-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 47.25226, -98.9328, 477 m, 13-Jun-2011, 4 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party); 5 km E of Edmunds; 47.25488, -98.9019, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 6 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 3 ♀ (J. Gardner, M. Smart); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 18-May-2012, 6 ♀ (E. Evans, M. Spivak); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 17-May-2011, 2 ♀ (E. Evans); 13-Jun-2011, 4 ♀ (E. Evans, M. Spivak); 18-May-2012, 4 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 2 ♀ (E. Evans & party); 47.2759, -98.06754, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 27-May-2010, 7 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 47.20049, -98.80618, 464 m, 27-May-2010, 11 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 3 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 4 ♀ (E. Evans, K. Lee); 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak)

Lasioglossum semicaeruleum

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 13-Jun-2011, 3 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 15 ♀ (M. Spivak, J. Castro); 11-Aug-2011, 2 ♀ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 6 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 29 ♀ (E. Evans & party); 15-Jun-2012, 6 ♀ (E. Evans & party); 12-Jul-2012, 3 ♀ (E. Evans & party); 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 6-Jul-2010, 4 ♀ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 3 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 2 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 6-Jul-2010, 17 ♀ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 3 ♀ (E. Evans & party); 11-Sep-2010, 4 ♀ (E. Evans & party); 47.0956, -98.08625, 434 m, 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 47.11298, -98.06702, 430 m, 13-Jun-2011, 6 ♀ (J. Castro, K. Knuth, R. Rudd); 15-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 23 ♀ (E. Evans & party); 16-Aug-2012, 4 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 6 ♀ (J. Gardner, K. Lee); 5-Jul-2010, 30 ♀ (J. Gardner, R. Borba); 2-Aug-2010, 2 ♀ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 6 ♀ (J. Gardner, M. Spivak, C. Carlson); 47.0823, -98.1718, 433 m, 13-Jun-2011, 3 ♀ (E. Evans & party); 20-May-2012, 3 ♀ (E. Evans & party); 14-Jun-2012, 5 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 13-

Jun-2011, 4 ♀ (E. Evans & party); 12-Jul-2011, 5 ♀ (E. Evans, M. Spivak, J. Castro); 20-May-2012, 4 ♀ (E. Evans & party); 14-Jun-2012, 23 ♀ (E. Evans & party); 12-Jul-2012, 14 ♀ (E. Evans & party); 13-Aug-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans & party); 3 km NE of Rogers; 47.08977, -98.17058, 433 m, 14-Jun-2012, 2 ♀ (E. Evans & party); 47.096, -98.172, 435 m, 13-Jun-2011, 13 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 5-Jul-2010, 3 ♀ (J. Gardner, R. Borba); 2-Aug-2010, 3 ♀ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 2 ♀ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 2 ♀ (E. Evans & party); 47.09598, -98.17888, 433 m, 14-Jun-2012, 2 ♀, 1 ♂ (E. Evans & party); 47.09616, -98.1509, 434 m, 13-Jun-2011, 9 ♀ (E. Evans & party); 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 10-Aug-2011, 2 ♀ (J. Castro, R. Rudd); 20-May-2012, 4 ♀ (E. Evans & party); 14-Jun-2012, 6 ♀ (E. Evans & party); 12-Jul-2012, 2 ♀ (E. Evans & party); 11-Sep-2012, 2 ♀, 1 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.986, -98.234, 438 m, 13-Jun-2011, 18 ♀ (J. Castro, K. Knuth, R. Rudd); 46.99384, -98.25588, 438 m, 25-May-2010, 2 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀ (E. Evans & party); 3-Aug-2010, 3 ♀ (E. Evans & party); 15-Aug-2010, 6 ♀, 1 ♂ (E. Evans & party); 46.9945, -98.257, 439 m, 13-Jun-2011, 12 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 1 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 2 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 1 ♀ (E. Evans, D. Morrison, K. Pouliquen); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 13-Jun-2011, 25 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 4 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 66 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 10 ♀ (E. Evans, D. Morrison, K. Pouliquen); 16-Aug-2012, 1 ♀, 2 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 46.97963, -98.27595, 441 m, 13-Jul-2012, 2 ♀, 1 ♂ (E. Evans, D. Morrison, K. Pouliquen); 46.97964, -98.28512, 443 m, 26-May-2010, 4 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, J. Gardner, K. Knuth); 6-Jul-2010, 17 ♀ (E. Evans & party); 3-Aug-2010, 3 ♀, 1 ♂ (E. Evans & party); 15-Aug-2010, 10 ♀, 1 ♂ (E. Evans & party); 12-Sep-2010, 1 ♀ (E. Evans, J. Gardner, R. Rudd); 46.98536, -98.27707, 441 m, 14-Jun-2012, 10 ♀ (R. Rudd, K. Lee, J. Castro); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 5 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Aug-2011, 1 ♂ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 2 ♀ (M. Spivak, J. Castro); 13-Jul-2012, 41 ♀, 3 ♂ (E. Evans, D. Morrison, K. Pouliquen); 13-Aug-2012, 6 ♂ (E. Evans, K. Holzenthal); 16-Aug-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 46.99628, -98.27705, 439 m, 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 9 km NE of Rogers; 47.095, -98.053, 428 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 47.0962, -98.07721, 432 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 1 ♀ (M. Spivak, J. Castro); 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 15-Jun-2012, 21 ♀, 1 ♂ (E. Evans & party); 12-Jul-2012, 4 ♀ (E. Evans & party); 16-Aug-2012, 1 ♀, 1 ♂ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 7 ♀ (E. Evans & party); 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 4 ♀ (E. Evans & party); 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 8 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2011, 12 ♀ (E. Evans & party); 18-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro); 47.2698, -98.03332, 427 m, 6-Jul-2010, 31 ♀ (E. Evans & party); 3-Aug-2010, 3 ♀, 1 ♂ (E. Evans & party); 15-Aug-2010, 2 ♀ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538,

-98.03372, 429 m, 14-Jun-2011, 5 ♀ (E. Evans & party); 18-May-2012, 3 ♀ (E. Evans & party); 14-Jun-2012, 22 ♀ (E. Evans & party); 14-Aug-2012, 2 ♀ (J. Gardner, J. Castro); Karnak; 47.27607, -98.06752, 430 m, 14-Jun-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 2 ♀ (J. Gardner, K. Lee); 5-Jul-2010, 21 ♀ (E. Evans, M. Spivak, K. Lee); 2-Aug-2010, 3 ♀ (J. Gardner, R. Borba); 15-Aug-2010, 2 ♀ (E. Evans, K. Knuth); 47.25226, -98.9328, 477 m, 13-Jun-2011, 13 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 10 ♀ (E. Evans & party); 12-Jul-2012, 11 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 4 ♀ (E. Evans, K. Holzenthal); 4 km SE of Edmunds; 47.225949, -98.917008, 481 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 5 km E of Edmunds; 47.25488, -98.9019, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 47.2258, -98.9217, 481 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 6 ♀ (J. Gardner, M. Spivak); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 14 ♀ (E. Evans & party); 12-Jul-2012, 16 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 1 ♀, 10 ♂ (E. Evans, K. Holzenthal); 47.254, -98.92969, 471 m, 12-Jul-2012, 1 ♀, 1 ♂ (E. Evans, M. Smart, K. Pouliquen); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 2 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 2 ♀ (J. Gardner, M. Spivak); 18-May-2012, 3 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 2 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 3 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 2 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 47.18348, -98.82031, 459 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 3-Aug-2010, 1 ♀, 2 ♂ (E. Evans & party); 15-Aug-2010, 4 ♀, 1 ♂ (E. Evans, K. Knuth); 10-Sep-2010, 2 ♀ (E. Evans, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 6 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 4 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 3 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 15-Jun-2010, 5 ♀ (J. Gardner, M. Smart); 5-Jul-2010, 3 ♀ (E. Evans, M. Spivak, K. Lee); 6-Jul-2010, 171 ♀ (E. Evans, K. Lee); 15-Aug-2010, 4 ♀, 1 ♂ (E. Evans, K. Knuth); 10-Sep-2010, 4 ♀ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 10-Aug-2011, 1 ♀ (E. Evans, J. Gardner); 18-May-2012, 9 ♀ (E. Evans, M. Spivak); 12-Jul-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 2 ♀, 1 ♂ (E. Evans & party)

Lasioglossum succinipenne
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 48 ♀ (J. Gardner, K. Lee); 5-Jul-2010, 1 ♀ (J. Gardner, R. Borba); 47.0823, -98.1718, 433 m, 20-May-2012, 7 ♀ (E. Evans & party); 13-Aug-2012, 1 ♂ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, K. Knuth); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 26-May-2010, 1 ♀

(J. Gardner, K. Lee); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jul-2012, 1 ♀ (E. Evans, D. Morrison, K. Pouliquen), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 16-Jun-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 10-Sep-2010, 1 ♂ (E. Evans, K. Lee); 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 27-May-2010, 15 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 3 ♀ (J. Gardner, M. Smart); 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 18-May-2012, 6 ♀ (E. Evans, M. Spivak); 12-Jul-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans & party)

Lasioglossum texanum
North Dakota, Barnes Co.: 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 3-Aug-2010, 1 ♀ (E. Evans & party)

Lasioglossum truncatum
North Dakota, Barnes Co.: 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 16-Aug-2012, 1 ♂ (E. Evans & party), 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 15-Aug-2010, 1 ♂ (E. Evans & party); Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 1 ♂ (E. Evans, R. Rudd), Stutsman Co.: 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee)

Lasioglossum versans
North Dakota, Barnes Co.: 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 2 ♀ (E. Evans & party); 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2011, 2 ♀ (E. Evans & party); 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 16-Jun-2010, 1 ♀ (E. Evans & party); 3-Aug-2010, 1 ♂ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 1 ♀ (E. Evans & party)
, Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 7 km NE of Pingree; 47.18273, -98.80644, 451 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 47.18306, -98.81944, 456 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 47.18348, -98.82031, 459 m, 27-May-2010, 12 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 7 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 3-Aug-2010, 1 ♂ (E. Evans & party); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 6-Jul-2010, 1 ♀ (E. Evans, K. Lee); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 12-Jul-2012, 1 ♀ (E. Evans & party)

Lasioglossum viridatum

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.11018, -98.07701, 431 m, 11-Sep-2010, 1 ♂ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 20-May-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 4 ♀ (J. Gardner, K. Lee); 11-Sep-2010, 2 ♂ (E. Evans & party); 47.09616, -98.1509, 434 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 20-May-2012, 1 ♀ (M. Spivak, J. Castro), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 16-Jun-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 18-May-2012, 2 ♀ (E. Evans & party); 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro), Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee)

Lasioglossum zephyrum

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 20-May-2012, 1 ♀ (E. Evans, J. Gardner), Griggs Co.: 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 2 ♀ (E. Evans & party); 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 5 ♀, 3 ♂ (E. Evans, R. Rudd), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak)

Lasioglossum zonulum

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 13-Jun-2011, 3 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 2 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 39 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 47.11018, -98.07701, 431 m, 25-May-2010, 2 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 30 ♀ (E. Evans & party); 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 2 ♀ (J. Gardner, K. Lee); 3-Aug-2010, 20 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 1 ♂ (E. Evans & party); 47.11298, -98.06702, 430 m, 13-Jun-2011, 37 ♀ (J. Castro, K. Knuth, R. Rudd); 14-Jun-2012, 13 ♀ (E. Evans & party); 16-Aug-2012, 1 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 5 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 16 ♀ (E. Evans, K. Knuth); 2-Aug-2010, 3 ♀ (E. Evans, M. Smart, R. Rudd); 47.0823, -98.1718, 433 m, 13-Jun-2011, 5 ♀ (E. Evans & party); 14-Jun-2012, 40 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 13-Jun-2011, 6 ♀ (E. Evans & party); 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 10-Aug-2011, 1 ♀ (J. Castro, R. Rudd); 20-May-2012, 4 ♀ (E. Evans & party); 14-Jun-2012, 15 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 9 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 12 ♀ (E. Evans, K. Knuth); 2-Aug-2010, 6 ♀, 1 ♂ (E. Evans, M. Smart, R. Rudd); 3-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd); 47.09616, -98.1509, 434 m, 13-Jun-2011, 22 ♀ (E. Evans & party); 12-Jul-2011, 4 ♀ (E. Evans, M. Spivak, J.

Castro); 10-Aug-2011, 9 ♀ (J. Castro, R. Rudd); 20-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 3 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 9 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 2 ♀ (E. Evans, J. Gardner, K. Knuth); 3-Aug-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans & party); 12-Sep-2010, 1 ♀ (E. Evans, J. Gardner, R. Rudd); 46.9945, -98.257, 439 m, 13-Jun-2011, 11 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 1 ♀ (M. Spivak , J. Castro); 14-Jun-2012, 7 ♀ (R. Rudd, K. Lee, J. Castro); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 13-Jun-2011, 9 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 1 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 3 ♀ (R. Rudd, K. Lee, J. Castro); 46.97964, -98.28512, 443 m, 26-May-2010, 5 ♀ (J. Gardner, K. Lee); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 3 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 2 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 6 ♀ (R. Rudd, K. Lee, J. Castro); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 13-Jun-2011, 18 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 4 ♀ (M. Spivak, J. Castro); 11-Aug-2011, 2 ♀ (J. Gardner, R. Borba, R. Rudd); 15-Jun-2012, 24 ♀ (E. Evans & party), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 7 ♀ (E. Evans & party); 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 18-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 15 ♀ (E. Evans & party); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 18-May-2011, 1 ♀ (E. Evans); 14-Jun-2011, 6 ♀ (E. Evans & party); 18-May-2012, 3 ♀ (E. Evans & party); 14-Jun-2012, 6 ♀ (E. Evans & party); 10-Sep-2012, 2 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 2 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 15 ♀ (E. Evans & party); 18-May-2012, 3 ♀ (E. Evans & party); 14-Jun-2012, 9 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 4 ♀ (J. Gardner, K. Lee); 47.25226, -98.9328, 477 m, 13-Jun-2011, 71 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 14-Jun-2012, 2 ♀ (E. Evans & party); 4 km SE of Edmunds; 47.225949, -98.917008, 481 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 21 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 22 ♀ (J. Gardner, M. Smart); 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 47.2258, -98.9217, 481 m, 13-Jun-2011, 10 ♀ (E. Evans, M. Spivak); 14-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 18-May-2012, 4 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 15 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀, 1 ♂ (E. Evans, R. Rudd); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 130 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 6 ♀ (J. Gardner, M. Spivak); 18-May-2012, 14 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 42 ♀ (E. Evans & party); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 10 ♀ (E. Evans, J. Gardner, M. Spivak); 47.18348, -98.82031, 459 m, 15-Jun-2010, 2 ♀ (J. Gardner, M. Smart); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 2 ♀ (E. Evans, J. Gardner, M. Spivak); 14-Jun-2012, 3 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 4 ♀ (J. Gardner, M. Smart); 3-Aug-2010, 1 ♀ (E. Evans & party); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 18-May-2012, 2 ♀ (E. Evans, M. Spivak)

Sphecodes confertus
North Dakota, Stutsman Co.: 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart)

Sphecodes coronus
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 20-May-2012, 1 ♀ (E. Evans, J. Gardner); 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 16-Aug-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 20-May-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09616, -98.1509, 434 m, 10-Aug-2011, 1 ♀ (J. Castro, R. Rudd); 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 20-May-2012, 1 ♀ (M. Spivak, J. Castro); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 47.2258, -98.9217, 481 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 14-Aug-2012, 2 ♂ (E. Evans, K. Holzenthal); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak)

Sphecodes cressonii
North Dakota, Barnes Co.: 8 km NW of Sanborn; 46.994, -98.293, 439 m, 11-Sep-2012, 1 ♂ (E. Evans, K. Foord)

Sphecodes dichrous
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 11-Sep-2010, 1 ♀ (E. Evans & party), Griggs Co.: 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 1 ♂ (E. Evans, R. Rudd); Karnak; 47.27607, -98.06752, 430 m, 14-Jun-2012, 1 ♀ (E. Evans & party)

Sphecodes prosphorus
North Dakota, Barnes Co.: 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 47.0965, -98.03688, 425 m, 16-Aug-2012, 1 ♂ (E. Evans & party)

Megachilidae

Ashmeadiella bucconis
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 16-Aug-2012, 1 ♂ (E. Evans & party)

Coelioxys moesta
North Dakota, Stutsman Co.: 4 km SE of Edmunds; 47.22327, -98.93243, 487 m, 2012 season, 1 ♀ (Joel Gardner)

Heriades carinata

North Dakota, Barnes Co.: 3 km NE of Rogers; 47.08977, -98.17058, 433 m, 2012 season, 2 ♀, 1 ♂ (Joel Gardner); 2010 season, 1 ♀ (Joel Gardner); 2011 season, 1 ♀, 1 ♂ (Joel Gardner), Griggs Co.: 2 km SE of Karnak; 47.26966, -98.03912, 428 m, 2011 season, 1 ♀ (Joel Gardner), Stutsman Co.: 4 km SE of Edmunds; 47.22327, -98.93243, 487 m, 2012 season, 1 ♀, 1 ♂ (Joel Gardner); 47.22517, -98.91158, 488 m, 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 5 km E of Edmunds; 47.22544, -98.89661, 489 m, 2012 season, 1 ♀ (Joel Gardner); 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen)

Heriades variolosa

North Dakota, Barnes Co.: 6 km N of Sanborn; 47.00085, -98.25402, 439 m, 2011 season, 1 ♀, 1 ♂ (Joel Gardner), Stutsman Co.: 3 km E of Edmunds; 47.24681, -98.93201, 473 m, 2010 season, 1 ♀ (Joel Gardner)

Hoplitis pilosifrons

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 47.11018, -98.07701, 431 m, 25-May-2010, 1 ♂ (J. Gardner, K. Lee); 2 km NE of Rogers; 47.0823, -98.1718, 433 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 14-Jun-2012, 1 ♀, 1 ♂ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 15-Jun-2010, 1 ♂ (E. Evans, K. Knuth); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 15-Jun-2010, 1 ♂ (E. Evans, J. Gardner, K. Knuth); 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 26-May-2010, 1 ♂ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, J. Gardner, K. Knuth), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 16-Jun-2010, 1 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 2 ♂ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♂ (J. Gardner, M. Smart); 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 47.25226, -98.9328, 477 m, 13-Jun-2011, 1 ♂ (E. Evans, M. Spivak); 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Jun-2010, 4 ♀, 4 ♂ (J. Gardner, M. Smart); 47.2258, -98.9217, 481 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 47.18348, -98.82031, 459 m, 27-May-2010, 4 ♂ (J. Gardner, K. Lee); 15-Jun-2010, 4 ♀, 4 ♂ (J. Gardner, M. Smart); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Jun-2010, 2 ♂ (J. Gardner, M. Smart)

Hoplitis producta

North Dakota, Barnes Co.: 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 16-Jun-2010, 1 ♂ (E. Evans & party); 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 16-Jun-2010, 1 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 15-Jun-2010, 1 ♂ (J. Gardner, M. Smart); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Jun-2010, 4 ♀, 10 ♂ (J. Gardner, M.

Smart); 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 47.2258, -98.9217, 481 m, 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Jun-2010, 2 ♀, 5 ♂ (J. Gardner, M. Smart)

Hoplitis spoliata
North Dakota, Griggs Co.: 2 km SE of Karnak; 47.26966, -98.03912, 428 m, 2010 season, 1 ♂ (Joel Gardner), Stutsman Co.: 6 km NE of Pingree; 47.18253, -98.82094, 458 m, 2011 season, 1 ♀ (Joel Gardner)

Megachile brevis brevis
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.11018, -98.07701, 431 m, 16-Jun-2010, 1 ♀ (E. Evans & party); 6-Jul-2010, 1 ♂ (J. Gardner, R. Borba, M. Spivak); 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 11-Aug-2011, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 11-Aug-2011, 3 ♀ (E. Evans & party)

Megachile centuncularis
North Dakota, Barnes Co.: 8 km E of Pingree; 47.09491, -98.04014, 426 m, 2012 season, 1 ♀, 1 ♂ (Joel Gardner); 47.11453, -98.06753, 431 m, 2012 season, 3 ♀, 4 ♂ (Joel Gardner), Stutsman Co.: 3 km E of Edmunds; 47.24681, -98.93201, 473 m, 2012 season, 4 ♀, 10 ♂ (Joel Gardner); 2010 season, 1 ♂ (Joel Gardner); 4 km SE of Edmunds; 47.22327, -98.93243, 487 m, 2012 season, 5 ♀, 3 ♂ (Joel Gardner); 5 km E of Edmunds; 47.22544, -98.89661, 489 m, 2012 season, 2 ♀ (Joel Gardner); 8 km NE of Pingree; 47.193, -98.80494, 464 m, 2012 season, 2 ♀, 2 ♂ (Joel Gardner); 47.1948, -98.8056, 465 m, 11-Sep-2012, 1 ♂ (E. Evans & party); 8 km E of Pingree; 47.18111, -98.79172, 449 m, 2012 season, 3 ♀, 2 ♂ (Joel Gardner)

Megachile inermis
North Dakota, Barnes Co.: 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 15-Jun-2012, 2 ♂ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 14-Aug-2012, 3 ♀ (E. Evans, K. Holzenthal)

Megachile latimanus
North Dakota, Barnes Co.: 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 15-Aug-2010, 1 ♀ (E. Evans & party); 46.9945, -98.257, 439 m, 16-Aug-2012, 1 ♀ (E. Evans & party), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 6-Jul-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro); 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 3-Aug-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 3 ♀ (E. Evans, K. Knuth); 47.2258, -98.9217, 481 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal)

Megachile relativa
North Dakota, Barnes Co.: 3 km NE of Rogers; 47.08977, -98.17058, 433 m, 2012 season, 3 ♀, 3 ♂ (Joel Gardner); 6 km N of Sanborn; 47.00085, -98.25402, 439 m, 2011 season, 1 ♀ (Joel Gardner), Griggs Co.: 2 km E of Karnak; 47.28431, -98.03321, 428 m, 2012 season, 2 ♀, 2 ♂ (Joel Gardner); 2 km SE of Karnak; 47.26966, -98.03912, 428 m, 2012 season, 2 ♀, 1 ♂ (Joel Gardner); 2010 season, 1 ♀, 1 ♂ (Joel Gardner); 2011 season, 1 ♀, 1 ♂ (Joel Gardner); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro); 4 km SE of Karnak; 47.25573, -98.03462, 430 m, 2012 season, 2 ♀, 3 ♂ (Joel Gardner), Stutsman Co.: 3 km E of Edmunds; 47.24681, -98.93201, 473 m, 2010 season, 1 ♀, 1 ♂ (Joel Gardner); 47.24819, -98.93286, 472 m, 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 4 km SE of Edmunds; 47.22327, -98.93243, 487 m, 2012 season, 2 ♀, 4 ♂ (Joel Gardner); 5 km E of Edmunds; 47.22544, -98.89661, 489 m, 2012 season, 2 ♀, 2 ♂ (Joel Gardner); 6 km NE of Pingree; 47.18253, -98.82094, 458 m, 2012 season, 1 ♀ (Joel Gardner)

Megachile rotundata
North Dakota, Griggs Co.: 2 km SE of Karnak; 47.26966, -98.03912, 428 m, 2011 season, 1 ♂ (Joel Gardner)

Megachile latimanus perihirta
North Dakota, Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 11-Sep-2010, 1 ♀ (E. Evans, K. Lee)

Osmia cyaneonitens
North Dakota, Barnes Co.: 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd), Stutsman Co.: 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 13-Jun-2011, 1 ♂ (E. Evans, M. Spivak)

Osmia illinoensis
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 22-Apr-2012, 1 ♂ (E. Evans)

Stelis lateralis
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee), Griggs Co.: 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 16-Jun-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart)

Apidae

Anthophora bomboides
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal)

Anthophora terminalis

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 15-Jun-2012, 2 ♀ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee)

Anthophora walshii

North Dakota, Barnes Co.: 9 km NE of Rogers; 47.0965, -98.03688, 425 m, 16-Aug-2012, 2 ♂ (E. Evans & party), Stutsman Co.: 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 16-Aug-2012, 1 ♀ (E. Evans & party)

Bombus bimaculatus

North Dakota, Barnes Co.: 12 km NE of Rogers; 47.09568, -98.06634, 427 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 15-Jun-2010, 3 ♀ (E. Evans, K. Knuth); 5-Jul-2010, 1 ♀ (J. Gardner, R. Borba); 15-Aug-2010, 3 ♀, 2 ♂ (J. Gardner, M. Spivak, C. Carlson); 47.0823, -98.1718, 433 m, 13-Aug-2012, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 15-Jun-2010, 1 ♀ (E. Evans, J. Gardner, K. Knuth); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 16-Aug-2012, 1 ♂ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak)

Bombus borealis

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 11-Aug-2011, 1 ♂ (J. Gardner, R. Borba, R. Rudd); 47.11018, -98.07701, 431 m, 11-Sep-2010, 1 ♂ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 15-Aug-2010, 1 ♀ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 3 ♀, 3 ♂ (E. Evans & party); 47.0823, -98.1718, 433 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 13-Aug-2012, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 3-Aug-2010, 1 ♂ (E. Evans & party); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 20-May-2012, 1 ♀ (M. Spivak, J. Castro), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 11-Aug-2011, 1 ♂ (E. Evans & party); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 15-Aug-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 47.25226, -98.9328, 477 m, 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 4 km E of Edmunds; 47.242362, -98.911291, 472 m, 7-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 6-Sep-2011, 2 ♀ (E. Evans, B. Finnegan); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 3-Aug-2010, 1 ♀ (E. Evans & party); 10-Sep-2010, 2 ♀ (E. Evans, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 11-Sep-2012, 1 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 10-Sep-2010, 1 ♀ (E. Evans, K. Lee)

Bombus fervidus

North Dakota, Barnes Co.: 12 km NE of Rogers; 47.09568, -98.06634, 427 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Jul-2011, 1 ♀ (M. Spivak, J. Castro); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 2-Aug-2010, 3 ♀ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 6 ♀ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 10-Aug-2011, 3 ♀ (J. Castro, R. Rudd); 13-Aug-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 7-Sep-2011, 2 ♀ (J. Castro, R. Rudd); 20-May-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09616, -98.1509, 434 m, 10-Aug-2011, 1 ♀ (J. Castro, R. Rudd); 20-May-2012, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 15-Aug-2010, 1 ♀ (E. Evans & party); 46.9945, -98.257, 439 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 18-May-2011, 1 ♀ (E. Evans & party); 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 15-Aug-2010, 4 ♀ (E. Evans & party); 11-Sep-2010, 5 ♀ (E. Evans, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 12-Sep-2012, 2 ♀ (E. Evans, R. Rudd), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 11-Sep-2010, 3 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 11-Aug-2011, 1 ♂ (E. Evans, J. Castro); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 18-May-2012, 2 ♀ (E. Evans, M. Spivak); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 47.18348, -98.82031, 459 m, 3-Aug-2010, 1 ♀ (E. Evans & party); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 16-Aug-2012, 3 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans & party); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 11-Sep-2012, 1 ♂ (E. Evans & party)

Bombus griseocollis

North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 47.11018, -98.07701, 431 m, 15-Aug-2010, 1 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 16-Jun-2010, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 15-Jun-2012, 1 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, K. Knuth); 15-Aug-2010, 2 ♀ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 20-May-2012, 1 ♀ (E. Evans & party); 13-Aug-2012, 2 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 10-Aug-2011, 1 ♀ (J. Castro, R. Rudd); 11-Sep-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 15-Aug-2010, 2 ♀ (J. Gardner, M. Spivak, C. Carlson); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 3-Aug-2010, 2 ♀ (E. Evans & party); 15-Aug-2010, 3 ♀, 3 ♂ (E. Evans & party); 12-Sep-2010, 5 ♀, 1 ♂ (E. Evans, J. Gardner, R. Rudd); 46.9945, -98.257, 439 m, 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 16-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 46.97964, -98.28512, 443 m, 15-Jun-2010, 1 ♀ (E. Evans, J. Gardner, K. Knuth); 3-Aug-2010, 1 ♀

(E. Evans & party); 15-Aug-2010, 2 ♀ (E. Evans & party); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 6-Sep-2011, 1 ♂ (J. Castro, R. Rudd); 15-Jun-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♀ (E. Evans & party), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 15-Aug-2010, 1 ♀, 1 ♂ (E. Evans & party); 11-Sep-2010, 3 ♂ (E. Evans, K. Lee); 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 16-Jun-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 5 ♀, 2 ♂ (E. Evans & party); 11-Sep-2010, 1 ♀, 2 ♂ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 12-Sep-2012, 1 ♂ (E. Evans, R. Rudd), Stutsman Co.: 2 km NE of Edmunds; 47.25482, -98.94766, 426 m, 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 15-Aug-2010, 1 ♀, 3 ♂ (E. Evans, K. Knuth); 11-Sep-2010, 1 ♀, 1 ♂ (E. Evans, K. Lee); 47.25226, -98.9328, 477 m, 7-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 4 km E of Edmunds; 47.23988, -98.91155, 477 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 47.24218, -98.91154, 422 m, 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 2-Aug-2010, 2 ♀ (J. Gardner, R. Borba); 10-Sep-2010, 2 ♀, 2 ♂ (E. Evans, K. Lee); 11-Sep-2010, 3 ♀, 10 ♂ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 10-Sep-2012, 2 ♀, 1 ♂ (E. Evans, R. Rudd); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 10-Aug-2011, 2 ♀ (E. Evans, J. Gardner); 47.18348, -98.82031, 459 m, 6-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 3-Aug-2010, 1 ♀ (E. Evans & party); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jul-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 6-Sep-2011, 1 ♂ (E. Evans, B. Finnegan); 16-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀, 1 ♂ (E. Evans & party); 47.20049, -98.80618, 464 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 11-Sep-2012, 3 ♀ (E. Evans & party)

Bombus huntii
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 15-Aug-2010, 2 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 15-Aug-2010, 1 ♀ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 1 ♀, 3 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 15-Aug-2010, 1 ♀ (E. Evans & party); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 11-Sep-2010, 1 ♂ (E. Evans, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 12-Sep-2012, 2 ♀ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 3-Aug-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 17-May-2011, 1 ♀ (E. Evans); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 11-Sep-2012, 1 ♂ (E. Evans, K. Foord); 47.18348, -98.82031, 459 m, 6-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 15-Aug-2010, 5 ♀ (E. Evans, K. Knuth); 10-Sep-2010, 2 ♂ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 23-May-2011, 1 ♀ (E. Evans)

Bombus rufocinctus
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.25491, -98.92525, 477 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m,

2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 15-Aug-2010, 1 ♀, 1 ♂ (E. Evans, K. Knuth); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 27-May-2010, 1 ♂ (J. Gardner, K. Lee)

Bombus ternarius
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 20-May-2012, 2 ♀ (E. Evans, J. Gardner); 47.11018, -98.07701, 431 m, 11-Sep-2010, 1 ♂ (E. Evans & party); 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 18-May-2011, 1 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 3 ♀ (E. Evans, K. Knuth); 47.0823, -98.1718, 433 m, 20-May-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 4 km NE of Rogers; 47.09616, -98.1509, 434 m, 20-May-2012, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 3-Aug-2010, 1 ♀ (E. Evans & party), Griggs Co.: 1 km S of Karnak; 47.26995, -98.06468, 426 m, 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 12-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 15-Aug-2010, 1 ♂ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 18-May-2011, 1 ♀ (E. Evans), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 11-Sep-2010, 1 ♂ (E. Evans, K. Lee); 47.25226, -98.9328, 477 m, 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 4 km E of Edmunds; 47.23988, -98.91155, 477 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 10-Sep-2010, 2 ♀ (E. Evans, K. Lee); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 7 km NE of Pingree; 47.18273, -98.80644, 451 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 47.18306, -98.81944, 456 m, 23-May-2011, 2 ♀ (E. Evans); 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 47.18348, -98.82031, 459 m, 3-Aug-2010, 3 ♀ (E. Evans & party); 15-Aug-2010, 5 ♀ (E. Evans, K. Knuth); 10-Sep-2010, 4 ♀, 2 ♂ (E. Evans, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 3 ♀ (E. Evans, J. Gardner, M. Spivak); 47.20049, -98.80618, 464 m, 6-Jul-2010, 1 ♀ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 23-May-2011, 1 ♀ (E. Evans); 10-Aug-2011, 1 ♀ (E. Evans, J. Gardner)

Bombus terricola
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.11298, -98.06702, 430 m, 12-Jul-2012, 1 ♂ (E. Evans & party)

Bombus vagans
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 11-Sep-2010, 3 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 13-Aug-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 7-Sep-2011, 1 ♀ (J. Castro, R. Rudd), Griggs Co.: 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 11-Sep-2010, 1 ♂

(E. Evans, K. Lee); 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 3-Aug-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 10-Sep-2010, 3 ♀ (E. Evans, K. Lee); 11-Sep-2010, 1 ♂ (E. Evans, K. Lee); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd)

Ceratina calcarata
North Dakota, Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 1 ♀, 1 ♂ (J. Gardner, K. Lee)

Ceratina mikmaqi
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 12-Jul-2012, 1 ♂ (E. Evans & party); 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 4 ♂ (J. Gardner, K. Lee); 16-Jun-2010, 1 ♀, 1 ♂ (E. Evans & party); 47.11298, -98.06702, 430 m, 15-Jun-2012, 3 ♂ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 1 ♂ (J. Gardner, K. Lee); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 20-May-2012, 1 ♂ (E. Evans & party); 14-Jun-2012, 3 ♀, 2 ♂ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 4 ♀ (E. Evans & party); 3 km NE of Rogers; 47.08977, -98.17058, 433 m, 14-Jun-2012, 2 ♀ (E. Evans & party); 47.096, -98.172, 435 m, 13-Jun-2011, 1 ♂ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 5 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 3 ♀ (E. Evans, K. Knuth); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 20-May-2012, 1 ♂ (E. Evans & party); 14-Jun-2012, 1 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 14-Jun-2012, 1 ♂ (R. Rudd, K. Lee, J. Castro); 46.97964, -98.28512, 443 m, 26-May-2010, 3 ♀, 3 ♂ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀ (E. Evans & party); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 1 ♀, 1 ♂ (J. Castro, K. Knuth, R. Rudd); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 15-Jun-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord); 47.0963, -98.03685, 425 m, 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 1 ♂ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 47.28403, -98.04595, 429 m, 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 1 ♀, 3 ♂ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀ (E. Evans & party); 3 km E of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2011, 1 ♂ (E. Evans & party); 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 1 ♂ (E. Evans & party); 47.2697, -98.0353, 427 m, 18-May-2012, 4 ♂ (E. Evans & party); 14-Jun-2012, 6 ♀, 6 ♂ (E. Evans & party); 14-Aug-2012, 2 ♀ (J. Gardner, J. Castro); 12-Sep-2012, 4 ♀, 2 ♂ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 27-May-2010, 4 ♀, 9 ♂ (J. Gardner, K. Lee); 16-Jun-2010, 5 ♂ (E. Evans & party); 6-Jul-2010, 1 ♀ (E. Evans & party); 3-Aug-2010, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 18-May-2012, 1 ♀, 3 ♂ (E. Evans & party); 14-Jun-2012, 2 ♀, 6 ♂ (E. Evans & party), Stutsman Co.: 2 km NE of Edmunds; 47.25482, -98.94766, 426 m, 10-Sep-2012, 3 ♀ (E. Evans, R. Rudd); 3 km E of Edmunds; 47.24819,

-98.93286, 472 m, 27-May-2010, 1 ♀, 1 ♂ (J. Gardner, K. Lee); 15-Jun-2010, 4 ♀ (J. Gardner, M. Smart); 47.25226, -98.9328, 477 m, 13-Jun-2011, 2 ♀, 1 ♂ (E. Evans, M. Spivak); 18-May-2012, 3 ♂ (E. Evans, M. Spivak); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 4 km E of Edmunds; 47.24218, -98.91154, 422 m, 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 4 km SE of Edmunds; 47.225949, -98.917008, 481 m, 13-Jun-2011, 8 ♂ (E. Evans, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 40 ♀, 44 ♂ (J. Gardner, K. Lee); 15-Jun-2010, 5 ♀, 22 ♂ (J. Gardner, M. Smart); 5-Jul-2010, 6 ♀ (E. Evans, M. Spivak, K. Lee); 10-Sep-2010, 7 ♀ (E. Evans, K. Lee); 11-Sep-2010, 2 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 17-May-2011, 1 ♀ (E. Evans); 13-Jun-2011, 2 ♂ (E. Evans, M. Spivak); 13-Jul-2011, 3 ♀ (J. Gardner, M. Spivak); 18-May-2012, 3 ♂ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♂ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 10-Sep-2012, 3 ♀, 2 ♂ (E. Evans, R. Rudd); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 17-May-2011, 1 ♀ (E. Evans); 18-May-2012, 2 ♂ (E. Evans, M. Spivak); 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 27-May-2010, 1 ♂ (J. Gardner, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 14-Jul-2011, 4 ♂ (E. Evans, J. Gardner, M. Spivak); 47.20049, -98.80618, 464 m, 27-May-2010, 1 ♀, 1 ♂ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 2 ♂ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 1 ♂ (E. Evans, M. Spivak)

Eucera hamata
North Dakota, Barnes Co.: 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 14-Jun-2012, 1 ♂ (R. Rudd, K. Lee, J. Castro)

Holcopasites heliopsis
North Dakota, Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 1 ♀, 1 ♂ (E. Evans, K. Knuth)

Melissodes agilis
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 6-Sep-2011, 2 ♀ (J. Castro, R. Rudd); 12-Jul-2012, 2 ♂ (E. Evans & party); 16-Aug-2012, 2 ♀ (E. Evans & party); 10-Sep-2012, 4 ♀ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 3-Aug-2010, 9 ♀, 16 ♂ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 1 ♀, 2 ♂ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 3-Aug-2010, 5 ♀, 2 ♂ (E. Evans, M. Spivak, R. Rudd); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 6-Sep-2011, 2 ♀ (J. Castro, R. Rudd); 12-Jul-2012, 2 ♀ (E. Evans & party); 16-Aug-2012, 2 ♀ (E. Evans & party); 10-Sep-2012, 1 ♂ (J. Gardner, K. Foord); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 2-Aug-2010, 7 ♀, 2 ♂ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 2 ♀, 2 ♂ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 5 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 10-Aug-2011, 2 ♀ (J. Castro, R. Rudd); 7-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 13-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 4 ♀, 2 ♂ (E. Evans & party); 3 km N of Rogers; 47.10305,

-98.1933, 436 m, 10-Aug-2011, 1 ♀, 15 ♂ (J. Castro, R. Rudd); 7-Sep-2011, 4 ♀ (J. Castro, R. Rudd); 12-Jul-2012, 1 ♂ (E. Evans & party); 13-Aug-2012, 18 ♀, 1 ♂ (E. Evans & party); 11-Sep-2012, 3 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 2-Aug-2010, 7 ♀, 1 ♂ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 9 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 7-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 13-Aug-2012, 10 ♀ (E. Evans & party); 11-Sep-2012, 4 ♀, 1 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 3-Aug-2010, 5 ♀ (E. Evans & party); 15-Aug-2010, 8 ♀, 3 ♂ (E. Evans & party); 12-Sep-2010, 1 ♂ (E. Evans, J. Gardner, R. Rudd); 46.99417, -98.25027, 439 m, 13-Aug-2012, 1 ♀, 4 ♂ (E. Evans, K. Holzenthal); 46.9945, -98.257, 439 m, 6-Sep-2011, 2 ♀ (J. Castro, R. Rudd); 13-Aug-2012, 3 ♀, 3 ♂ (E. Evans, K. Holzenthal); 16-Aug-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 4 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 6-Sep-2011, 1 ♀, 1 ♂ (J. Castro, R. Rudd); 16-Aug-2012, 2 ♀ (E. Evans & party); 46.97964, -98.28512, 443 m, 3-Aug-2010, 6 ♀, 1 ♂ (E. Evans & party); 15-Aug-2010, 2 ♀ (E. Evans & party); 12-Sep-2010, 2 ♀ (E. Evans, J. Gardner, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 6-Sep-2011, 4 ♀ (J. Castro, R. Rudd); 13-Aug-2012, 3 ♀ (E. Evans, K. Holzenthal); 11-Sep-2012, 15 ♀ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 11-Aug-2011, 2 ♂ (J. Gardner, R. Borba, R. Rudd); 6-Sep-2011, 1 ♀, 1 ♂ (J. Castro, R. Rudd); 12-Jul-2012, 2 ♂ (E. Evans & party); 16-Aug-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 7 ♀ (J. Gardner, K. Foord), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 11-Aug-2011, 1 ♂ (E. Evans & party); 6-Sep-2011, 2 ♀ (E. Evans); 14-Jun-2012, 1 ♀ (E. Evans & party); 14-Aug-2012, 4 ♀ (J. Gardner, J. Castro); 12-Sep-2012, 6 ♀ (E. Evans, R. Rudd); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 3-Aug-2010, 1 ♀, 2 ♂ (E. Evans & party); 11-Sep-2010, 2 ♀ (E. Evans, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 6-Sep-2011, 1 ♀ (E. Evans); 14-Aug-2012, 10 ♀, 1 ♂ (J. Gardner, J. Castro); 12-Sep-2012, 6 ♀ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 15-Aug-2010, 1 ♂ (E. Evans & party); 11-Sep-2010, 2 ♀ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 11-Aug-2011, 1 ♀, 2 ♂ (E. Evans & party); 14-Aug-2012, 2 ♀ (J. Gardner, J. Castro); 12-Sep-2012, 2 ♀ (E. Evans, R. Rudd); I km S of Karnak; 47.26996, -98.06083, 430 m, 14-Aug-2012, 1 ♀, 5 ♂ (J. Gardner, J. Castro), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 2-Aug-2010, 2 ♀, 11 ♂ (J. Gardner, R. Borba); 15-Aug-2010, 3 ♀, 5 ♂ (E. Evans, K. Knuth); 11-Sep-2010, 3 ♀ (E. Evans, K. Lee); 47.25226, -98.9328, 477 m, 11-Aug-2011, 1 ♀, 5 ♂ (E. Evans, J. Castro); 6-Sep-2011, 1 ♀, 2 ♂ (E. Evans, B. Finnegan); 14-Aug-2012, 7 ♀, 1 ♂ (E. Evans, K. Holzenthal); 10-Sep-2012, 11 ♀ (E. Evans, R. Rudd); 47.25491, -98.92525, 477 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 4 km E of Edmunds; 47.254903, -98.928577, 474 m, 7-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 2-Aug-2010, 1 ♀, 4 ♂ (J. Gardner, R. Borba); 15-Aug-2010, 1 ♀, 2 ♂ (E. Evans, K. Knuth); 11-Sep-2010, 3 ♀ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 12-Jul-2012, 1 ♀, 1 ♂ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 10-Sep-2012, 4 ♀ (E. Evans, R. Rudd); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 11-Aug-2011, 1 ♀, 1 ♂ (E. Evans, J. Castro); 6-Sep-2011, 1 ♀, 1 ♂ (E. Evans, B. Finnegan); 10-Sep-2012, 10 ♀, 2 ♂ (E. Evans, R. Rudd); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 10-Aug-2011, 5 ♀, 5 ♂ (E. Evans, J. Gardner); 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 12-Jul-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord);

47.18348, -98.82031, 459 m, 3-Aug-2010, 9 ♀, 14 ♂ (E. Evans & party); 15-Aug-2010, 3 ♀, 1 ♂ (E. Evans, K. Knuth); 10-Sep-2010, 2 ♀ (E. Evans, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 1 ♂ (E. Evans, J. Gardner, M. Spivak); 10-Aug-2011, 2 ♀ (E. Evans, J. Gardner); 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 16-Aug-2012, 1 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 10-Sep-2010, 1 ♀ (E. Evans, K. Lee); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 10-Aug-2011, 3 ♀ (E. Evans, J. Gardner); 12-Jul-2012, 1 ♂ (E. Evans & party); 11-Sep-2012, 5 ♀ (E. Evans & party)

Melissodes bimaculatus
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 16-Aug-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09616, -98.1509, 434 m, 13-Aug-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 6-Sep-2011, 1 ♂ (E. Evans, B. Finnegan); 14-Aug-2012, 2 ♂ (E. Evans, K. Holzenthal)

Melissodes confusus
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.11018, -98.07701, 431 m, 6-Jul-2010, 1 ♀ (J. Gardner, R. Borba, M. Spivak)

Melissodes coreopsis
North Dakota, Barnes Co.: 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jul-2012, 1 ♀ (E. Evans, D. Morrison, K. Pouliquen), Stutsman Co.: 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth)

Melissodes druriellus
North Dakota, Griggs Co.: 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro)

Melissodes illatus
North Dakota, Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 47.2258, -98.9217, 481 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 16-Aug-2012, 1 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 6-Jul-2010, 1 ♀ (E. Evans, K. Lee); 15-Aug-2010, 2 ♀ (E. Evans, K. Knuth)

Melissodes menuachus
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal)

Melissodes niveus
North Dakota, Barnes Co.: 7 km NW of Sanborn; 46.97964, -98.28512, 443 m, 3-Aug-2010, 1 ♀ (E. Evans & party)

Melissodes perlusus
North Dakota, Barnes Co.: 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 3-Aug-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth)

Melissodes rivalis
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.0823, -98.1718, 433 m, 11-Sep-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 11-Sep-2012, 1 ♀ (E. Evans & party), Griggs Co.: 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 15-Aug-2010, 2 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 11-Sep-2012, 1 ♀ (E. Evans & party)

Melissodes subillatus
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 5-Jul-2010, 1 ♀, 1 ♂ (J. Gardner, R. Borba); 2-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 7-Sep-2011, 2 ♀ (J. Castro, R. Rudd); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 2-Aug-2010, 2 ♀ (E. Evans, M. Smart, R. Rudd), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 6-Jul-2010, 3 ♀ (E. Evans & party); 3-Aug-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 6-Jul-2010, 2 ♀, 1 ♂ (E. Evans & party); 3-Aug-2010, 1 ♀ (E. Evans & party), Stutsman Co.: 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 6-Jul-2010, 1 ♂ (E. Evans, M. Spivak, K. Lee)

Melissodes trinodis
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 11-Aug-2011, 2 ♀ (J. Gardner, R. Borba, R. Rudd); 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 12-Jul-2012, 1 ♀, 6 ♂ (E. Evans & party); 16-Aug-2012, 3 ♀ (E. Evans & party); 10-Sep-2012, 2 ♀ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 6-Jul-2010, 1 ♂ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 15 ♀, 16 ♂ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 2 ♀, 3 ♂ (E. Evans & party); 11-Sep-2010, 2 ♂ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 6-Jul-2010, 2 ♂ (J. Gardner, R. Borba, M. Spivak); 3-Aug-2010, 12 ♀, 2 ♂ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 2 ♀ (E. Evans & party); 11-Sep-2010, 2 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 12-Jul-2012, 1 ♀, 1 ♂ (E. Evans & party); 16-Aug-2012, 3 ♀, 2 ♂ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 2-Aug-2010, 21 ♀, 3 ♂ (E. Evans, M. Smart, R. Rudd); 3-Aug-2010, 1 ♂ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 10 ♀ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 2 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 10-Aug-2011, 1 ♀ (J. Castro, R. Rudd); 7-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 12-Jul-2012, 1 ♀, 3 ♂ (E. Evans & party); 13-Aug-2012, 9 ♀ (E.

Evans & party); 11-Sep-2012, 2 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 10-Aug-2011, 2 ♀, 2 ♂ (J. Castro, R. Rudd); 7-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 12-Jul-2012, 2 ♀, 6 ♂ (E. Evans & party); 13-Aug-2012, 5 ♀, 2 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans & party); 3 km NE of Rogers; 47.09623, -98.17216, 434 m, 13-Aug-2012, 3 ♀, 1 ♂ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 2-Aug-2010, 19 ♀, 4 ♂ (E. Evans, M. Smart, R. Rudd); 3-Aug-2010, 1 ♀, 1 ♂ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 1 ♀, 1 ♂ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 2 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 12-Jul-2012, 1 ♂ (E. Evans & party); 13-Aug-2012, 23 ♀, 2 ♂ (E. Evans & party); 11-Sep-2012, 8 ♀, 1 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 3-Aug-2010, 14 ♀ (E. Evans & party); 15-Aug-2010, 12 ♀, 1 ♂ (E. Evans & party); 46.99417, -98.25027, 439 m, 13-Aug-2012, 7 ♀, 2 ♂ (E. Evans, K. Holzenthal); 46.99418, -98.27212, 439 m, 12-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 46.9945, -98.257, 439 m, 12-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 3 ♀ (E. Evans, D. Morrison, K. Pouliquen); 13-Aug-2012, 1 ♀, 6 ♂ (E. Evans, K. Holzenthal); 16-Aug-2012, 1 ♀, 1 ♂ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 12-Aug-2011, 2 ♀ (J. Gardner, R. Borba, R. Rudd); 6-Sep-2011, 2 ♀, 1 ♂ (J. Castro, R. Rudd); 13-Jul-2012, 2 ♀, 1 ♂ (E. Evans, D. Morrison, K. Pouliquen); 16-Aug-2012, 1 ♀ (E. Evans & party); 46.97964, -98.28512, 443 m, 3-Aug-2010, 28 ♀ (E. Evans & party); 12-Sep-2010, 2 ♀ (E. Evans, J. Gardner, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 12-Aug-2011, 4 ♀ (J. Gardner, R. Borba, R. Rudd); 6-Sep-2011, 2 ♀ (J. Castro, R. Rudd); 13-Jul-2012, 2 ♀, 1 ♂ (E. Evans, D. Morrison, K. Pouliquen); 13-Aug-2012, 3 ♀ (E. Evans, K. Holzenthal); 16-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 46.99628, -98.27705, 439 m, 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 11-Aug-2011, 2 ♀ (J. Gardner, R. Borba, R. Rudd); 12-Jul-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 2 ♀ (E. Evans & party); 10-Sep-2012, 4 ♀ (J. Gardner, K. Foord), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 11-Aug-2011, 6 ♀ (E. Evans & party); 6-Sep-2011, 3 ♀, 1 ♂ (E. Evans); 14-Jun-2012, 1 ♀ (E. Evans & party); 14-Aug-2012, 10 ♀ (J. Gardner, J. Castro); 12-Sep-2012, 4 ♀ (E. Evans, R. Rudd); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 3-Aug-2010, 9 ♀, 2 ♂ (E. Evans & party); 15-Aug-2010, 10 ♀, 1 ♂ (E. Evans & party); 11-Sep-2010, 2 ♀, 2 ♂ (E. Evans, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 11-Aug-2011, 1 ♀ (E. Evans & party); 14-Jun-2012, 1 ♀ (E. Evans & party); 14-Aug-2012, 18 ♀, 7 ♂ (J. Gardner, J. Castro); 12-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 3-Aug-2010, 6 ♀ (E. Evans & party); 15-Aug-2010, 2 ♀, 1 ♂ (E. Evans & party); 11-Sep-2010, 2 ♀, 1 ♂ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 11-Aug-2011, 1 ♂ (E. Evans & party); 14-Aug-2012, 4 ♀, 4 ♂ (J. Gardner, J. Castro); I km S of Karnak; 47.26996, -98.06083, 430 m, 14-Aug-2012, 2 ♀, 1 ♂ (J. Gardner, J. Castro); Karnak; 47.27607, -98.06752, 430 m, 14-Jun-2012, 1 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 2-Aug-2010, 17 ♀, 66 ♂ (J. Gardner, R. Borba); 15-Aug-2010, 5 ♀, 14 ♂ (E. Evans, K. Knuth); 10-Sep-2010, 1 ♂ (E. Evans, K. Lee); 11-Sep-2010, 2 ♂ (E. Evans, K. Lee); 47.25226, -98.9328, 477 m, 6-Sep-2011, 4 ♀ (E. Evans, B. Finnegan); 18-May-2012, 3 ♀ (E. Evans, M. Spivak); 14-Aug-2012, 2 ♀ (E. Evans, K. Holzenthal); 10-Sep-2012, 3 ♀ (E. Evans, R. Rudd);

47.25491, -98.92525, 477 m, 14-Aug-2012, 5 ♀, 1 ♂ (E. Evans, K. Holzenthal); 4 km E of Edmunds; 47.25108, -98.91161, 477 m, 14-Aug-2012, 18 ♀ (E. Evans, K. Holzenthal); 4 km SE of Edmunds; 47.22517, -98.91158, 488 m, 11-Aug-2011, 1 ♂ (E. Evans, J. Castro); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 2-Aug-2010, 10 ♀, 8 ♂ (J. Gardner, R. Borba); 15-Aug-2010, 7 ♀, 13 ♂ (E. Evans, K. Knuth); 10-Sep-2010, 2 ♀, 3 ♂ (E. Evans, K. Lee); 11-Sep-2010, 7 ♀, 1 ♂ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 11-Aug-2011, 3 ♀ (E. Evans, J. Castro); 12-Jul-2012, 3 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 3 ♀, 4 ♂ (E. Evans, K. Holzenthal); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 11-Aug-2011, 6 ♀ (E. Evans, J. Castro); 6-Sep-2011, 2 ♀, 2 ♂ (E. Evans, B. Finnegan); 12-Jul-2012, 3 ♀, 3 ♂ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 6 ♀, 5 ♂ (E. Evans, K. Holzenthal); 10-Sep-2012, 6 ♀ (E. Evans, R. Rudd); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 10-Aug-2011, 1 ♀ (E. Evans, J. Gardner); 6-Sep-2011, 2 ♀ (E. Evans, B. Finnegan); 11-Sep-2012, 2 ♀ (E. Evans, K. Foord); 47.18348, -98.82031, 459 m, 6-Jul-2010, 1 ♂ (E. Evans, M. Spivak, K. Lee); 3-Aug-2010, 12 ♀, 11 ♂ (E. Evans & party); 15-Aug-2010, 2 ♀, 2 ♂ (E. Evans, K. Knuth); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 10-Aug-2011, 5 ♀ (E. Evans, J. Gardner); 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 11-Sep-2012, 1 ♀ (E. Evans & party); 47.20049, -98.80618, 464 m, 3-Aug-2010, 3 ♀, 2 ♂ (E. Evans & party); 15-Aug-2010, 1 ♀, 1 ♂ (E. Evans, K. Knuth); 9 km NE of Pingree; 47.17958, -98.78922, 460 m, 10-Aug-2011, 1 ♀ (E. Evans, J. Gardner); 47.1816, -98.7945, 454 m, 10-Aug-2011, 1 ♀ (E. Evans, J. Gardner); 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 16-Aug-2012, 2 ♀, 1 ♂ (E. Evans & party)

Nomada aquilarum
North Dakota, Barnes Co.: 8 km NW of Sanborn; 46.994, -98.293, 439 m, 11-Sep-2012, 1 ♀ (E. Evans, K. Foord), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth)

Nomada articulata
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.11018, -98.07701, 431 m, 16-Jun-2010, 1 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 3-Aug-2010, 1 ♀ (E. Evans, M. Spivak, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 15-Jun-2012, 1 ♀ (E. Evans & party), Griggs Co.: 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee), Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Jun-2010, 1 ♀, 1 ♂ (J. Gardner, M. Smart); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 13-Jun-2011, 1 ♂ (E. Evans, J. Gardner, M. Spivak)

Nomada bethunei
North Dakota, Stutsman Co.: 4 km E of Edmunds; 47.22575, -98.90397, 470 m, 13-Jun-2011, 1 ♂ (E. Evans, M. Spivak)

Nomada sp. bidentate species group
North Dakota, Stutsman Co.: 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak)

Nomada cuneata
North Dakota, Stutsman Co.: 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Jun-2010, 2 ♀, 1 ♂ (J. Gardner, M. Smart)

Nomada denticulata
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 1 ♂ (J. Gardner, K. Lee)

Nomada vincta
North Dakota, Barnes Co.: 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 3-Aug-2010, 5 ♂ (E. Evans, M. Spivak, R. Rudd); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 11-Sep-2010, 1 ♂ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan)

Svastra obliqua
North Dakota, Barnes Co.: 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 15-Aug-2010, 1 ♂ (E. Evans & party)

Triepeolus helianthi
North Dakota, Barnes Co.: 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 12-Sep-2010, 2 ♀ (E. Evans, J. Gardner, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord), Stutsman Co.: 3 km E of Edmunds; 47.25491, -98.92525, 477 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.2258, -98.9217, 481 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 7 km NE of Pingree; 47.1824, -98.80691, 391 m, 11-Sep-2012, 1 ♀ (E. Evans, K. Foord)

Materials not identified to species level

Colletidae

Hylaeus affinis or *modestus*
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 12-Jul-2011, 2 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 1 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09568, -98.06634, 427 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 15-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord); 2 km NE of Rogers; 47.0823, -98.1718, 433 m, 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 14-Jun-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 12-Jul-2012, 2 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 11-Sep-2010, 1 ♀ (E. Evans & party); 47.09599, -98.17165, 433 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 6-Jul-2010, 1 ♀ (E. Evans & party); 46.9945, -98.257, 439 m, 14-Jun-2012, 2 ♀ (R. Rudd, K. Lee, J. Castro); 16-

Aug-2012, 1 ♀ (E. Evans & party); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 14-Jun-2012, 3 ♀ (R. Rudd, K. Lee, J. Castro); 46.97964, -98.28512, 443 m, 6-Jul-2010, 1 ♀ (E. Evans & party); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jul-2012, 1 ♀ (E. Evans, D. Morrison, K. Pouliquen); 13-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 16-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord), Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 14-Jun-2012, 6 ♀ (E. Evans & party); 14-Aug-2012, 6 ♀ (J. Gardner, J. Castro); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 6-Jul-2010, 1 ♀ (E. Evans & party); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2012, 11 ♀ (E. Evans & party); 14-Aug-2012, 6 ♀ (J. Gardner, J. Castro); 12-Sep-2012, 3 ♀ (E. Evans, R. Rudd); 47.2698, -98.03332, 427 m, 6-Jul-2010, 1 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 7 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 47.25226, -98.9328, 477 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Jun-2010, 3 ♀ (J. Gardner, M. Smart); 5-Jul-2010, 1 ♀ (E. Evans, M. Spivak, K. Lee); 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 47.2258, -98.9217, 481 m, 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 47.254, -98.92969, 471 m, 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 14-Jul-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 12-Jul-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♀ (E. Evans, K. Foord); 47.18348, -98.82031, 459 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 8 km NE of Pingree; 47.1948, -98.8056, 465 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 16-Aug-2012, 1 ♀ (E. Evans & party); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan)

Hylaeus modestus or species A
North Dakota, Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2012, 1 ♂ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 2 ♂ (E. Evans & party)

Andrenidae

Andrena sp.
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee), Stutsman Co.: 3 km E of Edmunds; 47.25491, -98.92525, 477 m, 14-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 4 km SE of Edmunds; 47.225949, -98.917008, 481 m, 13-Jun-2011, 1 ♂ (E. Evans, M. Spivak); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart)

Pseudopanurgus sp.
North Dakota, Barnes Co.: 3 km N of Rogers; 47.10305, -98.1933, 436 m, 10-Aug-2011, 1 ♀, 1 ♂ (J. Castro, R. Rudd), Griggs Co.: 3 km SE of Karnak; 47.2697, -98.0353, 427

m, 11-Aug-2011, 1 ♀ (E. Evans & party), 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 2-Aug-2010, 1 ♂ (J. Gardner, R. Borba); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth)
North Dakota, Griggs Co.:

Halictidae

Lasioglossum cf. *ellisiae*
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 14-Jun-2012, 2 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 15-Aug-2010, 1 ♀ (E. Evans & party); 47.09568, -98.06634, 427 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 47.0823, -98.1718, 433 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 12-Jul-2012, 3 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 12-Sep-2010, 1 ♀ (E. Evans, J. Gardner, R. Rudd); 46.99414, -98.2738, 440 m, 20-May-2012, 1 ♀ (M. Spivak , J. Castro); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 18-May-2011, 1 ♀ (E. Evans & party); 12-Jul-2012, 9 ♀ (E. Evans & party); 16-Aug-2012, 1 ♀, 3 ♂ (E. Evans & party); Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 9 ♀ (J. Gardner, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 18-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2012, 1 ♀ (E. Evans & party); Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 47.2258, -98.9217, 481 m, 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 18-May-2012, 3 ♀ (E. Evans, M. Spivak); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 3 ♀ (E. Evans, M. Spivak); 11-Aug-2011, 1 ♀ (E. Evans, J. Castro); 18-May-2012, 2 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 5 ♀ (J. Gardner, M. Smart); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 12-Jul-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 1 ♂ (E. Evans & party)

Lasioglossum cf. *ephialtum*
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 10-Sep-2012, 1 ♀ (J. Gardner, K. Foord); 47.11018, -98.07701, 431 m, 25-May-2010, 14 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 3 ♀ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 4 ♀ (J. Gardner, K. Lee); 6-Jul-2010, 1 ♀ (J. Gardner, R. Borba, M. Spivak); 15-Aug-2010, 1 ♂ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 20-May-2012, 3 ♀ (E. Evans, J. Gardner);

14-Jun-2012, 1 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 1 ♀ (J. Gardner, K. Lee);47.0823, -98.1718, 433 m, 13-Aug-2012, 1 ♂ (E. Evans & party); 3 km N of Rogers; 47.09584, -98.18879, 436 m, 18-May-2011, 1 ♀ (E. Evans & party); 47.10305, -98.1933, 436 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 13-Aug-2012, 1 ♀ (E. Evans & party); 3 km NE of Rogers; 47.096, -98.172, 435 m, 13-Jun-2011, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 8 ♀ (J. Gardner, K. Lee); 2-Aug-2010, 1 ♀ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 13-Jun-2011, 3 ♀ (E. Evans & party); 6 km NW of Sanborn; 46.99384, -98.25588, 438 m, 25-May-2010, 6 ♀ (J. Gardner, K. Lee); 46.9945, -98.257, 439 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 1 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 26-May-2010, 5 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, J. Gardner, K. Knuth);13-Jul-2012, 1 ♀ (E. Evans, D. Morrison, K. Pouliquen); 46.97964, -98.28512, 443 m, 26-May-2010, 9 ♀ (J. Gardner, K. Lee); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 3 ♀ (M. Spivak, J. Castro); 13-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 10-Sep-2012, 1 ♀, 1 ♂ (J. Gardner, K. Foord); Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 14-Jun-2011, 1 ♀ (E. Evans & party); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 2 ♀ (J. Gardner, K. Lee); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 18-May-2012, 1 ♀ (E. Evans & party); 14-Jun-2012, 3 ♀ (E. Evans & party); 47.2698, -98.03332, 427 m, 27-May-2010, 3 ♀ (J. Gardner, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 18-May-2012, 2 ♀ (E. Evans & party); 14-Jun-2012, 2 ♀ (E. Evans & party); 14-Aug-2012, 1 ♀, 1 ♂ (J. Gardner, J. Castro); 4 km E of Karnak; 47.26905, -98.01142, 391 m, 12-Sep-2012, 1 ♀, 1 ♂ (E. Evans, R. Rudd); Karnak; 47.27607, -98.06752, 430 m, 14-Jun-2012, 1 ♂ (E. Evans & party); Stutsman Co.: 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 10-Sep-2010, 1 ♂ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 13-Jun-2011, 1 ♀ (E. Evans, M. Spivak); 10-Sep-2012, 2 ♀ (E. Evans, R. Rudd); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 6-Jul-2010, 1 ♀ (E. Evans, K. Lee); 10-Sep-2010, 1 ♀ (E. Evans, K. Lee)

Lasioglossum cf. *novascotiae*
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.09572, -98.0468, 428 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 4 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 3 ♀ (E. Evans & party); 47.11018, -98.07701, 431 m, 25-May-2010, 4 ♀ (J. Gardner, K. Lee); 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 3-Aug-2010, 9 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 1 ♀ (E. Evans & party); 11-Sep-2010, 10 ♀, 9 ♂ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 25-May-2010, 1 ♀ (J. Gardner, K. Lee); 3-Aug-2010, 9 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 1 ♂ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 13-Jun-2011, 7 ♀ (J. Castro, K. Knuth, R. Rudd); 11-Aug-2011, 1 ♀ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 8 ♀ (E. Evans, J. Gardner); 14-Jun-2012, 23 ♀ (E. Evans

& party); 12-Jul-2012, 2 ♀ (E. Evans & party); 16-Aug-2012, 1 ♂ (E. Evans & party); 10-Sep-2012, 4 ♀, 1 ♂ (J. Gardner, K. Foord); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 11 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (E. Evans, K. Knuth); 2-Aug-2010, 2 ♀ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 1 ♀ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 3 ♀ (E. Evans & party); 47.0823, -98.1718, 433 m, 13-Jun-2011, 10 ♀ (E. Evans & party); 10-Aug-2011, 6 ♀ (J. Castro, R. Rudd); 20-May-2012, 7 ♀ (E. Evans & party); 14-Jun-2012, 16 ♀ (E. Evans & party); 12-Jul-2012, 6 ♀ (E. Evans & party); 11-Sep-2012, 4 ♀ (E. Evans & party); 3 km N of Rogers; 47.10305, -98.1933, 436 m, 18-May-2011, 1 ♀ (E. Evans & party); 13-Jun-2011, 28 ♀ (E. Evans & party); 12-Jul-2011, 1 ♀ (E. Evans, M. Spivak, J. Castro); 10-Aug-2011, 8 ♀ (J. Castro, R. Rudd); 7-Sep-2011, 2 ♀ (J. Castro, R. Rudd); 20-May-2012, 60 ♀ (E. Evans & party); 14-Jun-2012, 41 ♀ (E. Evans & party); 12-Jul-2012, 3 ♀ (E. Evans & party); 11-Sep-2012, 4 ♀, 2 ♂ (E. Evans & party); 3 km NE of Rogers; 47.09623, -98.17216, 434 m, 13-Aug-2012, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09569, -98.15723, 433 m, 20-May-2012, 1 ♀ (E. Evans, J. Gardner); 47.09591, -98.15093, 434 m, 26-May-2010, 129 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 11 ♀ (E. Evans, K. Knuth); 5-Jul-2010, 2 ♀ (J. Gardner, R. Borba); 2-Aug-2010, 40 ♀ (E. Evans, M. Smart, R. Rudd); 15-Aug-2010, 4 ♀ (J. Gardner, M. Spivak, C. Carlson); 11-Sep-2010, 10 ♀, 7 ♂ (E. Evans & party); 47.09598, -98.17888, 433 m, 14-Jun-2012, 36 ♀ (E. Evans & party); 47.09616, -98.1509, 434 m, 18-May-2011, 2 ♀ (E. Evans & party); 13-Jun-2011, 43 ♀ (E. Evans & party); 12-Jul-2011, 4 ♀ (E. Evans, M. Spivak, J. Castro); 10-Aug-2011, 20 ♀ (J. Castro, R. Rudd); 7-Sep-2011, 2 ♀ (J. Castro, R. Rudd); 20-May-2012, 52 ♀ (E. Evans & party); 14-Jun-2012, 12 ♀ (E. Evans & party); 12-Jul-2012, 12 ♀ (E. Evans & party); 13-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 2 ♀, 1 ♂ (E. Evans & party); 6 km NW of Sanborn; 46.986, -98.234, 438 m, 13-Jun-2011, 2 ♀ (J. Castro, K. Knuth, R. Rudd); 46.99384, -98.25588, 438 m, 25-May-2010, 41 ♀ (J. Gardner, K. Lee); 26-May-2010, 1 ♀ (J. Gardner, K. Lee); 3-Aug-2010, 4 ♀ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans & party); 46.9945, -98.257, 439 m, 13-Jun-2011, 18 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Aug-2011, 13 ♀ (J. Gardner, R. Borba, R. Rudd); 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 20-May-2012, 7 ♀ (M. Spivak , J. Castro); , 4 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 135 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 3 ♀ (E. Evans, D. Morrison, K. Pouliquen); 11-Sep-2012, 5 ♀ (E. Evans, K. Foord); 7 km NW of Sanborn; 46.9794, -98.2916, 442 m, 17-May-2011, 1 ♀ (E. Evans); 20-May-2012, 18 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 10 ♀ (R. Rudd, K. Lee, J. Castro); 16-Aug-2012, 1 ♀ (E. Evans & party); 11-Sep-2012, 2 ♀ (E. Evans, K. Foord); 46.97964, -98.28512, 443 m, 26-May-2010, 11 ♀ (J. Gardner, K. Lee); 12-Sep-2010, 11 ♀ (E. Evans, J. Gardner, R. Rudd); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 17-May-2011, 3 ♀ (E. Evans); 13-Jun-2011, 24 ♀ (J. Castro, K. Knuth, R. Rudd); 12-Aug-2011, 2 ♀ (J. Gardner, R. Borba, R. Rudd); 20-May-2012, 202 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 74 ♀ (R. Rudd, K. Lee, J. Castro); 13-Jul-2012, 6 ♀, 1 ♂ (E. Evans, D. Morrison, K. Pouliquen); 13-Aug-2012, 4 ♀ (E. Evans, K. Holzenthal); 16-Aug-2012, 3 ♂ (E. Evans & party); 11-Sep-2012, 7 ♀, 2 ♂ (E. Evans, K. Foord); 9 km NE of Rogers; 47.0962, -98.07721, 432 m, 13-Jun-2011, 3 ♀ (J. Castro, K. Knuth, R. Rudd); 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd); 15-Jun-2012, 4 ♀ (E. Evans & party); 10-Sep-2012, 3 ♀ (J. Gardner, K. Foord); 11-Sep-2012, 1 ♀ (J. Gardner, R. Rudd); Griggs Co.: 2 km E of Karnak; 47.2784, -98.03435, 427 m, 11-Aug-2011, 1 ♀ (E. Evans & party); 18-May-2012, 2 ♀ (E. Evans & party); 14-Jun-

2012, 5 ♀ (E. Evans & party); 2 km SE of Karnak; 47.26968, -98.04474, 428 m, 27-May-2010, 18 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 3 ♀ (E. Evans & party); 3-Aug-2010, 1 ♀ (E. Evans & party); 15-Aug-2010, 1 ♀ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3 km SE of Karnak; 47.26966, -98.03912, 428 m, 18-May-2012, 5 ♀ (E. Evans & party); 47.2697, -98.0353, 427 m, 18-May-2011, 2 ♀ (E. Evans); 14-Jun-2011, 50 ♀ (E. Evans & party); 12-Jul-2011, 2 ♀ (E. Evans, M. Spivak, J. Castro); 11-Aug-2011, 1 ♀ (E. Evans & party); 18-May-2012, 23 ♀ (E. Evans & party); 14-Jun-2012, 69 ♀ (E. Evans & party); 14-Aug-2012, 1 ♀ (J. Gardner, J. Castro); 47.2698, -98.03332, 427 m, 27-May-2010, 6 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 4 ♀ (E. Evans & party); 6-Jul-2010, 3 ♀ (E. Evans & party); 3-Aug-2010, 6 ♀ (E. Evans & party); 11-Sep-2010, 1 ♀ (E. Evans, K. Lee); 3.5 km SE of Karnak; 47.25538, -98.03372, 429 m, 14-Jun-2011, 29 ♀ (E. Evans & party); 11-Aug-2011, 2 ♀ (E. Evans & party); 18-May-2012, 4 ♀ (E. Evans & party); 14-Jun-2012, 22 ♀ (E. Evans & party); 12-Sep-2012, 3 ♀ (E. Evans, R. Rudd); I km S of Karnak; 47.26996, -98.06083, 430 m, 14-Aug-2012, 1 ♂ (J. Gardner, J. Castro); Karnak; 47.2759, -98.06754, 437 m, 14-Jun-2012, 4 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 17 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart); 2-Aug-2010, 3 ♀ (J. Gardner, R. Borba); 10-Sep-2010, 3 ♂ (E. Evans, K. Lee); 11-Sep-2010, 6 ♀, 3 ♂ (E. Evans, K. Lee); 47.25226, -98.9328, 477 m, 13-Jun-2011, 14 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 1 ♀ (J. Gardner, M. Spivak); 18-May-2012, 2 ♀ (E. Evans, M. Spivak); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 14-Aug-2012, 1 ♀ (E. Evans, K. Holzenthal); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 8 ♀ (J. Gardner, K. Lee); 15-Jun-2010, 12 ♀ (J. Gardner, M. Smart); 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba); 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth); 11-Sep-2010, 1 ♂ (E. Evans, K. Lee); 47.2258, -98.9217, 481 m, 13-Jun-2011, 6 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 5 ♀ (J. Gardner, M. Spivak); 11-Aug-2011, 2 ♀ (E. Evans, J. Castro); 18-May-2012, 17 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 2 ♀ (E. Evans & party); 14-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal); 10-Sep-2012, 1 ♀ (E. Evans, R. Rudd); 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 17-May-2011, 4 ♀ (E. Evans); 13-Jun-2011, 21 ♀ (E. Evans, M. Spivak); 13-Jul-2011, 8 ♀ (J. Gardner, M. Spivak); 11-Aug-2011, 4 ♀ (E. Evans, J. Castro); 18-May-2012, 29 ♀ (E. Evans, M. Spivak); 14-Jun-2012, 1 ♀ (E. Evans & party); 12-Jul-2012, 1 ♀ (E. Evans, M. Smart, K. Pouliquen); 10-Sep-2012, 1 ♂ (E. Evans, R. Rudd); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Jun-2010, 2 ♀ (J. Gardner, M. Smart); 9 km NE of Pingree; 47.1816, -98.7945, 454 m, 13-Jun-2011, 2 ♀ (E. Evans, J. Gardner, M. Spivak); 18-May-2012, 1 ♀ (E. Evans, M. Spivak)

Lasioglossum (*Dialictus*) sp.
North Dakota, Barnes Co.: 11 km NE of Rogers; 47.11018, -98.07701, 431 m, 25-May-2010, 3 ♀ (J. Gardner, K. Lee); 16-Jun-2010, 1 ♀ (E. Evans & party); 12 km NE of Rogers; 47.09531, -98.04099, 427 m, 3-Aug-2010, 2 ♀ (E. Evans, M. Spivak, R. Rudd); 15-Aug-2010, 1 ♀ (E. Evans & party); 47.11298, -98.06702, 430 m, 16-Aug-2012, 1 ♀ (E. Evans & party); 2 km NE of Rogers; 47.08152, -98.17183, 433 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 2-Aug-2010, 1 ♂ (E. Evans, M. Smart, R. Rudd); 11-Sep-2010, 1 ♀ (E. Evans & party); 4 km NE of Rogers; 47.09591, -98.15093, 434 m, 26-May-2010, 2 ♀ (J. Gardner, K. Lee); 15-Aug-2010, 1 ♂ (J. Gardner, M. Spivak, C. Carlson); 6 km NW of Sanborn; 46.9945, -98.257, 439 m, 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro); 7

km NW of Sanborn; 46.97964, -98.28512, 443 m, 26-May-2010, 8 ♀ (J. Gardner, K. Lee); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 13-Jun-2011, 1 ♀ (J. Castro, K. Knuth, R. Rudd); 20-May-2012, 1 ♀ (M. Spivak, J. Castro); 14-Jun-2012, 1 ♀ (R. Rudd, K. Lee, J. Castro), Griggs Co.: 3 km SE of Karnak; 47.2697, -98.0353, 427 m, 14-Jun-2012, 1 ♀ (E. Evans & party), Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 27-May-2010, 2 ♀ (J. Gardner, K. Lee); 47.25226, -98.9328, 477 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 27-May-2010, 1 ♀ (J. Gardner, K. Lee); 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 3-Aug-2010, 1 ♂ (E. Evans & party); 10-Sep-2010, 1 ♂ (E. Evans, K. Lee)

Lasioglossum near *pictum*
North Dakota, Stutsman Co.: 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Aug-2010, 1 ♀ (E. Evans, K. Knuth)

Sphecodes cf. *atlantis*
North Dakota, Barnes Co.: 4 km NE of Rogers; 47.09616, -98.1509, 434 m, 11-Sep-2012, 1 ♂ (E. Evans & party); 8 km NW of Sanborn; 46.994, -98.293, 439 m, 6-Sep-2011, 1 ♂ (J. Castro, R. Rudd), Stutsman Co.: 6 km SE of Edmunds; 47.2259, -98.901, 489 m, 14-Aug-2012, 1 ♂ (E. Evans, K. Holzenthal)

Sphecodes near *coronus*
North Dakota, Stutsman Co.: 7 km NE of Pingree; 47.18306, -98.81944, 456 m, 13-Jun-2011, 1 ♀ (E. Evans, J. Gardner, M. Spivak); 8 km NE of Pingree; 47.20049, -98.80618, 464 m, 15-Jun-2010, 1 ♀ (J. Gardner, M. Smart)

Sphecodes near *cressonii*
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 18-May-2012, 1 ♀ (E. Evans, M. Spivak)

Sphecodes sp. *ranunculi* group
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 14-Jun-2012, 1 ♀ (E. Evans & party); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Jun-2010, 1 ♂ (J. Gardner, M. Smart)

Sphecodes sp.
North Dakota, Barnes Co.: 8 km NW of Sanborn; 46.994, -98.293, 439 m, 6-Sep-2011, 1 ♀ (J. Castro, R. Rudd)

Sphecodes (*Sphecodium*) sp.
North Dakota, Griggs Co.: 3 km SE of Karnak; 47.2698, -98.03332, 427 m, 15-Aug-2010, 1 ♀ (E. Evans & party)

Apidae

Melissodes near *druriellus*
North Dakota, Barnes Co.: 2 km NE of Rogers; 47.0823, -98.1718, 433 m, 20-May-2012, 1 ♂ (E. Evans & party)

Melissodes sp.
North Dakota, Barnes Co.: 3 km N of Rogers; 47.10305, -98.1933, 436 m, 10-Aug-2011, 1 ♂ (J. Castro, R. Rudd), Stutsman Co.: 3 km E of Edmunds; 47.25226, -98.9328, 477 m, 6-Sep-2011, 1 ♀ (E. Evans, B. Finnegan); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth); 7 km NE of Pingree; 47.18348, -98.82031, 459 m, 15-Aug-2010, 1 ♂ (E. Evans, K. Knuth)

Melissodes sp. 1 (Arduser*)*
North Dakota, Stutsman Co.: 3 km E of Edmunds; 47.24819, -98.93286, 472 m, 2-Aug-2010, 1 ♀ (J. Gardner, R. Borba)

Nomada sp.
North Dakota, Stutsman Co.: 4 km E of Edmunds; 47.235483, -98.911533, 474 m, 13-Jul-2011, 1 ♂ (J. Gardner, M. Spivak); 5 km SE of Edmunds; 47.22578, -98.9096, 485 m, 15-Aug-2010, 1 ♀, 1 ♂ (E. Evans, K. Knuth)

Appendix B.

Blooming plants occupying less than 0.1% of survey areas. * indicates that plant is of non-native origin.

Apiaceae: *Zizia aurea, Zizia aptera*

Apocynaceae: *Apocynum androsaemifolium, Apocynum cannabinum, Asclepias speciosa, Asclepias verticilata*

*Asteraceae: Achillea millefolium, Ambrosia artemisifolia, Artemisia ludoviciana, Bidens cernua, Centaurea cyanus**, *Cichorium intybus**, *Conyza canadensis, Echinacea angustifolia, Erigeron strigosus, Helianthus grosseserratus, Helianthus petiolaris, Helianthus tuberosus, Heliopsis helianthoides, Heterotheca villosa, Liatris punctata, Liatris pycnostachya, Matricaria discoidea**, *Ratibida columnifera, Rudbeckia columnifera, Solidago nemoralis, Symphyotrichum ericoides, Taraxacum officinale**, *Tragopogon dubius**, *Tragopogon pratensis**

Boraginaceae: *Lithospermum canescens*

Brassicaceae: *Hesperis matronalis**, *Sinapis arvensis**, *Sisymbrium altissimum**, *Sisymbrium officinale**, *Thlaspi arvense**. *Berteroa incana**, *Brassica juncea**, *Brassica nigra**, *Descurainia pinnata, Lepidium virginicum*

Caprifoliaceae: *Lonicera tatarica**, *Sambucus nigra, Symphoricarpos occidentalis*

Carophyllaceae: *Stellaria graminea*

Chenopodiaceae: *Chenopodium simplex*

Convolvulaceae: *Calystegia sepium**, *Convolvulus arvensis**

Fabaceae: *Amorpha canescens, Astragalus agrestis, Astralagus canadensis, Caragana arborescens**, *Dalea purpurea, Glycyrrhiza lepidota, Medicago polymorpha**, *Pediomelum argophyllum, Trifolium arvense**, *Trifolium campestre**, *Trifolium dubium**, *Trifolium pratense**, *Trifolium repens**, *Vicia villosa**

Hydrophyllaceae: *Hydrophyllum virginianum*

Iridaceae: *Sisyrinchium angustifolium*

Lamiaceae: *Dracocephalum parviflorum, Mentha arvensis, Stachys palustris, Teucrium canadense*

Liliaceae: *Maianthemum racemosum, Maianthemum stellatum*

Nyctaginaceae: *Mirabilis nyctaginea*

Oleaceae: *Syringa vulgaris**

Onagraceae: *Oenothera biennis*

Oxalidaceae: *Oxalis corniculata*

Polygonaceae: *Polygonum amphibium, Rumex crispus**

Rosaceae: *Argentina anserina, Crataegus succulenta, Fragaria virginiana, Rosa arkansana*

Rubiaceae: *Houstonia longifolia*

Salicaceae: *Salix* sp.

Scrophulaceae: *Linaria vulgaris**

Solonaceae: *Solanum dulcamara**