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The Bee Communities of Young Living Lavender Farm, Mona, Utah, USA

Joseph S. Wilson [1,*], Jacob G. Young [2] and Lindsey Topham Wilson [3]

[1] Department of Biology, Utah State University—Tooele, Tooele, UT 84074, USA
[2] D. Gary Young Research Institute, Lehi, UT 840432, USA
[3] Native Pollinator Project, Stansbury Park, UT 84074, USA
* Correspondence: joeswilson@gmail.com; Tel.: +1-435-797-9953

Abstract: It is now widely recognized that bees are among the most important pollinators worldwide, yet the bee faunas of many regions and habitats remain inadequately documented. The Great Basin Desert in North America is thought to host some of the richest bee communities in the world, as indicated by several studies documenting diverse bee faunas in the region's natural habitats. However, limited attention has been given to the bee communities present on agricultural lands within the Great Basin Desert. Here, we describe a rich bee community housed at the Young Living Lavender Farm in Juab County, Utah, near the eastern edge of the Great Basin Desert. Our survey of bees on this farm identified 68 bee species across 22 genera. This represents 34% of the bee species known from the county, including 34 new county records. Among the numerous flower species cultivated at the farm, we found that lavender supported the richest bee community, with 32 species collected from cultivated lavender fields. While lavender is frequently recommended for homeowners to plant in support of pollinators, our study is among the first to provide a list of bee species that visit lavender in western North America. Furthermore, our results demonstrate that agricultural lands, particularly those implementing pollinator-friendly farming practices, can support rich bee communities in the Great Basin Desert.

Keywords: pollination; pollinator conservation; faunal survey; lavender pollination; *Lavandula angustifolia*

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1. Introduction

While declines in bee populations have been documented in a variety of species across North America (e.g., [1–4]), the bee fauna of many ecosystems remains largely unknown. Often, the limited understanding of bee communities poses challenges for land managers attempting to assess the quality and distinctiveness of their bee faunas without a contextual basis from other published reports. Furthermore, documenting bee declines, while important, is challenging in the absence of baseline data.

The Great Basin Desert in western North America is predicted to host some of the highest bee species richness in the world [5], with numerous studies chronicling these diverse bee communities. For example, Wilson et al. [6] documented 146 bee species from 31 genera in a two-year study focusing on sand dune habitat in Dugway Proving Ground (DPG), a military facility spanning roughly 3200 km^2 in Tooele County, Utah. Similarly, Bohart and Knowlton [7] reported 132 bee species from 33 genera in their four-year survey of the Curlew Valley (CV), a 600 km^2 area spanning the Utah/Idaho border.

While these studies clearly demonstrate the potential for diverse bee communities on arid lands in the Great Basin, there remains a notable gap in faunal research concerning the region's agricultural lands. Alfalfa (*Medicago sativa*) prevails as the most predominant crop across the West [8,9], yet other small-scale, agriculturally diverse farms exist, which might also harbor diverse bee communities. One such farm is situated on the eastern edge of the

Great Basin Desert, adjacent to the Wasatch Mountains in Juab County Utah. The Young Living Lavender Farm and Distillery (YL), established in 1994, is a roughly 680-hectare organic lavender farm (USDA organic certificate number 6001-1266) and events center that also grows 18 other species of aromatic plants. In addition to the crops, which cover about 40 hectares, the YL farm also maintains a 2.5-hectare conservation area that houses nesting raptors and shore birds, as well as a monarch waystation with native milkweed plants.

It is becoming evident that bees, particularly wild bees, can have a mutually beneficial relationship with farms. Several studies have highlighted the substantial role played by wild bees in crop pollination, even in the presence of managed European Honey Bees (*Apis mellifera*) (e.g., [10–14]. Many other studies have emphasized the contribution of gardens and farms in maintaining diverse bee communities, particularly when farm/garden plans incorporate a variety of flowering plants. (e.g., [15–18]). This recognition, that planting diverse gardens can benefit wild bees, has prompted many to seek lists of plants that support bees in their community. When searching "what flowers should I plant for bees" on the internet, lavender (*Lavandula angustifolia*) is frequently recommended, despite being non-native to North America (e.g., [19–21]). Although lavender is commonly suggested for pollinator-friendly planting, there is limited knowledge about which bee species visit lavender, particularly in western North America.

A recent study on how pollinators affect lavender essential oil yield and quality documented 12 different bee species visiting their study plot [22]. Of these 12 species, 9 were native bees and 3 were non-native species. The most common visitor was the European Honey Bee, significantly outnumbering other visitors, including multiple species of bumble bee (*Bombus* spp.) [22]. These findings are in contrast to several studies from Europe (where lavender is native) that found bumble bees as the most abundant pollinator [23–26].

Our primary goals in this study were to (1) document the bee richness present on the Young Living Lavender Farm, and (2) investigate which bee species visit the farm's flagship crop, lavender.

2. Materials and Methods

2.1. Study Site

The Young Living Lavender Farm and Distillery (YL) is situated in the eastern Great Basin Desert in Juab County Utah (39.872052, −111.846272) (Figure 1). The farm sits on the valley floor (~1493 m) about 4 km west of the base of the Wasatch Mountains. The farm is flanked to the north and the south by agricultural lands, primarily dedicated to the cultivation of alfalfa and wheat. Toward the west, the property is bounded by a seasonal reservoir and an adjoining riparian habitat while to the east, a major interstate highway runs alongside native sagebrush scrubland. Although the primary focus of the YL farm lies in the cultivation of lavender (33 hectares), the farm also features fields of goldenrod (*Solidago canadensis*: 2.8 hectares), melissa (*Melissa officinalis*: 2.5 hectares), and yarrow (*Achillea millefolium*: 2.4 hectares), In addition to these crops, YL farm maintains a demonstration garden with smaller patches (less than 0.15 hectares) of floral crops including *Salvia sclarea*, *Salvia officinalis*, *Hyssopus officinalis*, *Lycium* sp., *Artemisia dracunculoides*, *Tanacetum anuum*, *Chamomilla nobile*, *Matricaria recutita*, *Satureja montana*, *Gaillardia aristata*, *Thymus vulgaris*, *Valeriana officinalis*, *Nepeta cataria*, *Angelica archangelica*, *Vitex agnus-castus* and *Ruta graveolens*. The western boundary of the farm, which abuts the seasonal reservoir, has been set aside as a conservation area, hosting a variety of wildflowers comprising both non-native and native plant species. Among these are *Salix* sp., *Asclepias speciosa*, *Sphaeralcea* sp., *Taraxacum officinale*, *Potentilla anserina*, *Melilotus officinalis*, *Grindelia* sp., *Lactuca serriola*, *Hedysarum boreale*, *Oenothera* sp. *Helianthus nuttallii*, and *Asclepias incarnata*.

All crops grown on the farm strictly adhered to organic guidelines, prohibiting the use of both pesticides and herbicides. Weed management was carried out manually or through the controlled grazing of sheep. Sheep were purposefully introduced during the growing season as they targeted weeds and grasses, leaving the lavender undisturbed. All

fields were bordered by dirt roads, which, based on our observations, provided a habitat for ground-nesting bees.

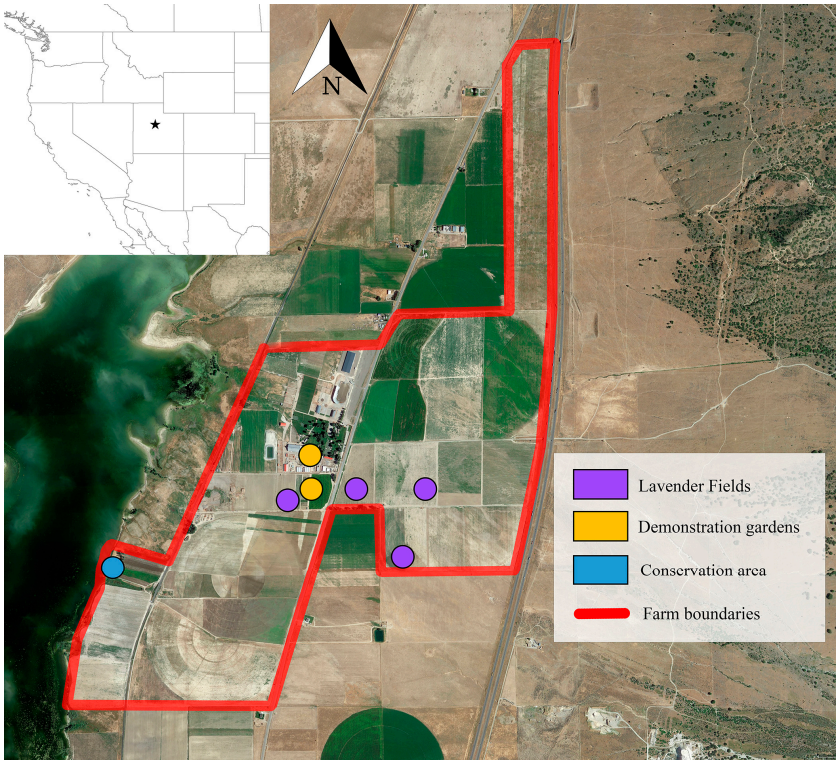

Figure 1. Map of the Young Living Lavender Farm (YL) showing the boundaries of the farmed areas of the property and the conservation area. Collection locations are also shown. The star symbol on the map in the upper left indicates the location of the farm in the state of Utah.

2.2. Collection Methods

Collections were made from May through October of 2022 using aerial nets to collect bee specimens directly on flowers. To obtain a broad understanding of bee diversity, opportunistic sampling was conducted across YL farm, targeting wild bees from a variety of plants and locations. In total, seven different locations were sampled (Figure 1). Many parts of the farm were not actively sampled (e.g., the northern fields and the southern fields: see Figure 1) because these areas were newly planted and were not actively flowering. Each location was visited every other week from May through October, with weekly visits in June and July, when lavender is more likely to be blooming. All specimens were euthanized, pinned, labeled and recorded in a relational database. Each entry included the specific area of the farm where the specimen was collected, the date of collection, and, if ascertainable, the flower it was visiting at the time of collection. Where possible, bee specimens were identified to species using available taxonomic keys and compared to referential collections for validation. However, if/when species-level identification keys were not available, those specimens were sorted into morpho-species. Sorting specimens to morphospecies can be useful because it allows us to measure species richness, even when precise species identifications are not possible.

2.3. Online Database Bee Data

There is no published bee species list for the state of Utah, or for any of its counties. In order to compare the bee fauna of YL farm to the bee fauna known from Juab County we had to make a county-specific species list based on online, publicly available data. While several online databases of natural history collections exist, we downloaded bee data from the Symbiota Collections of Arthropods Network (https://scan-bugs.org/portal/: accessed

30 January 2023) as it has a user-friendly search and download interface. Also, SCAN contains occurrence records from over 225 North American providers (over 33 million records) including dozens of university arthropod collections, federal institutions and private collections [27].

To create a Juab County bee species list we first downloaded all specimen records for each North American bee family (Andrenidae, Apidae, Megachilidae, Colletidae, Halictidae, and Melittidae) using the "Locality Criteria" search parameters with data filtered to include records from only Juab County Utah. We then combined the individual family-level datasets into one large dataset. Because online datasets often contain some amount of error, some data cleaning is often needed [5]. Duplicate records were removed as well as records identified above the species level (i.e., specimens only identified to family). Data were then uploaded into ArcMap 10.3 and specimen records that were located outside of the Juab County boundaries were removed (occasionally collectors label a specimen as "Juab County" but the Latitude and Longitude coordinates show the locality was actually outside of the county boundaries). We then used this dataset to create our Juab County species list (Appendix A). Because Juab County extends into the Wasatch Mountains, including high-elevation habitats, we created a second dataset excluding bee species only found higher in the mountains (above 1800 m). This provided a list of bee species known from the valleys and foothills of Juab County so we could make comparisons between the bee community found at the farm to the broader bee community from the surrounding area.

3. Results and Discussion

3.1. Bees of Young Living Lavender Farm

A total of 566 bee specimens were collected from the Young Living Lavender Farm (YL), representing 68 species in 22 genera (Table 1). Bee species diversity was spread among the five most common bee families in North America (Figure 2). Among the species collected at the farm, 34 were new county records (Appendix A). In total, the YL farm housed approximately 34% of the bee species known from Juab County, accounting for the inclusion of the 34 new county records on the species list. This is particularly noteworthy given that the farm covers less than 0.08% of the county's land area. Excluding bees collected from high elevations, the farm supported nearly 50% of the bees known from the valleys and foothills of Juab County. We acknowledge that this understanding of Juab County bee species richness is likely an underestimate due to limited collecting in the area. Currently, 200 species are documented in the county (Appendix A), and this number will undoubtedly grow with additional collection. Similarly, further sampling at the YL farm is likely to yield additional species. In fact, several studies have shown significant variations in estimates of bee diversity from year to year. [6,28]. For example, collections made in Grand Staircase Escalante National Monument found 384 species in the first year of sampling, with an additional 50 species found in the second year. By the end of the 4-year study, a total of 660 species were documented [28].

Table 1. Bee species found at the Young Living Farm with their abundance and the flowers they were collected on.

Family	Species	Abundance	Floral Association
Andrenidae	*Andrena candida*	2	air/ground, *Salvia* sp.
Andrenidae	*Andrena microchlora*	2	*Chamomilla recutita*, *Chorispora* sp.
Andrenidae	*Andrena prunorum*	2	*Valeriana officinalis*
Andrenidae	*Andrena* sp.	1	*Lavandula angustifolia*
Andrenidae	*Andrena striatifrons*	1	*Taraxacum officinale*

Table 1. *Cont.*

Family	Species	Abundance	Floral Association
Andrenidae	*Calliopsis scutellaris*	8	air/ground, *Potentilla anserina*, *Cleome serriulata*, *Trifolium* sp.
Apidae	*Anthophora affabilis*	1	*Salvia sclarea*
Apidae	*Anthophora urbana*	30	*Calendula* sp., *Carduus nutans*, *Gaillardia aristate*, *Lavandula angustifolia*, *Melilotus officinalis*, *Nepeta* × *faassenii*, *Salvia officinalis*, *Salvia sclarea*, *Vitex agnus-castus*
Apidae	*Apis mellifera*	464	*Cynoglossum officianale*, *Gaillardia aristate*, *Hyssopus officinalis*, *Lavandula angustifolia Thymus vulgaris*
Apidae	*Bombus fervidus*	2	*Salvia sclarea*, *Vitex agnus-castus*
Apidae	*Bombus griseocollis*	4	*Carduus nutans*, *Circium* sp., *Lavandula angustifolia*, *Vitex agnus-castus*
Apidae	*Bombus huntii*	1	*Lavandula angustifolia*
Apidae	*Bombus morrisoni*	1	*Salvia sclarea*
Apidae	*Bombus nevadensis*	1	*Salvia officinalis*
Apidae	*Ceratina acantha*	3	*Chorispora* sp., *Taraxacum officinale*
Apidae	*Diadasia diminuta*	11	*Sphaeralcea* sp.
Apidae	*Diadasia enavata*	1	*Circium* sp.
Apidae	*Eucera* (*Peponapis*) *pruinosa*	1	*Lavandula angustifolia*
Apidae	*Eucera actuosa*	1	air/ground
Apidae	*Melissodes communis*	52	*Carduus nutans*, *Circium* sp., *Gaillardia aristate*, *Hyssopus officinalis*, *Lavandula angustifolia*, *Melissa officinalis*, *Salvia sclarea*, *Vitex agnus-castus*
Apidae	*Melissodes lupinus*	5	*Lavandula angustifolia*
Apidae	*Melissodes tristis*	3	*Gaillardia aristate*, *Lavandula angustifolia*
Apidae	*Svastra obliqua*	1	*Lavandula angustifolia*
Apidae	*Triepeolus paenepectoralis*	15	*Gaillardia aristate*, *Lavandula angustifolia*
Apidae	*Brachymelecta californica*	3	*Gaillardia aristate*, *Lavandula angustifolia*
Colletidae	*Colletes fulgidus*	10	*Mentha piperita*, *Sphaeralcea* sp., *Vitex agnus-castus*
Colletidae	*Colletes kincaidii*	10	*Melilotus officinalis*, *Salix* sp., *Solidago canadensis*, *Valeriana officinalis*
Colletidae	*Hylaeus leptocephalus*	12	*Chamomilla recutita*, *Melilotus officinalis*, *Nepeta* × *faassenii*, *Salvia officinalis*, *Salvia* sp., *Solidago canadensis*, *Valeriana officinalis*
Colletidae	*Hylaeus mesillae*	7	*Achillea millefolium*, *Solidago canadensis*
Colletidae	*Hylaeus rudbeckiae*	1	*Achillea millefolium*
Colletidae	*Hylaeus* sp. 1	2	*Potentilla anserina*
Halictidae	*Agapostemon angelicus*	18	*Gaillardia aristate*, *Hyssopus officinalis*, *Lavandula angustifolia*, *Melissa officinalis*, *Origanum vulgare*, *Taraxacum officinale*
Halictidae	*Agapostemon femoratus*	3	*Hyssopus officinalis*, *Lavandula angustifolia*
Halictidae	*Agapostemon virescens*	1	*Lavandula angustifolia*
Halictidae	*Halictus farinosus*	2	*Solidago canadensis*

Table 1. *Cont.*

Family	Species	Abundance	Floral Association
Halictidae	*Halictus ligatus*	113	*Achillea millefolium*, air/ground, *Calendula* sp., *Carduus nutans*, *Chamaemelum nobile*, *Chamomilla recutita*, *Circium* sp., *Convolvulus arvensis*, *Gaillardia aristate*, *Hyssopus officinalis*, *Lavandula angustifolia*, *Melissa officinalis*, *Mentha piperita*, *Origanum vulgare*, *Potentilla anserina*, *Potentilla* sp., *Salvia sclarea*, *Solidago canadensis*, *Sphaeralcea* sp., *Taraxacum officinale*, *Valeriana officinalis*
Halictidae	*Halictus rubicundus*	25	air/ground, *Melilotus officinalis*, *Origanum vulgare*, *Potentilla anserina*, *Salvia officinalis*, *Solidago canadensis*
Halictidae	*Halictus tripartitus*	23	air/ground, *Convolvulus arvensis*, *Hyssopus officinalis*, *Lavandula angustifolia*, *Salvia sclarea*, *Solidago canadensis*, *Sphaeralcea* sp., *Taraxacum officinale*
Halictidae	*Lasioglossum athabascense*	1	*Lavandula angustifolia*
Halictidae	*Lasioglossum glabriventre*	1	*Melilotus officinalis*
Halictidae	*Lasioglossum hyalinum*	5	*Achillea millefolium*, *Lavandula angustifolia*, *Salvia sclarea*
Halictidae	*Lasioglossum incompletum*	75	*Achillea millefolium*, *Chorispora* sp., *Circium* sp., *Gaillardia aristate*, *Hyssopus officinalis*, *Lavandula angustifolia*, *Melilotus officinalis*, *Melissa officinalis*, *Mentha piperita*, *Origanum vulgare*, *Salsola* sp., *Salvia sclarea*, *Taraxacum officinale*
Halictidae	*Lasioglossum kincaidii*	3	*Potentilla anserina*, *Potentilla* sp.
Halictidae	*Lasioglossum nevadense*	6	*Carduus nutans*, *Chorispora* sp., *Lavandula angustifolia*, *Salvia sclarea*, *Taraxacum officinale*
Halictidae	*Lasioglossum pulveris*	3	*Potentilla anserina*, *Salvia sclarea*
Halictidae	*Lasioglossum semicaeruleum*	1	*Ruta graveolens*
Halictidae	*Lasioglossum sisymbrii*	16	*Lavandula angustifolia*, *Origanum vulgare*, *Ruta graveolens*, *Salvia officinalis*, *Salvia sclarea*
Halictidae	*Lasioglossum* sp. 1	2	air/ground
Halictidae	*Lasioglossum* sp. 2	1	*Chamomilla recutita*
Halictidae	*Lasioglossum* spp.	6	*Lavandula angustifolia*, *Melilotus officinalis*, *Ruta graveolens*
Halictidae	*Lasioglossum tegulare group*	1	*Melissa officinalis*
Halictidae	*Sphecodes* sp. 1	3	air/ground, *Taraxacum officinale*
Halictidae	*Sphecodes* sp. 2	2	air/ground, *Lavandula angustifolia*
Megachilidae	*Anthidium manicatum*	11	*Lavandula angustifolia*, *Melilotus officinalis*, *Melissa officinalis*, *Salvia sclarea*
Megachilidae	*Anthidium utahense*	1	*Carduus nutans*
Megachilidae	*Coelioxys octodentata*	1	*Origanum vulgare*
Megachilidae	*Coelioxys rufitarsis*	2	*Carduus nutans*, *Gaillardia aristata*
Megachilidae	*Megachile apicalis*	6	*Lavandula angustifolia*, *Nepeta* × *faassenii*, *Thymus vulgaris*
Megachilidae	*Megachile brevis*	1	*Lavandula angustifolia*
Megachilidae	*Megachile fidelis*	1	*Gaillardia aristata*
Megachilidae	*Megachile montivaga*	1	*Lavandula angustifolia*
Megachilidae	*Megachile onobrychidis*	1	*Lavandula angustifolia*
Megachilidae	*Megachile parallela*	3	*Gaillardia aristata*
Megachilidae	*Megachile perihirta*	1	*Lavandula angustifolia*
Megachilidae	*Megachile pugnata*	1	*Taraxacum officinale*

Table 1. *Cont.*

Family	Species	Abundance	Floral Association
Megachilidae	*Megachile rotundata*	21	*Hyssopus officinalis*, *Lavandula angustifolia*, *Lotus lorilulatus*, *Melilotus officinalis*, *Mentha piperita*, *Salvia officinalis*, *Thymus vulgaris*
Megachilidae	*Osmia bruneri*	3	air/ground, *Lavandula angustifolia*, *Nepeta* × *faassenii*
Megachilidae	*Osmia texana*	2	*Achillea millefolium*, *Melilotus officinalis*

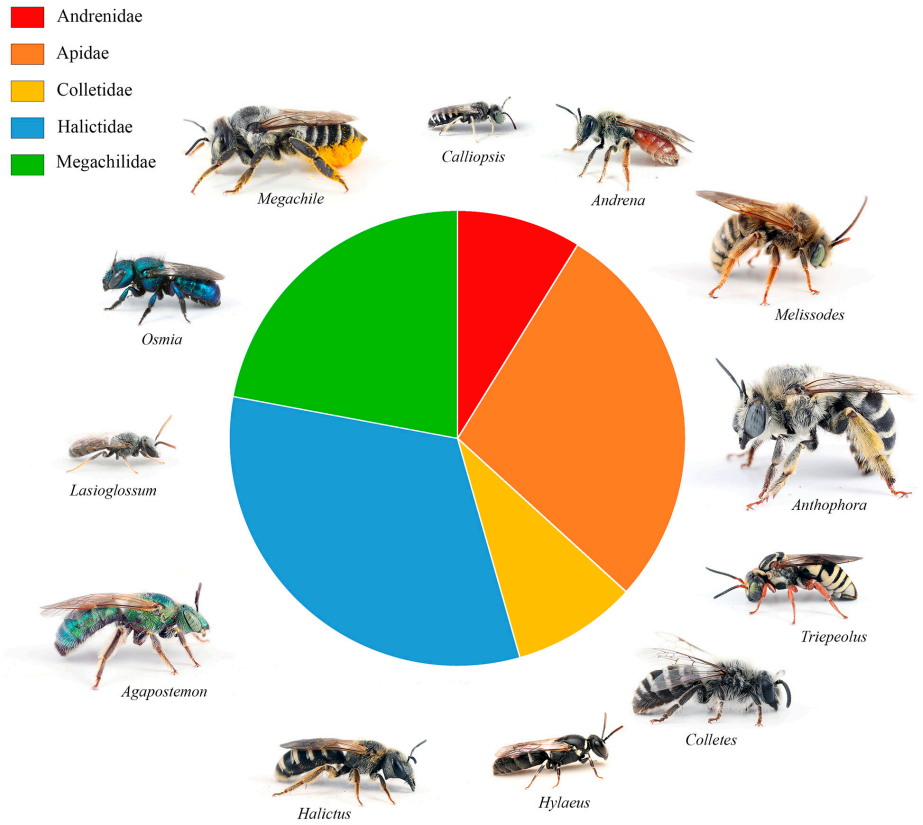

Figure 2. Graph of the species richness of bees collected at the Young Living Lavender Farm categorized by family. Andrenidae included 8.8% of the total species richness, Apidae included 27.9%, Colletidae contained 8.8%, Halictidae had 32.4% and Megachilidae had 22.1% of the bee fauna (see Table 1 for details). Examples of bees collected at the farm are also presented for each family.

While our study of bees on the YL farm found fewer species compared to other faunal surveys from the Great Basin (Dugway Proving Ground (DPG): 146 spp.; Curlew Valley (CV): 132 spp.), this discrepancy could be expected given the smaller sampling area both in terms of km^2 and habitat. Despite the reduced bee diversity in this study compared to other regional faunal surveys, noteworthy patterns emerge when comparing the bee fauna at the YL farm to both DPG and CV [6,7]. For instance, one of the most species-rich genera found in DPG was *Perdita*, with 22 species. Only seven *Perdita* species were found in CV, and none were found at the YL farm. This discrepancy might be attributed in part to the floral specialization of many *Perdita* species, suggesting their host flowers might not be present at the farm. For example, many Perdita species in the Great Basin specialize on fall blooming composites like rabbit brush (*Ericameria* spp.) while others specialize on wirelettuce (*Stephanomeria* spp.) [6], which was not present at the farm. When comparing bumble bee (*Bombus*) richness, we found five species were present at YL, eight at CV, and only one was found at DPG. Similarly, no *Hylaeus* were collected at DPG, five species were found in CV, and four at YL. In total, 31 of the species collected at YL (Table 1),

nearly half of the farm's collected species, were not documented in other published faunal surveys of bees in the Great Basin (DPG and CV). While interesting, this is not particularly surprising because bee faunal surveys are generally limited in most habitats, especially in the Great Basin. Furthermore, the current study investigating bee diversity in agricultural lands is markedly different from other published studies, which focused on desert sand dunes and grassland areas, respectively [6,7]. All of the 68 species collected at the YL farm have also been found at other sites in Utah based on searches of online databases like www.discoverlife.org (accessed on 30 January 2023).

Many of the bee species found at YL were not common; in fact, 25 of the species collected at the farm were represented by a single specimen, while 10 other species were only represented by two specimens. Conversely, some species were more abundant, represented by dozens of specimens. The top five most abundant bee species found at the farm (excluding European Honey Bees) were *Halictus ligatus* (N = 113), *Lasioglossum incompletum* (N = 75), *Melissodes communis* (N = 52), *Anthophora urbana* (N = 30), and *Halictus rubicundus* (N = 25).

The YL farm hosted a diverse floral community, encompassing various crops and vegetation in the conservation area and along the margins of the fields. In total, bees were collected from 34 different plant species. Some of the plants that supported rich bee communities were crops at the farm, while others were weedy species found in other areas of the property. The plants found to support the most bee species were *Lavandula angustifolia* (N = 31), *Salvia sclarea* (N = 13), *Gaillardia aristate* (N = 12), *Taraxacum officinale* (N = 11), and *Melilotus officinalis* (N = 10).

Of the 68 bee species collected at YL farm, 29 were found in the conservation area and 59 species were found across the cultivated farm area. Of these, 40 of the 68 species were only detected on farmland, and 9 were only detected in the conservation area. This could suggest that both the farmlands and the conservation lands play important roles in maintaining the diverse bee community found in the area.

3.2. Bees Visiting Lavender

A total of 149 bee specimens were collected on lavender, representing 32 bee species (Figure 3, Table 2). Excluding the European Honey Bees, which were ubiquitous in all the fields, the five most abundant wild bees were *Lasioglossum incompletum* (N = 45), *Melissodes communis* (N = 29), *Anthophora urbana* (N = 14), *Agapostemon angelicus* (N = 6), and *Halictus ligatus* (N = 6). The majority of bees collected on lavender were male specimens (N = 103 male, N = 46 female). This might indicate that lavender serves as an important nectar resource for bees on the farm, rather than a prominent pollen resource. This is further reinforced by the presence of multiple specialist bee species (bees that exclusively collect pollen from a limited number of plant species but visit a variety of plants for nectar) observed visiting lavender, despite it not being their host plant. For example, a male *Eucera* (*Peponapis*) *pruinosa*, a specialist of squash flowers (Cucurbitaceae), and a female *Svastra obliqua*, a sunflower (*Helianthus*) specialist, were both collected while visiting lavender. It is well established that both male and female specialist bees will visit a variety of floral hosts for nectar [29]. Therefore, the fact that specialist bees were collected visiting lavender, a floral resource they do not specialize on, is not uncommon, but indicative that lavender is being used for nectar rather than pollen by many wild bees.

Table 2. Bee species collected on lavender.

Family	Species	Abundance
Andrenidae	*Andrena* sp.	1
Apidae	*Anthophora urbana*	14
Apidae	*Apis mellifera*	464
Apidae	*Bombus griseocollis*	1
Apidae	*Bombus huntii*	1
Apidae	*Eucera* (*Peponapis*) *pruinosa*	1

Table 2. *Cont.*

Family	Species	Abundance
Apidae	*Melissodes communis*	29
Apidae	*Melissodes lupinus*	5
Apidae	*Melissodes tristis*	1
Apidae	*Svastra obliqua*	1
Apidae	*Triepeolus paenepectoralis*	4
Apidae	*Xeromelecta californica*	2
Halictidae	*Agapostemon angelicus*	6
Halictidae	*Agapostemon femoratus*	1
Halictidae	*Agapostemon virescens*	1
Halictidae	*Halictus ligatus*	6
Halictidae	*Halictus tripartitus*	1
Halictidae	*Lasioglossum athabascense*	1
Halictidae	*Lasioglossum hyalinum*	1
Halictidae	*Lasioglossum incompletum*	45
Halictidae	*Lasioglossum nevadense*	2
Halictidae	*Lasioglossum sisymbrii*	4
Halictidae	*Lasioglossum* spp.	3
Halictidae	*Sphecodes* sp. 2	1
Megachilidae	*Anthidium manicatum*	2
Megachilidae	*Megachile apicalis*	4
Megachilidae	*Megachile brevis*	1
Megachilidae	*Megachile montivaga*	1
Megachilidae	*Megachile onobrychidis*	1
Megachilidae	*Megachile perihirta*	1
Megachilidae	*Megachile rotundata*	6
Megachilidae	*Osmia bruneri*	1

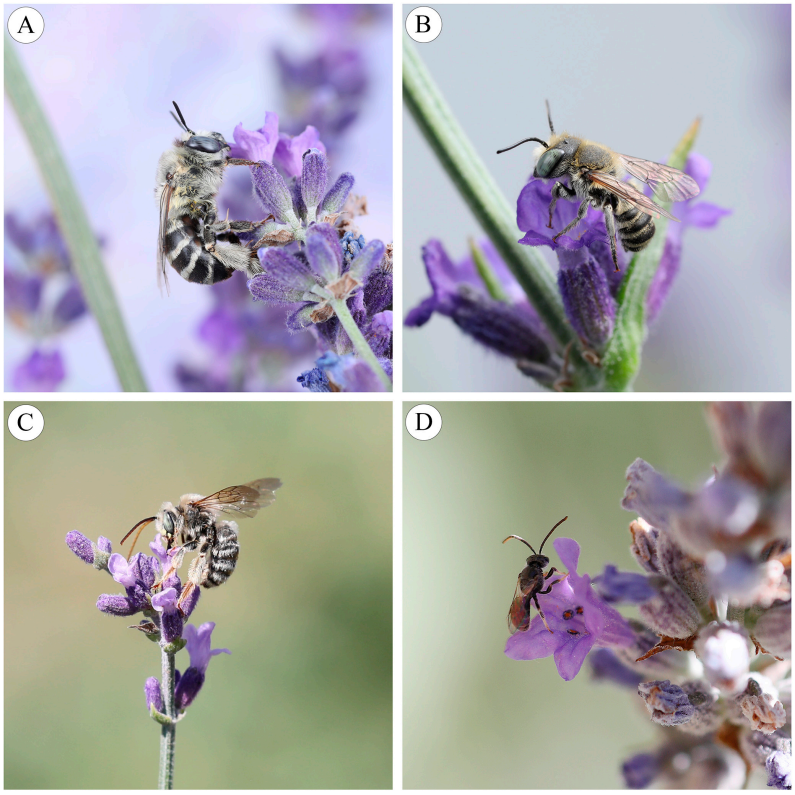

Figure 3. Photos of bees visiting lavender (*Lavandula angustifolia*). (**A**) Anthophora urbana female, (**B**) *Megachile rotundata* male, (**C**) *Melissodes communis* male, and (**D**) *Lasioglossum* (*Dialictus*) sp. male.

4. Conclusions

In addition to providing a bee species list for Juab County, Utah, our analyses clearly demonstrate that agricultural lands in the Great Basin Desert, particularly those like the Young Living Lavender Farm (YL), employing pollinator-friendly farming practices (diversifying crops, avoiding pesticides, setting aside land for conservation, and leaving space like dirt roads and trails for nesting sites) can house diverse pollinator communities. It is probable that additional sampling at YL farm will yield even more bee species, consistent with findings in other faunal surveys (e.g., [28]). Moreover, this study marks the first comprehensive survey of bees visiting lavender. Although lavender is frequently recommended as a beneficial plant for homeowners to "help pollinators," there have been limited data on the bee species that visit lavender in western North America until now. Our discovery of 31 bee species from 15 genera supports the notion that lavender can indeed sustain a diverse bee community. Studies like this one are vital as they furnish baseline data valuable for comparative faunal analyses and future investigations into bee declines.

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Appendix A

Table A1. Bee species list for Juab County, Utah. An * indicates species collected in the current study that were not previously known from the county.

Family	Species	Author
Andrenidae	*Andrena amphibola*	(Viereck 1904)
Andrenidae	*Andrena angustitarsata*	Viereck 1904
Andrenidae	*Andrena arabis*	Robertson 1897
Andrenidae	*Andrena candida* *	Smith 1879
Andrenidae	*Andrena costillensis*	Viereck & Cockerell 1914
Andrenidae	*Andrena crataegi*	Robertson 1893
Andrenidae	*Andrena forbesii*	Robertson 1891
Andrenidae	*Andrena hallii*	Dunning 1898
Andrenidae	*Andrena helianthi*	Robertson 1891
Andrenidae	*Andrena medionitens*	Cockerell 1902
Andrenidae	*Andrena microchlora* *	Cockerell 1922
Andrenidae	*Andrena pallidiscopa*	(Viereck 1904)
Andrenidae	*Andrena pertristis*	Viereck & Cockerell 1914
Andrenidae	*Andrena piperi*	Viereck 1904
Andrenidae	*Andrena prunorum*	Cockerell 1896
Andrenidae	*Andrena salicifloris*	Cockerell 1897
Andrenidae	*Andrena scurra* × *capricornis* × *arabis*	NA
Andrenidae	*Andrena sola*	Viereck 1916
Andrenidae	*Andrena specularia*	Donovan 1977

Table A1. *Cont.*

Family	Species	Author
Andrenidae	*Andrena striatfrons* *	Cockerell 1897
Andrenidae	*Andrena subtilis*	Smith 1879
Andrenidae	*Andrena thaspii*	Graenicher 1903
Andrenidae	*Andrena vicinoides*	Viereck 1904
Andrenidae	*Calliopsis coloratipes*	Cockerell 1898
Andrenidae	*Calliopsis personata*	Cockerell 1897
Andrenidae	*Calliopsis scutellaris* *	Fowler 1899
Andrenidae	*Perdita albipennis*	Cresson 1868
Andrenidae	*Perdita amoena*	Timberlake 1956
Andrenidae	*Perdita crotonis*	Cockerell 1896
Andrenidae	*Perdita lepidosparti*	Timberlake 1958
Andrenidae	*Perdita lingualis*	Cockerell 1896
Andrenidae	*Perdita oregonensis*	Timberlake 1929
Andrenidae	*Perdita salicis*	Cockerell 1896
Andrenidae	*Perdita similis*	Timberlake 1958
Andrenidae	*Perdita subfasciata*	Cockerell 1897
Andrenidae	*Perdita xanthochroa*	Timberlake 1960
Andrenidae	*Perdita zebrata*	Cresson 1878
Andrenidae	*Protandrena* sp.	NA
Andrenidae	*Pseudopanurgus aethiops*	(Cresson 1872)
Apidae	*Anthophora affabilis* *	Cresson 1878
Apidae	*Anthophora albata*	Cresson 1876
Apidae	*Anthophora dammersi*	Timberlake 1937
Apidae	*Anthophora lesquerellae*	(Cockerell 1896)
Apidae	*Anthophora maculifrons*	Cresson 1879
Apidae	*Anthophora neglecta*	Timberlake & Cockerell 1936
Apidae	*Anthophora pacifica*	Cresson 1878
Apidae	*Anthophora petrophila*	Cockerell 1905
Apidae	*Anthophora porterae*	Cockerell 1900
Apidae	*Anthophora terminalis*	Cresson 1869
Apidae	*Anthophora urbana*	Cresson 1878
Apidae	*Anthophora ursina*	Cresson 1869
Apidae	*Apis mellifera*	Linnaeus 1758
Apidae	*Bombus appositus*	Cresson 1878
Apidae	*Bombus auricomus*	(Robertson 1903)
Apidae	*Bombus bifarius*	Cresson 1878
Apidae	*Bombus centralis*	Cresson 1864
Apidae	*Bombus fervidus*	(Fabricius 1798)
Apidae	*Bombus griseocollis* *	(De Geer 1773)
Apidae	*Bombus huntii*	Greene 1860
Apidae	*Bombus morrisoni*	Cresson 1878
Apidae	*Bombus nevadensis*	Cresson 1874
Apidae	*Bombus occidentalis*	Greene 1858
Apidae	*Bombus rufocinctus*	Cresson 1863
Apidae	*Ceratina acantha* *	Provancher 1895
Apidae	*Ceratina pacifica*	H.S. Smith 1907
Apidae	*Diadasia australis*	(Cresson 1878)
Apidae	*Diadasia diminuta*	(Cresson 1878)
Apidae	*Diadasia enavata*	(Cresson 1872)
Apidae	*Diadasia lutzi*	Cockerell 1924
Apidae	*Eucera* (*Peponapis*) *pruinosa* *	(Say 1837)
Apidae	*Eucera acerba*	(Cresson 1879)
Apidae	*Eucera actuosa* *	(Cresson 1878)
Apidae	*Eucera edwardsii*	(Cresson 1878)
Apidae	*Eucera fulvitarsis*	(Cresson 1878)
Apidae	*Eucera primiveris*	(Timberlake 1969)
Apidae	*Eucera territella*	(Cockerell 1909)
Apidae	*Melissodes agilis*	Cresson 1878

Table A1. *Cont.*

Family	Species	Author
Apidae	*Melissodes appressa*	LaBerge 1961
Apidae	*Melissodes coloradensis*	Cresson 1878
Apidae	*Melissodes communis*	Cresson 1878
Apidae	*Melissodes dagosa*	Cockerell 1909
Apidae	*Melissodes glenwoodensis*	Cockerell 1905
Apidae	*Melissodes lupinus* *	Cresson 1878
Apidae	*Melissodes lutulenta*	LaBerge 1961
Apidae	*Melissodes menuachus*	Cresson 1868
Apidae	*Melissodes microsticta*	Cockerell 1905
Apidae	*Melissodes pallidisignata*	Cockerell 1905
Apidae	*Melissodes rivalis*	Cresson 1872
Apidae	*Melissodes subagilis*	Cockerell 1905
Apidae	*Melissodes tristis* *	Cockerell 1894
Apidae	*Melissodes utahensis*	LaBerge 1961
Apidae	*Nomada argentea*	(Schwarz 1966)
Apidae	*Nomada bohartorum*	Moalif 1988
Apidae	*Nomada suavis*	Cresson 1878
Apidae	*Nomada utahensis*	Moalif 1988
Apidae	*Svastra obliqua*	(Say 1837)
Apidae	*Triepeolus concavus*	(Cresson 1878)
Apidae	*Triepeolus diversipes*	(Cockerell 1924)
Apidae	*Triepeolus helianthi*	(Robertson 1897)
Apidae	*Triepeolus paenepectoralis* *	Viereck, 1905
Apidae	*Xeromelecta californica*	(Cresson 1878)
Colletidae	*Colletes compactus*	Cresson 1868
Colletidae	*Colletes fulgidus* *	Swenk 1904
Colletidae	*Colletes gypsicolens*	Cockerell 1897
Colletidae	*Colletes kincaidii* *	Cockerell 1898
Colletidae	*Colletes louisae*	Cockerell 1897
Colletidae	*Colletes lutzi*	Timberlake 1943
Colletidae	*Colletes phaceliae*	Cockerell 1906
Colletidae	*Colletes simulans*	Cresson 1868
Colletidae	*Colletes sphaeralceae*	Timberlake 1951
Colletidae	*Hylaeus annulatus*	(Linnaeus 1758)
Colletidae	*Hylaeus basalis*	(Smith 1853)
Colletidae	*Hylaeus episcopalis*	(Cockerell 1896)
Colletidae	*Hylaeus hurdi*	Snelling 1966
Colletidae	*Hylaeus leptocephalus*	(Morawitz 1871)
Colletidae	*Hylaeus mesillae*	(Cockerell 1907)
Colletidae	*Hylaeus modestus*	(Cockerell 1896)
Colletidae	*Hylaeus rudbeckiae*	(Cockerell & Casad 1895)
Colletidae	*Hylaeus rudbeckiae* *	(Cockerell & Casad 1895)
Halictidae	*Agapostemon angelicus/texanus*	Cockerell 1924
Halictidae	*Agapostemon cockerelli*	Crawford 1901
Halictidae	*Agapostemon femoratus*	Crawford 1901
Halictidae	*Agapostemon melliventris*	Cresson 1874
Halictidae	*Agapostemon virescens* *	(Fabricius 1775)
Halictidae	*Dieunomia nevadensis*	(Cresson 1874)
Halictidae	*Dieunomia triangulifera*	(Vachal 1897)
Halictidae	*Dufourea marginata*	(Cresson 1878)
Halictidae	*Halictus confusus*	Smith 1853
Halictidae	*Halictus farinosus*	Smith 1853
Halictidae	*Halictus ligatus*	Say 1837
Halictidae	*Halictus rubicundus*	(Christ 1791)
Halictidae	*Halictus tripartitus*	Cockerell 1895
Halictidae	*Lasioglossum athabascense* *	(Sandhouse 1933)
Halictidae	*Lasioglossum cinctipes*	(Provancher 1888)
Halictidae	*Lasioglossum foxii*	(Robertson 1890)
Halictidae	*Lasioglossum glabriventre*	(Crawford 1907)

Table A1. *Cont.*

Family	Species	Author
Halictidae	*Lasioglossum hyalinum* *	(Crawford 1907)
Halictidae	*Lasioglossum incompletum* *	(Crawford 1907)
Halictidae	*Lasioglossum kincaidii* *	(Cockerell 1898)
Halictidae	*Lasioglossum lampronotum*	McGinley 1986
Halictidae	*Lasioglossum nevadense* *	(Crawford, 1907)
Halictidae	*Lasioglossum pruinosum*	(Robertson 1892)
Halictidae	*Lasioglossum pulveris* *	(Cockerell 1930)
Halictidae	*Lasioglossum semicaeruleum* *	(Cockerell 1895)
Halictidae	*Lasioglossum sisymbrii*	(Cockerell 1895)
Halictidae	*Lasioglossum tegulare group* *	NA
Halictidae	*Lasioglossum trizonatum*	(Cresson 1874)
Halictidae	*Nomia melanderi*	Cockerell 1906
Halictidae	*Sphecodes* sp. 1 *	NA
Halictidae	*Sphecodes* sp. 2 *	NA
Megachilidae	*Anthidium maculosum*	Cresson 1878
Megachilidae	*Anthidium manicatum* *	(Linnaeus 1758)
Megachilidae	*Anthidium utahense* *	Swenk 1914
Megachilidae	*Ashmeadiella californica*	(Ashmead 1897)
Megachilidae	*Coelioxys octodentatus* *	Say 1824
Megachilidae	*Coelioxys productus*	Cresson 1865
Megachilidae	*Coelioxys rufitarsis* *	Smith 1854
Megachilidae	*Dianthidium curvatum*	(Smith 1854)
Megachilidae	*Dianthidium pudicum*	(Cresson 1879)
Megachilidae	*Dianthidium subparvum*	Swenk 1914
Megachilidae	*Dianthidium ulkei*	(Cresson 1878)
Megachilidae	*Heriades carinatus*	Cresson 1864
Megachilidae	*Heriades cressoni*	Michener 1938
Megachilidae	*Heriades micropthalma*	Michener 1954
Megachilidae	*Heriades variolosus*	(Cresson 1872)
Megachilidae	*Hoplitis albifrons*	(Cresson 1864)
Megachilidae	*Hoplitis fulgida*	(Cresson 1864)
Megachilidae	*Hoplitis hypocrita*	(Cockerell 1906)
Megachilidae	*Lithurgus apicalis*	(Cresson 1875)
Megachilidae	*Megachile agustini*	Cockerell 1905
Megachilidae	*Megachile apicalis* *	Spinola 1808
Megachilidae	*Megachile brevis*	Say 1837
Megachilidae	*Megachile fidelis* *	Cresson 1878
Megachilidae	*Megachile montivaga*	Cresson 1878
Megachilidae	*Megachile onobrychidis* *	Cockerell 1908
Megachilidae	*Megachile parallela*	Smith 1853
Megachilidae	*Megachile perihirta*	Cockerell 1898
Megachilidae	*Megachile pugnata*	Say 1837
Megachilidae	*Megachile relativa*	Cresson 1878
Megachilidae	*Megachile rotundata*	(Fabricius 1793)
Megachilidae	*Megachile texana*	Cresson 1878
Megachilidae	*Osmia albolateralis*	Cockerell 1906
Megachilidae	*Osmia bakeri*	Sandhouse 1924
Megachilidae	*Osmia bruneri* *	Cockerell 1897
Megachilidae	*Osmia cyanella*	Cockerell 1897
Megachilidae	*Osmia grinnelli*	Cockerell 1910
Megachilidae	*Osmia integra*	Cresson 1878
Megachilidae	*Osmia latisulcata*	Michener 1936
Megachilidae	*Osmia lignaria*	Cresson 1864
Megachilidae	*Osmia marginipennis*	Cresson 1878
Megachilidae	*Osmia montana*	Cresson 1864
Megachilidae	*Osmia nemoris*	Sandhouse 1924
Megachilidae	*Osmia pentstemonis*	Cockerell 1906
Megachilidae	*Osmia pusilla*	Cresson 1864

Table A1. *Cont.*

Family	Species	Author
Megachilidae	*Osmia rawlinsi*	Sandhouse 1939
Megachilidae	*Osmia subaustralis*	Cockerell 1900
Megachilidae	*Osmia texana*	Cresson 1872
Megachilidae	*Osmia tristella*	Cockerell 1897
Melittidae	*Hesperapis oliviae*	(Cockerell 1897)

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