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Quantifying Bee Diversity and Resource Use in the Appalachian Foothills near Marietta, Ohio

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Abstract: We surveyed bee richness, abundance, and diversity within Washington County, Ohio. Bees were collected at three sites within Washington County every two weeks from April to October 2013 using pan traps, vane traps, and hand collecting. A total of 2,753 bees were pinned and identified to genus, and when possible, species. A total of 35 genera of bees were collected representing over 130 species in five families. Of the species collected, 74 had fewer than 3 representatives. The most common genera were *Andrena*, *Lasioglossum*, and *Ceratina*. Of the bees collected, 81 individuals, the majority of which were either *Andrena erigeniae* (n=49) or *Andrena violae* (n=12), had visible pollen loads. *Andrena erigeniae* was found to collect pollen mainly from *Claytonia virginica*. *Andrena violae* collected pollen from a variety of spring ephemerals in addition to violets. Overall, this research provides a baseline understanding of the current bee populations in southeastern Ohio. More work is needed in a larger variety of habitats to better understand the bee diversity and richness across southeastern Ohio.

Introduction

Victorian-era collection and identification of organisms seems to have gone out of style. However, habitat surveys are imperative for understanding changes in biodiversity over time. Local changes in richness and/or species diversity can only be determined if there is a baseline for comparison. Worldwide, bees have been documented as in decline (Brown and Paxton, 2009). This includes decreases in both abundance and diversity and varies greatly depending on landscape changes (Burkle et al., 2013). As anthropogenic change continues, especially climate change, it is imperative to establish biodiversity baselines against which further surveys can be compared.

Washington county is 1,657 km^2 and includes the small town (population 15,000) of Marietta (39.4154° N, 81.4548° W). Marietta, Ohio, is rich in human history as the first capital of the Northwest Territory. However, the natural history of southeastern Ohio is sparse, especially involving bee species records. Therefore, this study set out to 1) determine the bee species richness and abundance in and around Marietta, Ohio, and 2) determine floral resource utilization of bees.

Materials and Methods

Sampling Sites. Three sites were chosen in Washington County: the Barbara A. Beiser Field Station, the Marietta College campus, and the Washington County Career Center. From east to west, the Barbara A. Beiser Field station is ≈12 kilometers from the Marietta College campus, which is ≈8 kilometers from the Washington County Career Center. The Barbara A. Beiser Field Station was formally established in 2008 and transferred to co-management by Marietta College and Friends of the Lower Muskingum. It is 77 acres of forest, old field, and streamfront, most of which is on a slope. Each site had three transects of ≈150 meters (Figure 1). The transects at the field station were in old field habitat bordered by forest edge. The transects at the Marietta College campus were on turf grass next to a stream overrun with invasive and ornamental plants. At the Washington County Career Center, one transect was on turf grass and the other two transects were old field habitat bordered by forest edge. The final transect at the Washington County Career Center was a clearing for an oil well surrounded by many acres of dense forest.

Bee Collection. Sampling consisted of bee bowls, hand-netting, and blue vane trapping. Bee bowls consisted of 96 ml soufflé (Solo®) cups painted either fluorescent yellow, fluorescent blue, or left white (Guerra Paints) as per the standardized guidelines of the Handy Bee Manual (Droege, 2012). Ninety bee bowls were set every five meters along each 150 meter transect. The bowls were half-filled with soap solution (0.5% blue Dawn® dish soap and distilled water mixture) and left out for 24 hours. Sampling for the bee bowls took place approximately every 2 weeks from April 2013 to mid-October 2013 on non-rainy days.

Hand-collection and netting occurred three times: April 29th, July 3rd, and August 2nd. Hand-collection or netting involved timed walks of 5 minutes along the transects to catch any observed bee within 5 meters of the transect. Blue vane traps (SpringStar™) were incorporated in an attempt to catch larger bees that escape from smaller traps (Stephan and Rao, 2005). The vane traps were used starting at the end of August until the first frost in October. Only one vane trap was set per transect and they were deployed for the same duration as the bee bowls. As with the bee bowls, these were half-filled with the soapy water solution.

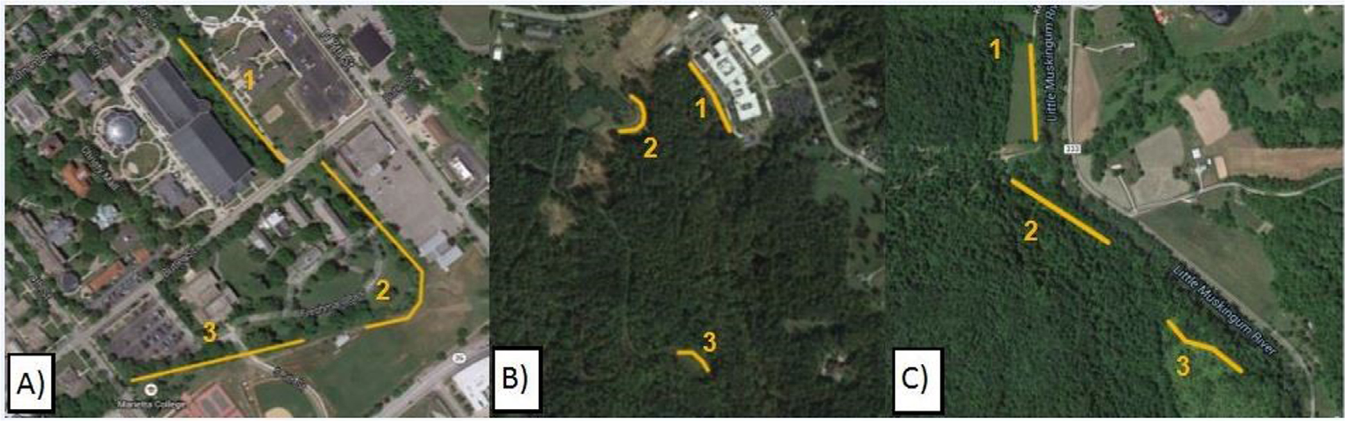

Figure 1. Sampling sites: A) the Marietta College campus; B) the Washington County Career Center; C) the Barbara A. Beiser Field Station.

Sample Preparation. Samples were stored in 70% ethanol. Bees were sorted from bycatch, washed, blown dry, and pinned as per recommendations from the Handy Bee Manual (Droege, 2012). Bees were identified to genus using Michener et al. (1994). Species identification was based largely on Discoverlife.org (Droege et al., 2013). Sam Droege (USGS Bee Inventory and Monitoring Lab) confirmed species-level identification of bees and identified all specimens in the genera *Lasioglossum* and *Nomada*.

In addition to calculated species richness, the Simpson's Diversity Index was used to calculate diversity (Simpson 1949). The modified Simpson's Diversity Equation is as follows:

$$D = 1 - \left(\sum \left(ni\,(ni - 1)\right) / N\,(N - 1)\right)$$

Species accumulation curves for bee bowl samples were created in R (3.2.2) with package vegan (2.3-1). Samples were summed over the entire year and species complexes were removed from the analysis to get an estimate of species present. Simpson's Diversity Index provides information about the diversity and evenness of the samples and range from 0 to 1, where 0 is a 100% probability of getting two specimens of the same species from a sample and 1 is a 0% probability of randomly selecting two specimens of the same species from a sample (Simpson 1949).

Since most bees were collected in a soapy water solution, only bees with large, visible pollen loads were chosen for pollen analysis. Contamination from the collection method is possible; hence, only dominant pollen grains were identified to decrease the likelihood of identifying contaminants in the pollen masses. The pollen loads were gently scraped from the scopa with an insect pin and placed in labeled microcentrifuge tubes with 70% ethanol until they could be processed. Pollen slides were made using basic fuschin jelly to stain the grains (Kearns and Inouye, 1993) and then compared to a reference collection of pollen.

Results

Bees Collected. We collected 2,753 bees from the three locations sampled during 2013. A total of 28 bees were collected from vane traps, 147 were hand collected, and the remaining 2,578 were from bee bowls. Overall abundance was 995 at the Barbara A. Beiser Field Station, 760 at the Marietta College Campus, and 972 at the Washington County Career Center, with 26 bees collected elsewhere in Washington County. Five families of bees were collected: Apidae, Andrenidae, Colletidae, Halictidae, and Megachilidae. These pollinators belonged to 35 genera, and 130 species (Appendix 1). Of these 130 species, 74 had fewer than 3 representatives. The most common species were *Andrena erigeniae*, *A. violae*, *Calliopsis andreniformis*, *Apis mellifera*, *Ceratina calcarata*, *C. mikmaqi*, *C. strenua*, and *Lasioglossum versatum*. Eight species were state records (not previously reported) for Ohio: *A. macra*, *Hylaeus leptocephalus*, *Nomada annulata*, *N. luteola*, *Melecta pacifica*, *Stelis nitida*, *L. gotham*, and *L. subviridatum*. Only a small number of bees not native to the United States were found: *A. wilkella* (n=1), *Anthidium* *manicatum* (n=5), *An. oblongatum* (n=41), *Apis mellifera* (n=146), *H. leptocephalus* (n=2), *Megachile rotundata* (n=35), *Osmia cornifrons* (n=3), and *O. taurus* (n=10). This study also found the first reported case of gynandromorphy (individual with both male and female body parts) in the bumble bee *Bombus bimaculatus* at the Barbara A. Beiser Field Station (Spring et al., 2015). This has only been reported in 113 bee species worldwide (Hinojosa-Diaz et al., 2012) with Michez et al. (2009) providing a comprehensive review of the condition. Very few of the bees were stylopized, with the authors only finding six specimens of *Andrena* with strepsipterans remaining in their abdomen (Spring et al., 2015).

Species diversity estimates. The calculated bee diversity (*D*) for all sites was as follows: the Washington County Career Center (0.929), the Barbara A. Beiser Field Station (0.875), and the Marietta College Campus (0.957).

A total of 2,434 specimens were used to create the species accumulation curves once species complexes were removed from the bee bowl data. Species accumulation curves were created for each site using chao, jackknife, and bootstrap (Table 1). The estimated species richness that could be collected via bee bowls is 172 (Chao), 172 (Jackknife1), 194 (Jackknife2), and 147 (Bootstrap) (Figure 2).

Table 1. Species Accumulation Curve for bee bowl collection.

Site	Sampled species richness	Chao	Chao SE	Jack1	Jack1 SE	Jack 2	Boot	n
Overall	126	172.22	17.11	172.22	18.91	194.97	147.24	9
BFS	52	82.25	14.75	74	16.93	83.0	62.22	3
MC	77	105.00	11.83	105	19.80	115.5	90.22	3
WCCC	77	93.90	7.46	103	19.87	111.0	89.67	3

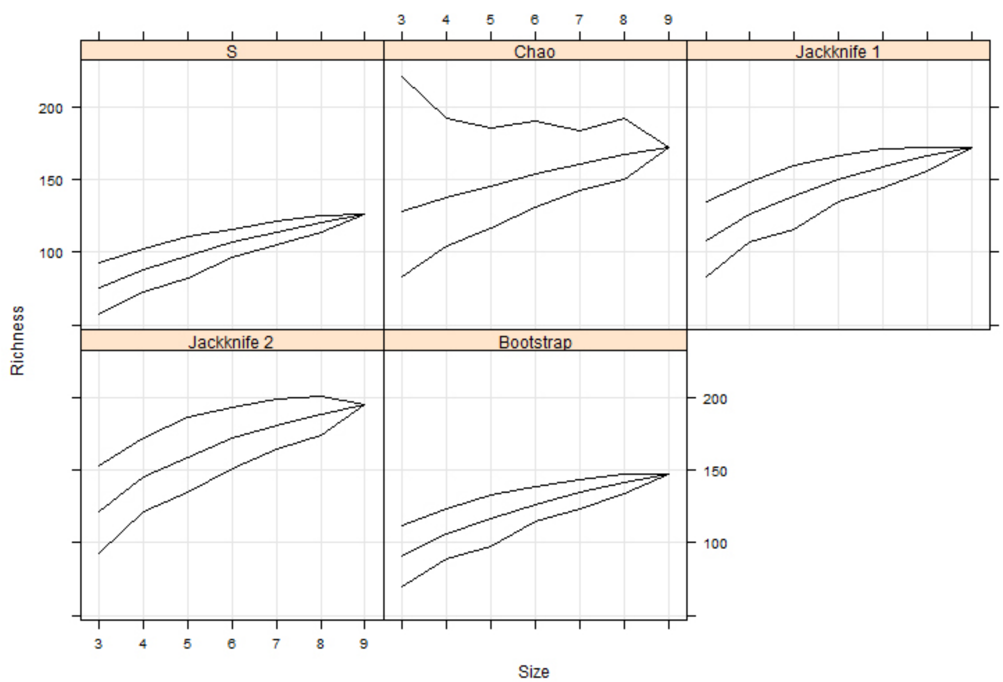

Figure 2. Species Accumulation Curve for bee bowl samples.

Pollen analysis. A total of 81 bees collected had visible pollen loads. Of these 81 bees, 66 were from the genus *Andrena*. Furthermore, a majority of these bees were from either *Andrena erigeniae* (n=50) or *Andrena violae* (n=12). *Andrena erigeniae* was found to collect mainly *Claytonia virginica*, a spring ephemeral common in Southeastern Ohio, but occasionally had other pollen in their loads including *Taraxacum officinale*, Caryophyllaceae, and Brassicaceae (Table 2). *Andrena violae* was found to have on average two dominant pollen types per load, but the types of pollen varied greatly by individual (Table 2).

Table 2. Pollen Loads

Bee Species	Average # of pollen types dominant per individual	Pollen Type
Andrena erigeniae (n=50)	1.24	*Claytonia virginica*, *Taraxacum officinale*, Caryophyllaceae, Brassicaceae
Andrena perplexa (n=3)	4	*Cornus* spp., *Viburnum* spp., *Carya* spp.
Andrena violae (n=12)	2.16	Rosaceae, Lamiaceae, Ranunculaceae, *Lonicera* spp., *Oxalis stricta*
Halictus ligatus (n=7)	1.71	*Taraxacum officinale*, Asteraceae

Discussion

There are only a few studies involving bees in Ohio, with most as part of ecological or agricultural studies and completed within the last decade (Arduser, 2010; Bernhardt et al., 2008; Cusser and Goodell, 2013; Iler and Goodell, 2014; Goodell et al., 2010; Pardee and Philpott, 2014; Phillips and Gardiner 2015). Of the studies in the nearby states, there is a tendency to focus on an agricultural crop, such as apple orchards (Gardner and Ascher, 2006, Russo et al., 2015), sunflowers (Todd et al., 2016), or blueberry (Tuell et al., 2009) among many others. Occasionally, nearby studies focus on specific habitat such as sand dunes (Grundel et al., 2011), powerline right-of-ways (Russell et al., 2005), or shale barrens (Kalhorn et al., 2003). Other states are working on bee diversity and richness estimates, but many states lack a defined species list (Tucker and Rehan, 2016).

There is a dearth of species diversity surveys in Ohio. It is a large state, rich in biodiversity (thanks to the variety of habitats), and is thus likely to host a wide diversity of bees. The most recently published bee diversity survey occurred in the northwestern portion of Ohio in the Oak Openings (Arduser, 2010). This study took place on a nature preserve known for its biodiversity and unique habitat (Arduser, 2010). A direct comparison of diversity between these two studies is challenging because Arduser (2010) used hand-netting as the main sampling method, whereas this study largely utilized bee bowls, which are known to attract a slightly different subset of pollinators. Moreover, this study took place throughout the entire flying season from end of frost to first frost in the fall. The sampling effort for Arduser (2010) was mainly when the author had a chance to be in northern Ohio over a period of 3 years. Despite this discrepancy in sampling methods, Arduser (2010) found 116 species among 486 individuals hand-collected from flowers.

However, other than Mitchell's early work on bees across the United States, which only shows estimated distributions (Mitchell, 1960; Mitchell, 1962), and the study in Northwestern Ohio by Arduser, bee diversity remains largely understudied in Ohio. This is the first published year-long survey of bee diversity in southeastern Ohio known to the authors. We found a total of 130 bee species, which is similar in number, but not composition, to other bee diversity studies (Arduser, 2010; Giles and Ascher, 2006; Grundel et al., 2011). We found a total of eight state records of bee species not previously reported in Ohio (Sam Droege, pers. comm). Of these records, one was a newly split species group (*L. gotham*) (Gibbs, 2011) or invasive (*H. leptocephalus*). Two records are of species not reported in many collections (*A. macra* and *L. subviridatum*); thus, they are rare in general. The remainder are parasites of other bees (*N. annulata, N. luteoloa, Melecta pacifica, and S. nitida*). This number of state records could be partly due to the habitat; the Appalachian foothills are still understudied for their bee diversity, and most research involving bees occurs in the central and northern region of the state.

Species diversity was calculated using the reciprocal Simpson's Diversity Index. With this equation, a larger value (between 0-1) on the Simpson's Diversity Index indicates a greater likelihood of randomly selecting two different species when selecting two specimens. A larger value can therefore be interpreted as a higher-diversity assemblage. All three sites had high index values (>0.85), which would imply diverse assemblages and good biodiversity of the overall area. Moreover, the species estimates for just bowl collection of the area range from 147-194 species, whereas we only collected a total of 126 species with bee bowls. This implies that subsequent years of sampling with bee bowls should still find more species. Importantly, this calculation did not take into account alternative sampling methods, which are known to collect a different subset of the biodiversity in bees. Thus, the authors recommend additional effort in Washington County focusing on vane traps and hand-collection to get a better idea of bee richness.

Pollen loads. Of the 2,753 bees collected, few had visible pollen loads remaining once they got back to the lab. This could be partly due to the pollen packing methods of different bee species. Some species mix pollen with nectar to get the mass to stay attached to the scopa, whereas others just brush the pollen onto their scopa. Of the bees collected with visible pollen loads, most were in the genus *Andrena*. *Andrena erigeniae* is often stated as a pollen specialist on *Claytonia virginica (*Reese and Barrows, 1980). All of our specimens were found to be collecting *C. virginica* pollen, though they did occasionally have large quantities of other pollens present.

Many articles, without referencing sources, state that *A. violae* only pollinates violets (Motton, 1986; Giles and Ascher, 2006). In our case, *A. violae* is found to collect pollen from a variety of sources, rarely having similar pollen loads. Older literature shows that *A. violae* is documented on many spring ephemerals in addition to violets (Robertson 1929; Mitchell 1960), which is more in line with our data.

Future Research

The authors recommend that the study be repeated in a few years with more hand-netting to collect more species. Increased hand-collection has the potential to find more species that are unlikely to visit bee bowls. Furthermore, collection at additional sites with a wider variety of habitats and floral resources is recommended to get a better idea of the diversity present in and around the historic area of Marietta, Ohio.

Acknowledgements

We would like to thank Sam Droege from the USGS Bee Inventory and Monitoring Lab for his help with confirmations of IDs and species identification of the *Lasioglossum* and *Nomada*. We would also like to thank Karen Goodell for access to her reference collection of Ohio bees in the spring of 2014. Thanks also go to the following undergraduates at Marietta College who assisted with the 3:00 a.m. set-up time for bee bowls and vane traps or hand-collecting during the day: Rachel Shoop, Anna Cooper, Tristine Toves, and Rachel Stahl. Furthermore, we would like to thank the Marietta College Investigative Studies program and the Biology and Environmental Science Department for funding this project, and the Investigative Studies Travel grant for funding travel to both the Association for Southeastern Biologists meeting and the International Conference for Pollinator Biology, Health, and Policy. Thanks for diversity index calculation and interpretation goes to Katherine Todd and Bryan Zake. A synoptic collection of this research is housed at the Museum of Biological Diversity at The Ohio State University.

Appendix 1. Species list and abundance of individuals.

Species	Total	BFS T1	BFS T2	BFS T3	BFS Total	MC T1	MC T2	MC T3	MC Total	WCCC T1	WCCC T2	WCCC T3	WCCC Total	Other Sites
Agapostemon virescens	29	1	1	0	2	5	4	10	19	5	3	0	8	0
Andrena barbara	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Andrena barbilabris	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Andrena bisalicis	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Andrena bradleyi	1	0	0	0	0	0	0	1	1	0	0	0	0	0
Andrena brevipalpis	3	0	0	1	1	1	0	1	2	0	0	0	0	0
Andrena carlini	3	0	0	2	2	0	0	0	0	1	0	0	1	0

Species	Total	BFS T1	BFS T2	BFS T3	BFS Total	MC T1	MC T2	MC T3	MC Total	WCCC T1	WCCC T2	WCCC T3	WCCC Total	Other Sites
Andrena commoda	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Andrena cressonii	1	0	0	0	0	0	0	0	0	0	0	1	1	0
Andrena cressonii cressonii	5	0	1	0	1	0	1	0	1	0	0	1	1	2
Andrena distans	3	1	0	0	1	0	1	1	2	0	0	0	0	0
Andrena erigeniae	323	42	94	96	232	10	16	21	47	6	10	28	44	0
Andrena gardineri	1	0	0	0	0	0	0	0	0	0	0	1	1	0
Andrena illini	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Andrena imitatrix	2	0	0	0	0	0	1	1	2	0	0	0	0	0
Andrena macra	3	0	0	0	0	0	0	0	0	0	1	2	3	0
Andrena miserabilis	2	0	0	0	0	1	1	0	2	0	0	0	0	0
Andrena nasonii	3	0	0	1	1	0	0	0	0	1	0	1	2	0
Andrena nubecula	1	0	0	0	0	0	0	0	0	0	1	0	1	0
Andrena perplexa	40	0	6	0	6	8	10	4	22	4	7	1	12	0
Andrena placata	2	0	1	0	1	0	0	0	0	0	1	0	1	0
Andrena pruni	2	0	2	0	2	0	0	0	0	0	0	0	0	0
Andrena robertsonii	2	0	0	0	0	0	0	1	1	0	1	0	1	0
Andrena sayi	2	0	2	0	2	0	0	0	0	0	0	0	0	0
Andrena simplex	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Andrena sp.	4	0	0	0	0	0	0	0	0	0	1	3	4	0
Andrena vicina	3	0	0	0	0	1	1	1	3	0	0	0	0	0
Andrena violae	266	59	77	44	180	12	14	18	44	5	21	16	42	0
Andrena wheeleri	1	0	0	0	0	1	0	0	1	0	0	0	0	0

Species	Total	BFS T1	BFS T2	BFS T3	BFS Total	MC T1	MC T2	MC T3	MC Total	WCCC T1	WCCC T2	WCCC T3	WCCC Total	Other Sites
Andrena wilkella	1	0	1	0	1	0	0	0	0	0	0	0	0	0
Anthidiellum notatum notatum	1	0	0	0	0	0	0	0	0	0	0	1	1	0
Anthidium manicatum	6	0	0	0	0	2	0	1	3	0	2	0	2	1
Anthidium oblongatum	40	0	0	0	0	7	13	5	25	0	11	3	14	1
Anthophora terminalis	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Apis mellifera	147	5	10	4	19	21	41	27	89	15	11	10	36	3
Augochlora pura	49	6	22	2	30	2	2	3	7	2	7	3	12	0
Augochlorella aurata	16	0	0	0	0	0	0	1	1	1	7	7	15	0
Augochloropsis metallica	7	0	1	0	1	1	1	1	3	1	1	1	3	0
Bombus auricomus	2	0	0	0	0	0	0	1	1	0	0	0	0	1
Bombus bimaculatus	15	6	1	0	7	2	1	2	5	0	1	1	2	1
Bombus griseocollis	4	0	0	0	0	0	4	0	4	0	0	0	0	0
Bombus impatiens	20	0	0	0	0	7	3	2	12	0	3	3	6	2
Bombus perplexus	3	1	0	0	1	0	1	1	2	0	0	0	0	0
Bombus vagans	2	0	0	0	0	1	1	0	2	0	0	0	0	0
Calliopsis andreniformis	95	2	2	0	4	0	3	3	6	0	16	69	85	0
Ceratina calcarata	169	7	64	15	86	38	5	5	48	11	5	19	35	0
Ceratina dupla	38	2	7	8	17	3	0	1	4	1	7	9	17	0
Ceratina mikmaqi	97	5	26	21	52	4	0	1	5	3	14	23	40	0
Ceratina sp.	5	0	3	0	3	1	0	0	1	0	0	1	1	0
Ceratina strenua	396	7	115	27	149	26	17	23	66	22	25	134	181	0
Chelostoma philadelphi	1	0	0	0	0	1	0	0	1	0	0	0	0	0

Species	Total	BFS T1	BFS T2	BFS T3	BFS Total	MC T1	MC T2	MC T3	MC Total	WCCC T1	WCCC T2	WCCC T3	WCCC Total	Other Sites
Coelioxys sayi	1	0	0	0	0	0	0	1	1	0	0	0	0	0
Coelioxys sayi/ octodenata	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Colletes inaequalis	3	0	1	0	1	0	0	1	1	0	0	0	0	1
Colletes simulans	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Eucera atriventris	15	3	0	1	4	2	1	3	6	2	0	3	5	0
Eucera dubitata	3	0	2	0	2	0	0	1	1	0	0	0	0	0
Eucera hamata	3	0	1	0	1	0	0	1	1	1	0	0	1	0
Eucera sp.	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Halictus confusus	23	0	0	0	0	7	10	4	21	0	0	0	0	2
Halictus ligatus	76	2	7	1	10	11	3	6	20	8	15	23	46	0
Halictus rubicundus	9	1	2	0	3	1	1	0	2	2	2	0	4	0
Halictus sp.	2	0	0	0	0	2	0	0	2	0	0	0	0	0
Heriades leavitti/ variolosa	2	0	2	0	2	0	0	0	0	0	0	0	0	0
Holcopasites calliopsidis	2	0	0	0	0	0	0	0	0	0	0	2	2	0
Hoplitis pilosifrons	8	0	0	0	0	1	0	0	1	0	2	5	7	0
Hoplitis producta	22	4	3	4	11	6	0	2	8	0	2	1	3	0
Hoplitis spoliata	1	0	0	0	0	0	0	1	1	0	0	0	0	0
Hylaeus affinis/ modestus	27	3	5	2	10	4	2	1	7	0	6	4	10	0
Hylaeus hyalinatus	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Hylaeus leptocephalus	2	0	0	0	0	2	0	0	2	0	0	0	0	0
Hylaeus mesillae	3	0	0	0	0	1	1	0	2	0	0	1	1	0
Hylaeus sp.	1	0	0	0	0	0	0	0	0	0	0	1	1	0

Species	Total	BFS T1	BFS T2	BFS T3	BFS Total	MC T1	MC T2	MC T3	MC Total	WCCC T1	WCCC T2	WCCC T3	WCCC Total	Other Sites
Lasioglossum admirandum	2	0	0	0	0	2	0	0	2	0	0	0	0	0
Lasioglossum bruneri	4	0	0	0	0	2	2	0	4	0	0	0	0	0
Lasioglossum cattallae	2	0	0	0	0	0	1	0	1	0	1	0	1	0
Lasioglossum coriaceum	6	0	0	0	0	2	0	1	3	0	0	3	3	0
Lasioglossum cressonii	5	2	0	1	3	0	0	0	0	0	1	1	2	0
Lasioglossum ephialtum	6	0	0	0	0	4	1	0	5	1	0	0	1	0
Lasioglossum foxii	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Lasioglossum fuscipenne	2	0	1	0	1	0	0	0	0	1	0	0	1	0
Lasioglossum gotham	10	1	0	0	1	1	4	1	6	1	0	2	3	0
Lasioglossum hitchensi	52	1	5	1	7	10	11	10	31	3	5	6	14	0
Lasioglossum imitatum	21	0	1	0	1	9	6	5	20	0	0	0	0	0
Lasioglossum katherineae	1	0	0	0	0	0	1	0	1	0	0	0	0	0
Lasioglossum obscurum	3	0	0	0	0	2	1	0	3	0	0	0	0	0
Lasioglossum para-admirandum	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Lasioglossum quebecense	3	0	1	0	1	0	0	0	0	1	0	1	2	0
Lasioglossum sp.	76	3	9	2	14	20	6	7	33	5	11	9	25	4
Lasioglossum subviridatum	10	0	3	1	4	1	0	0	1	2	2	1	5	0
Lasioglossum tegulare	3	0	0	0	0	1	0	1	2	0	0	1	1	0
Lasioglossum truncatum	2	0	0	0	0	0	0	1	1	0	0	1	1	0
Lasioglossum versans	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Lasioglossum versatum	202	4	34	12	50	8	9	1	18	34	49	51	134	0
Megachile brevis	2	0	0	0	0	0	0	0	0	0	1	1	2	0

Species	Total	BFS T1	BFS T2	BFS T3	BFS Total	MC T1	MC T2	MC T3	MC Total	WCCC T1	WCCC T2	WCCC T3	WCCC Total	Other Sites
Megachile campanulae	2	0	0	0	0	0	0	0	0	0	1	1	2	0
Megachile centuncularis	1	0	0	0	0	0	0	0	0	0	0	1	1	0
Megachile inimica sayi	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Megachile mendica	6	0	0	0	0	0	2	2	4	1	1	0	2	0
Megachile montivaga	1	0	0	0	0	0	0	0	0	0	1	0	1	0
Megachile petulans	1	0	0	0	0	0	0	0	0	0	0	1	1	0
Megachile rotundata	37	0	0	0	0	13	15	5	33	1	0	2	3	1
Megachile sp.	2	0	0	0	0	0	0	0	0	1	1	0	2	0
Melecta pacifica	1	0	0	0	0	0	0	0	0	0	0	1	1	0
Melissodes bimaculatus	15	2	2	0	4	3	2	3	8	1	0	1	2	1
Melissodes coloradensis	1	0	1	0	1	0	0	0	0	0	0	0	0	0
Melissodes denticulata	13	2	6	0	8	0	0	0	0	1	3	1	5	0
Melissodes desponsa	7	0	1	1	2	0	1	0	1	1	2	1	4	0
Melissodes druriella	2	0	0	0	0	0	1	0	1	0	1	0	1	0
Melissodes sp.	2	0	0	2	2	0	0	0	0	0	0	0	0	0
Melitoma taurea	15	4	6	0	10	1	0	2	3	1	0	1	2	0
Nomada (Bidentate)	15	0	2	0	2	1	3	1	5	4	1	3	8	0
Nomada annulata	1	0	0	0	0	0	0	0	0	0	0	1	1	0
Nomada articulata	4	0	0	0	0	3	0	1	4	0	0	0	0	0
Nomada cressonii	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Nomada denticulata	2	1	0	0	1	0	0	0	0	0	1	0	1	0
Nomada depressa	1	0	0	0	0	0	0	0	0	0	0	1	1	0
Nomada fervida	1	0	1	0	1	0	0	0	0	0	0	0	0	0

Species	Total	BFS T1	BFS T2	BFS T3	BFS Total	MC T1	MC T2	MC T3	MC Total	WCCC T1	WCCC T2	WCCC T3	WCCC Total	Other Sites
Nomada imbricata	18	0	2	0	2	0	2	0	2	3	4	7	14	0
Nomada luteola	1	0	0	0	0	0	0	0	0	1	0	0	1	0
Nomada luteoloides	4	0	0	0	0	0	1	0	1	1	0	2	3	0
Nomada parva	3	0	0	0	0	0	0	1	1	1	0	1	2	0
Nomada pygmaea	7	0	1	0	1	1	0	1	2	3	0	1	4	0
Nomada sp.	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Osmia atriventris	7	0	0	0	0	2	1	1	4	0	2	1	3	0
Osmia bucephala	17	6	1	2	9	2	1	0	3	0	1	4	5	0
Osmia caerulescens/ cordata	5	0	0	0	0	2	0	0	2	2	0	1	3	0
Osmia collinsiae	3	0	0	0	0	0	0	0	0	2	0	1	3	0
Osmia cordata	18	0	0	1	1	10	1	2	13	2	1	1	4	0
Osmia cornifrons	3	0	0	0	0	0	0	1	1	1	0	1	2	0
Osmia distincta	4	0	0	0	0	0	0	1	1	1	2	0	3	0
Osmia georgica	15	2	2	2	6	3	1	0	4	2	0	3	5	0
Osmia inspergens	1	0	0	0	0	0	1	0	1	0	0	0	0	0
Osmia pumila	9	0	2	1	3	0	0	0	0	1	2	3	6	0
Osmia sp.	21	1	1	0	2	7	0	1	8	5	3	3	11	0
Osmia subfasciata	1	0	0	0	0	0	0	0	0	0	0	1	1	0
Osmia taurus	12	1	0	1	2	0	1	2	3	3	0	2	5	2
Panurginus potentillae	3	0	0	0	0	0	0	0	0	0	0	3	3	0
Peponapis pruinosa	4	0	0	0	0	1	1	0	2	0	1	1	2	0
Ptilothrix bombiformis	11	0	0	0	0	2	4	2	8	1	1	1	3	0

Species	Total	BFS T1	BFS T2	BFS T3	BFS Total	MC T1	MC T2	MC T3	MC Total	WCCC T1	WCCC T2	WCCC T3	WCCC Total	Other Sites
Sphecodes coronus	1	0	0	0	0	0	0	0	0	0	0	1	1	0
Stelis lateralis	1	0	0	0	0	0	0	0	0	0	1	0	1	0
Stelis nitida	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Triepeolus cressonii?	1	0	0	0	0	0	0	0	0	0	1	0	1	0
Xylocopa virginica	4	0	0	0	0	0	0	0	0	0	0	1	1	3
SUM	2753				995				760				972	26

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