Preliminary assessment of pollinators on Red Wagon Organic Farm and notes on potential conservation practices to promote wild bees

Boulder County Open Space

Report

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Abstract

As part of this unfunded research permit, Dr. Adrian Carper, Dr. Tobin Hammer, and the undergraduate students in EBIO 2040, Principles of Ecology, visited Red Wagon Organic Farm, a BCPOS Agricultural Property. As part of a learning module on pollinators, the students conducted preliminary surveys for bees on the farm, made initial observations of bee foraging and nesting resources, and explored potential areas of conservation improvement on the farm for pollinators. Dr. Carper lectured on pollinators, native bees, and their conservation in class prior to field work. Students then used vane traps and hand nets to survey bees on the farm during a single visit in July 2018. Based on the sampled bee diversity, their knowledge of bee ecology, and their preliminary assessment of pollinator habitats on the farm, the students then made conservation recommendations for both native and managed pollinators on the BCPOS Agricultural Property. In addition, they discussed the challenges of organic farming, with implications for pollinators, and how farm management and conservation practices could interact in terms of pollinators and pollination. Here, we report the findings of this student lead research, and make recommendations for future pollinator conservation efforts on the farm.

Introduction

Boulder County Parks and Open Space has been interested in identifying one of their agricultural properties for implementing conservation practices targeting native pollinators. Red Wagon Organic Farm LLC is partially located on Boulder County Parks and Open Space land, off 63rd St. just south of Oxford Rd. in Longmont, CO (Figure 1). The approximately 30 acre property is surrounded by fairly agriculturally intensive landscapes, including monocropped hayfields, highly impacted rangeland, and recent exurban development. Regardless, the property is in close proximity to Left Hand Creek, and given its diverse microhabitats, offers good potential for pollinator conservation. The owner/operator, Wyatt Barnes, manages the farm which maintains a USDA Organic Certification for its products. In addition to adhering to organic agricultural practices and guidelines, Wyatt also strives to manage the farm using sustainable agricultural practices. This includes using diversified farming practices, rotational fallows, planting ecologically sensitive crops, and implementing whole farm management, with an emphasis on creating wildlife-friendly habitat on the property, including for pollinators.

In order to determine the value of Red Wagon Organic Farm for pollinator conservation efforts as a Boulder County Parks and Open Space Agricultural Property, Dr. Adrian Carper and Dr. Tobin Hammer included it as part of a learning module on pollinators and pollinator conservation for Dr. Hammer's Principles of Ecology course (EBIO 2040) at the University of Colorado Boulder. As such, Dr. Carper provided in-class lectures on pollinators, specifically native bees and their conservation, and organized a research field trip to Red Wagon Organic Farm. As part of the learning module on pollinators, students conducted preliminary surveys for bees on the farm, made initial observations of bee habitats on the farm, including foraging and nesting resources, and explored potential areas of conservation improvement on the farm for pollinators. Students assisted in the collection and determination of bees, and based on the sampled bee diversity, their newly gained knowledge of bee ecology, and their preliminary assessment of pollinator habitats on the farm, made conservation recommendations for native pollinators on this BCPOS Agricultural Property.

Given that many students had never even been on a farm before, we also discussed the challenges of organic farming with Wyatt, especially in terms of the implications for pollinators, and how farm management and conservation practices could interact in terms of pollinators and pollination, and how it impacted farm operations. Below, we outline our efforts, including a description of field trip activities, and report the findings of this student lead research. In addition, we make general recommendations for future pollinator conservation efforts on the farm.

Figure 1. Location of Red Wagon Organic Farm, west of Longmont, CO, USA.

Course Research Field Trip

Given the constraints of coursework and timing of student schedules, we visited Red Wagon Organic Farm once on the 24th July, 2018. Drs. Carper and Hammer were accompanied by 17 students (Figure 2). Upon arrival, the group met with Wyatt Barnes for introductions, a description of the farm, and discussion of farm management. Dr. Carper reviewed bee sampling techniques, provided an overview or potential host plants, and an outline for surveying. Students then divided into groups to survey different habitats of the farm. In addition to collecting bees, DSLR cameras were distributed to a number of students to photo-document bees and the trip in general. Notes on microhabitats and their potential for conservation were recorded as we sampled.

Figure 2. Dr. Tobin Hammer organizes his Principles of Ecology class to survey bees on Red Wagon Organic Farm.

Bee Community Surveys

To explore the diversity of pollinators on the farm, we used a combination of blue and yellow vane traps and hand-netting. We decided not to include bee bowls given time and processing constraints within class time, and the known taxonomic bias of bowl traps for common, social, Halictid bees. We placed four blue vane and four yellow vane traps in different microhabitats haphazardly chosen around the farm. These included: along the main road, adjacent to lawns and pastures, behind the pond which was weedy and less managed, and on the edges of a diversified squash/sunflower/other crop field. We set traps around 9:30am and left them to collect until roughly 4:00pm. Afterward, A. Carper collected traps, froze all specimens, and stored them in the University of Colorado Museum of Natural History Entomology Section (UCMC). In addition, to collect bees not attracted to vane traps we netted bees from 10:00-11:30am (Figure 3). Any bees observed on flowers were collected with insect nets, euthanized in ethyl acetate collecting jars, and processed as above. We purposefully avoided collecting redundant samples of honeybees and bumblebees, given the ease of visual identification of the former, and the conservation concern of the latter. Queen bumble bees in particular, were released after capture. Dr. Carper's Insect Biology class also assisted in the pinning, labeling, and curation of specimens. Bees were identified to the lowest taxonomic resolution possible by Dr. Carper and V. Scott in the UCMC and those belonging to difficult taxonomic groupings will be compiled for eventual determination by experts as part of ongoing curatorial work in the UCMC.

Figure 3. Students explore Red Wagon Farm and collect representative specimens of different types of bees for their Principles of Ecology class.

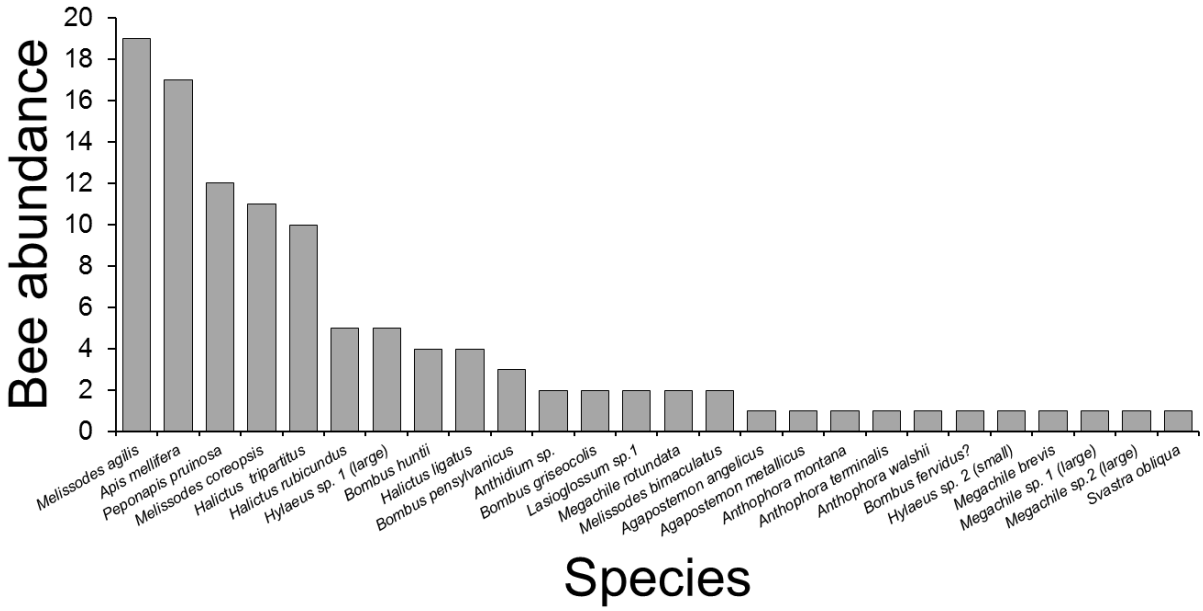
Results

In total, we collected 111 bees, spanning four different families, 13 different genera, and at least 25 different species (Table 1). Bees in the family Apidae were the most commonly collected, making up 68% of all individuals. Sunflower bees, *Melissodes* spp., were the most abundant bee, with three species; the common sunflower specialist, *Melissodes agilis*, being the most abundant bee species collected (Figure 4). Notably, squash bees, *Peponapis pruinosa*, were also collected, often from the flowers of cucurbitaceous crops such as squash and zucchini. Moreover, we found four different species of bumble bees, *Bombus* spp.. Bumble bees were particularly attracted to the herb garden, given the abundance of lamiaceous herbs which are highly attractive to these large, generalist bees. Also of interest: while rare in our sample, we also found three separate species of digger bees, *Anthophora* spp., which are large conspicuous bees that preferentially nest in vertical soil banks. Social halictid bees (*Agapostemon*, *Augochlopsis*, *Halictus*, and *Lasioglossum*) were also fairly common. Typically less common, megachilids and colletids were found in lower abundance, although we did collect four different species of *Megachile*, including the introduced but ubiquitous alfalfa leaf-cutter bee, *Megachile rotundata*. The large *Megachile* species are likely sunflower specialist species. Interestingly, we did not collect any bees in the Andrenidae family, likely given that most species are early or late season specialists and simply were not present during our surveys.

Table 1. Taxonomic distribution of bees surveyed.

Family	Species	Abundance
Apidae	*Anthophora montana*	1
	Anthophora terminalis	1
	Anthophora walshii	1
	Apis mellifera	17
	Bombus fervidus	1
	Bombus griseocolis	2
	Bombus huntii	4
	Bombus pensylvanicus	3
	Melissodes agilis	19
	Melissodes bimaculatus	2
	Melissodes coreopsis	11
	Peponapis pruinosa	12
	Svastra obliqua	1
Colletidae	*Hylaeus* sp. 1 (large)	5
	Hylaeus sp. 2 (small)	1
Halictidae	*Agapostemon angelicus*	1
	Augochloropsis metallicus	1
	Halictus tripartitus	10
	Halictus ligatus	4
	Halictus rubicundus	5
	Lasioglossum sp.1	2
Megachilidae	*Anthidium* sp.	2
	Megachile brevis	1
	Megachile rotundata	2
	Megachile sp. 1 (large)	1
	Megachile sp. 2 (large)	1

Figure 4. Rank abundance plot of bee species surveyed from Red Wagon Organic Farm on July 24th, 2018.



In addition, we observed a number of crops in bloom on the farm that actually support wild pollinators, including: squash, zucchini, and pumpkins (squash bees and other apids); herbs (megachilids and bumble bees); tomatoes and peppers (bumblebees and digger bees); cut flowers (bumblebees); and cover crops like buckwheat (small halictids and many flies). Moreover, Sunflowers were commonly planted along with other crops and were particularly attractive to long-horn bees (Melissodes and also Svastra), bumble bees, megachilids, and other pollinators such as flies, wasps, and butterflies. We also observed that many wild bees were also particularly attracted to the weedy species found in unmanaged areas, such as sweet clover. We compiled photos of our research for use by Red Wagon Organic Farm or Boulder County Parks and Open Space on a google drive folder (Figure 5). All photos are free to download and use from the following address:

https://drive.google.com/open?id=1pT6tO4PKsvJvv3SAz6-jzeu0OlCqHNH4

Figure 5. This stunning view illustrates the diversity of both crops and non-target plant species on Red Wagon Farm. The hoop house on the left housed tomatoes and is where we observed *Anthophora* sp. and *Bombus* sp. pollinating tomato flowers.

Discussion

In general, we were surprised to find a relatively abundant and diverse community of wild bees on Red Wagon Organic Farm, especially given our limited survey extent. July likely represents a lull in bee community diversity over the flowering season, as early-season specialist bees are replaced by mid-season generalist species, and ultimately late-season specialists. That being said, in just a few hours we collected over 25 different species, including several specialist species that were likely there as a direct results of farm management practices. For example, the squash bee, *Peponapis pruinosa*, was observed and collected on cucurbitaceous crops. This native bee coevolved with wild cucurbits in N. America and now is reliant on crops which also depend on this and a handful of other squash bee species as their most effective pollinators. In addition, the presence of sunflower-associates, including *Melissodes*, *Svastra*, and some *Megachile*, are likely the result of planting sunflowers within diversified crop fields. This has the additional benefit of providing excellent hunting platforms for beneficial insect predators such as ambush bugs and ladybird beetles (Figure 6a), while also providing extra floral nectar to both generalist bees and beneficial wasps (Figure 6b). While likely secondary to actual crop production, by planting crops that offer floral rewards, i.e., both nectar and pollen, farmers can attract and support wild bees and in turn help bolster multiple ecosystem services such as pollination services and biocontrol.

Figure 6. Sunflowers, *Helianthus annuus*, provide both hunting platforms for solitary predators such as a) this jagged ambush bug, *Phymata americana*, and ladybird beetle, *Hypodamis convergens*; in addition to extrafloral nectar for both pollinators and b) social predatory wasps such as this yellowjacket, *Vespula* spp.

In addition to managing target crops, the management of non-target plants within cropped areas and uncropped areas of Red Wagon Organic Farm also impacts wild pollinators. During our visit Wyatt pointed out their methods of weed control which focus on manual removal of weeds from crops but only when necessary. The students found his economic analysis of the cost of weed removal vs benefit in terms of increased harvest particularly interesting. In addition to costing money to remove, many weed species may also be important alternate floral resources for wild bees. Understanding which weeds present economic problems and identifying their potential value to pollinators could impact weed management. For instance, sweet clover is likely not a problem within fields, and provides abundance nectar and pollen for foraging bees alongside roads and field edges. However, *Amaranthus* spp., while offering pollen to generalist bees, is also particularly invasive in crop fields and the economic cost of its impact on crops may warrant its removal, given little value for pollinators.

Outside of cropped fields, unmanaged areas provide additional benefits to wild bees other than floral resources. Irrigation ponds provide water, an often overlook resource for wild pollinators which may need to collect water for their own nutrition or as part of their nest construction. For example, some digger bees, *Anthophora* spp., collect water and mix with soil to form turrets around their entrance burrows. Moreover, these unmanaged areas may provide undisturbed soil for ground nesting bees in general, which make up roughly 70% of local bee diversity. Having areas devoted to fewer disturbances could encourage ground nesting bee colonization and populations. Indeed, the role of nesting resources are typically less well-understood than floral resources, but are likely extremely important or even limiting for local bee

populations. For instance, we found only a handful of cavity-nesting species, and probably species which are capable of facultatively nesting in soil such as the introduced alfalfa leaf-cutter bee. While the farm has little woody habitat, woody substrate could be cheaply supplemented in unmanaged areas by accumulating woody residues there or actually providing additional nesting resources through bundles of cane, bamboo, or bee nest blocks. This could be of particular interest in close proximity to fruit bearing trees which would benefit from increased nesting and thus populations of early season mason bees, *Osmia* spp., given that they are highly effective pollinators of orchard crops.

We made a number of additional observations about potential management impacts on wild pollinators on the farm not related to floral or nesting resources. Another often overlooked resource for wild bees is overwintering habitat. Little is known about the impacts of management practices on overwintering wild bees. While most ground-nesting bees overwinter in burrows underground, cavity and hive nesting species may be more susceptible to above ground habitat management. For instance, some bee species nest in hollow stems. While likely a small percentage of diversity, these bees may be particularly susceptible to winter and early spring mowing practices. Sunflowers, thistles, and other plants growing in unmanaged areas, likely provide hollow stems for these bees, but are often mowed. Leaving some areas unmowed could encourage these cavity-nesting species to nest there, and protect overwintering larvae in their nests. Bumble bees are also fairly unique in terms of wild pollinators as they are our only hive nesting native bees. Moreover, while colonies die back every autumn, new queens must find suitable places to overwinter. These may include burrows, buildings or other structures, or refuse piles. A large compost pile on the farm likely provides an attractive shelter for overwintering queens, as the heat form decomposition can mitigate extreme cold. Consideration could be given to turning dates or times to minimize potential impact on bumblebees. For instance, turning compost on extremely warm winter days could give any disturbed queens the chance to find other overwintering locations without freezing. Conversely, simply leaving some naturally shrubby areas along field or road edges could provide additional overwintering sites.

In summary, these results suggest that Red Wagon Organic Farm has much potential for wild bee conservation and in addition to its organic practices, could employ a number of different strategies to help promote wild pollinators. We would encourage Boulder County Parks and Open Space to engage with the owners/operators to explore potential conservation practices to promote bees on the property. While planting additional floral resources would likely help wild bees there, through small changes in already established practices such as mowing, weed management, and nesting resource protection, farm managers could cheaply and effectively begin to conserve wild pollinators and help sustain their pollination services on the farm.