Demonstrating Creation of Habitat for Beneficial Insects – Year 2 (2019)

Project Leaders

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Abstract

Many people are interested in protecting pollinators by creating good habitat for them. The same habitat (flowers and grasses of varied shapes and sizes that provide blooms throughout the growing season) is also good for other beneficial arthropods (including both insects and arachnids, like spiders and predatory mites) that are natural enemies of pests. There are a lot of different ways to establish these plants and manage weeds during the establishment process. In this project, we demonstrate some of these options, while also collecting data on how effective (both in terms of plant establishment success and attracting beneficial insects) and costly each method is. In this second year of the project, we continued to maintain the plots established in 2018, collected data on the time and costs required and weed control achieved using each method, visually documented the growth of the habitat plants, and collected arthropods. From May through September we sampled all plots 25 times using four different techniques and collected numerous arthropods. Identification is ongoing, but some preliminary results are presented here. Successfully establishing habitat for beneficial arthropods is a multi-year process.

Background and Justification

From farmers to backyard gardeners to 4-H clubs to golf course managers, there continues to be strong interest in protecting pollinators. Providing perennial plants that produce pollen and nectar or offer shelter is one popular way to support pollinators. In and around agricultural fields, this same habitat can also shelter and feed other beneficial arthropods like natural enemies of pests (e.g., Grab et al. 2018, McCabe et al. 2017). It could also harbor pest arthropods. In backyard gardens, attracting natural enemies to a small vegetable plot is likely to be much more cost effective than releasing natural enemies.

There are many ways to establish perennial habitat for beneficial insects, and these methods typically involve some combination of the following three choices:

- Transplant small seedlings or direct seed
- Plant in the spring or in the fall
- Type of weed management

All three choices involve very different labor and supply costs, and are also expected to contribute to the speed and success of establishment. People who want to protect pollinators or attract natural enemies want to know which method is best, and facing a broad array of choices without advice or guidance can be daunting. Choosing an inexpensive but slow establishment method could also lead to frustration and abandonment of a pollinator habitat project when planting seeds in the spring does not produce a beautiful weed-free meadow of flowers by August.

This project provides data to help stakeholders select a beneficial arthropod habitat establishment method that fits their budget, timeline, and goals. It is also creating a demonstration field site where stakeholders and educators can view and learn about habitat establishment. Finally, it will enable us to collect additional data on the benefits of this habitat (which beneficial arthropod species are attracted, impacts on pests in an adjacent Christmas tree planting) and potential drawbacks (whether pest species are also attracted, and how many).

Objectives

1. Establish habitat (perennial wildflowers and grasses) using different methods and timing for planting and weed control in a research field at Cornell AgriTech in Geneva, NY.
2. Record the costs of materials and the amount of time required for plant establishment using each method.
3. Document the success and speed of establishment with each method (including weed control) during the first several years after establishment.
4. Quantify the arthropods present (pollinators, natural enemies, and pests) in the habitat plots established by different methods and compare them to arthropods present in nearby mowed grass.
5. Quantify the impact of these habitat plots on pest populations in the adjacent Christmas tree planting. This objective will be completed in a later year.

Procedures

Plot maintenance (Objective 1)

Establishment of the beneficial insect habitat plots began in 2018 (Table 1) and continued in 2019 (Table 2). Treatment H was added in 2019 by marking out four, 23-foot long sections of mowed grass (orchard vineyard mix) between rows of Christmas trees in the middle of the field. A walk-behind mower was used to mow all plots except for treatment H. A mower pulled by a tractor was used to mow these plots (along with all other tree row middles). We hand weeded transplanted plots (A, B, and D) as needed to ensure establishment of the habitat plants. We hand weeded seeded plots (C, F, and G) just once to remove perennial weeds, which would not have been controlled by mowing.

Table 1. Summary of the methods used to establish habitat for beneficial arthropods in 2018.

TREATMENT	FALL 2017	SPRING 2018	SUMMER 2018	FALL 2018
A	Herbicide	Herbicide, transplant	Weed 2x	Replace dead plants
B	Herbicide	Till, transplant, mulch	Weed 2x	Replace dead plants
C	Herbicide	Till, direct seed	Mow 3x	Mow 1x
D	Herbicide	Till, plant buckwheat	Mow 1x, till, plant buckwheat	Mow 1x, transplant
E - CONTROL	Herbicide	Herbicide	Mow 3x	Mow 1x
F	Herbicide	Till, lay plastic	Continue solarization	Remove plastic, direct seed
G	Herbicide	Herbicide/till	Herbicide 2x, till 1x	Till 1x, direct seed

Table 2. Summary of the methods used to establish habitat for beneficial arthropods in 2019.

TREATMENT	SPRING 2019	SUMMER 2019	FALL 2019
A	Hand weed 1x	-	Hand weed 1x
B	Hand weed 1x	-	-
C	Mow 1x	Mow 2x; hand weed 1x	Mow 1x
D	Hand weed 1x	Hand weed 1x	Hand weed 1x
E - CONTROL	Mow 1x	Mow 2x	Mow 1x
F	Mow 1x	Mow 2x; hand weed 1x	Mow 1x
G	Mow 1x	Mow 2x; hand weed 1x	Mow 1x
H - CONTROL	Mow as needed	Mow as needed	Mow as needed

We kept a record of supplies purchased and time spent maintaining each plot (mowing and hand weeding) throughout the season. A full description of the procedures used to establish each treatment in Year 1 of this project can be found online. Details of the perennial wildflower and grass species used in the plots are in the Year 1 report for this project.

Plant survival and bloom

We assessed transplanted treatments (A, B, and D) in Spring and Fall for survival of transplanted habitat plants. In late August and late September, we scouted the seeded plots (C, F, and G) for identifiable seedlings of the perennial species that had been seeded. From May through September, we took pictures of each plot and kept a list of which species were blooming (including weeds that were not planted) weekly.

Insect sampling

From May through September, we sampled arthropods a total of 25 times using four different methods. Pitfall trapping was used to catch arthropods that are moving across the surface of the ground (Brown and Matthews 2016). Traps consisted of 16-oz clear plastic deli cups that were set in the ground so that the lip was just level with the soil (or in the case of Treatment B, mulch) surface and half filled with a 50% solution of propylene glycol. One trap was placed in the center of each plot once a month for three days at a time. Flying insects (especially those attracted to the colors yellow and blue) were sampled approximately twice a month (nine times, May through September) using pan traps. One yellow and one blue 12-oz plastic bowl were placed on the ground in the middle (north to south) but on the eastern side of each plot such that they were minimally obscured by the foliage of the habitat plants in those plots. A small rock was placed in each bowl to keep it from blowing away, and each bowl was filled with a solution of soapy water and left in the plots for two days each time traps were set. Once a month (plus one extra sampling in late September), we used sweep nets to sample insects that were flying through or resting on plants in the habitat plots. The same person sampled all plots and maintained a consistent pace while sweeping. Captured arthropods were killed in sampling jars using ethyl acetate. On the same dates that plots were sampled with a sweep net, a Pollard walk was used to assess butterflies visiting each plot. A steady pace was maintained while walking along each plot, and the number and type of butterflies observed in the plot during that time was recorded.

Sorting, counting, and identifying insects

Arthropods (and some annelids and mollusks) sampled in pitfall or pan traps were washed and stored in 70% or 95% ethanol until they could be sorted and counted. Arthropods collected in sweep nets were stored frozen until they could be sorted, and then transferred to 70% ethanol for longer-term storage. Organisms captures in pan traps, pitfall traps, and sweep nets were sorted mostly to family or other relevant ecological group (e.g., plant-feeding vs. insect-feeding stink bugs). Larger adult lady beetles and some pests of interest (e.g., tarnished plant bug, Japanese beetle) were identified to species. Paige Muniz identified bees to at least family (and sometimes genus or species). Jason Dombroskie did much of the fly, beetle and non-bee Hymenoptera identification. Sorting and counting of insects are ongoing, and only preliminary results are reported here.

Christmas trees

These beneficial arthropod habitats are being established at the edges of a 1-acre field planted with Christmas trees. The trees were planted in Spring 2018, and maintenance continues, including weed management and fertilization, as needed. Once the trees are larger, we will use them to address Objective 5, as well as to test and demonstrate other Christmas tree IPM strategies.

Results and Discussion

Supply Costs and Time (Objective 2)

The only additional supply we purchased in the second year of this project was gasoline to mow the direct seeded (and control) plots. The primary time investment was hand weeding of the transplanted plots (although we did a small amount of hand weeding in the direct seeded plots to remove perennial weeds). Because of the extra effort required to hand weed treatments A (spring transplant into bare ground) and D (fall transplant following buckwheat), the total time spent establishing these treatments is catching up with treatment B (spring transplanted and mulched; Figure 1). A summary of costs and time for both years is in Table 3.

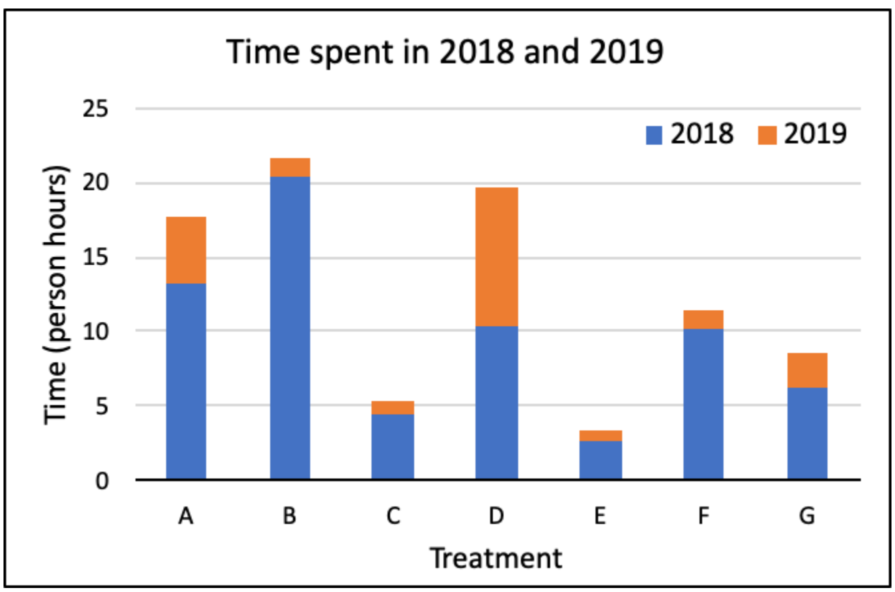

Figure 1. Amount of time spent establishing and maintaining beneficial arthropod habitat plots in Years 1 (2018) and 2 (2019) of this project. Total time spent on all four replicate plots is shown for each treatment.

Table 3. Summary of total costs for methods used to establish habitat for beneficial insects.

TREATMENT	2018 SUPPLY COSTS	2019 SUPPLY COSTS	2018 TIME*	2019 TIME*
A – SPRING TRANSPLANT	$417.12	-	13.2	4.4
B – SPRING TRANSPLANT & MULCH	$539.29	-	20.4	1.2
C – SPRING SEED	$17.75	$1.08	4.4	0.9
D – BUCKWHEAT & FALL TRANSPLANT	$390.55	-	10.3	9.4
E – CONTROL	$2.32	$1.08	2.6	0.7
F – SOLARIZE & FALL SEED	$148.02	$1.08	10.2	1.2
G – HERBICIDE/TILLAGE & FALL SEED	$22.04	$1.08	6.3	2.3

*Time is expressed in person hours. One person working for 1 hour = 1 person hour.

Establishment (Objective 3)

The spring-transplanted treatments (A and B) continue to have larger plants than the fall-transplanted treatment (D; Fig. 2). At least 80% of the wildflowers in transplanted plots (treatments A, B, and D) survived (Fig. 3). In the plots that were transplanted in the fall after the buckwheat cover crop (D), the survival was slightly lower than in treatments A and B. Poorer performance in treatment D may be due to the early weed competition the fall transplants experienced (see report from Year 1). Some species survived better than others, but survival was generally pretty good (Fig. 4).

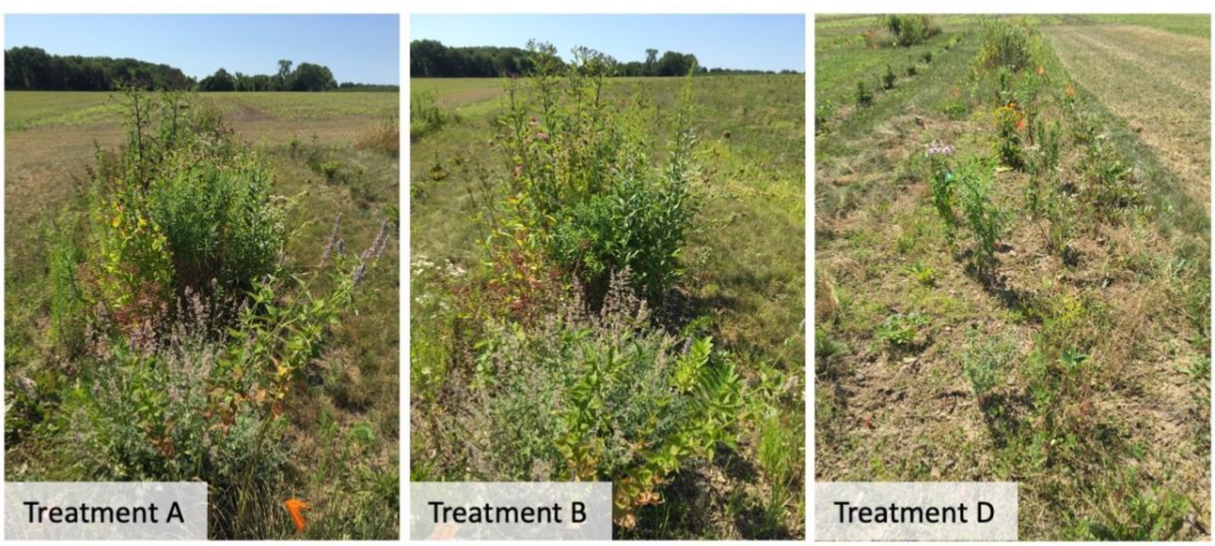

Figure 2. Pictures of sample plots from treatments A (spring transplant, no mulch), B (spring transplant, mulch), and D (fall transplant after buckwheat) taken on 5 August 2019.

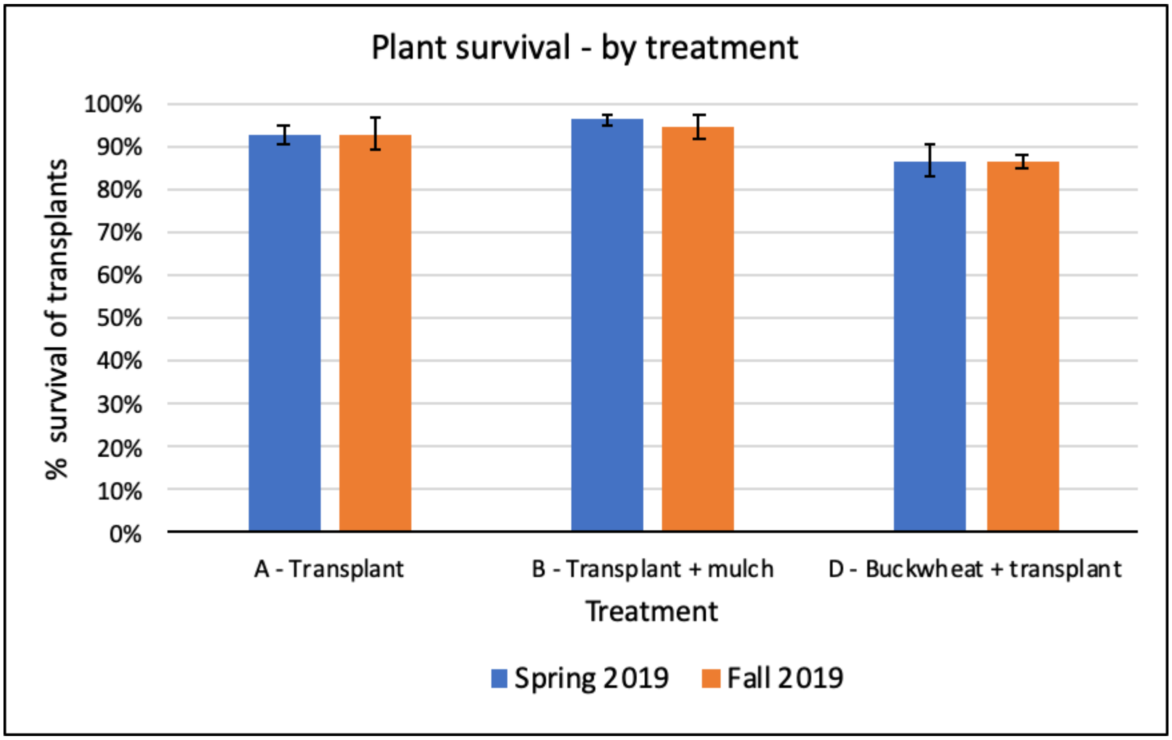

Figure 3. Percent of transplanted wildflowers surviving in plots transplanted in the spring without mulch (A), transplanted in the spring with mulch (B), and transplanted in the fall after a buckwheat cover crop (D). Survival was assessed in both Spring and Fall 2019, and the average survival across four replicated plots per treatment is graphed with error bars showing one standard error above and below the mean for each treatment.

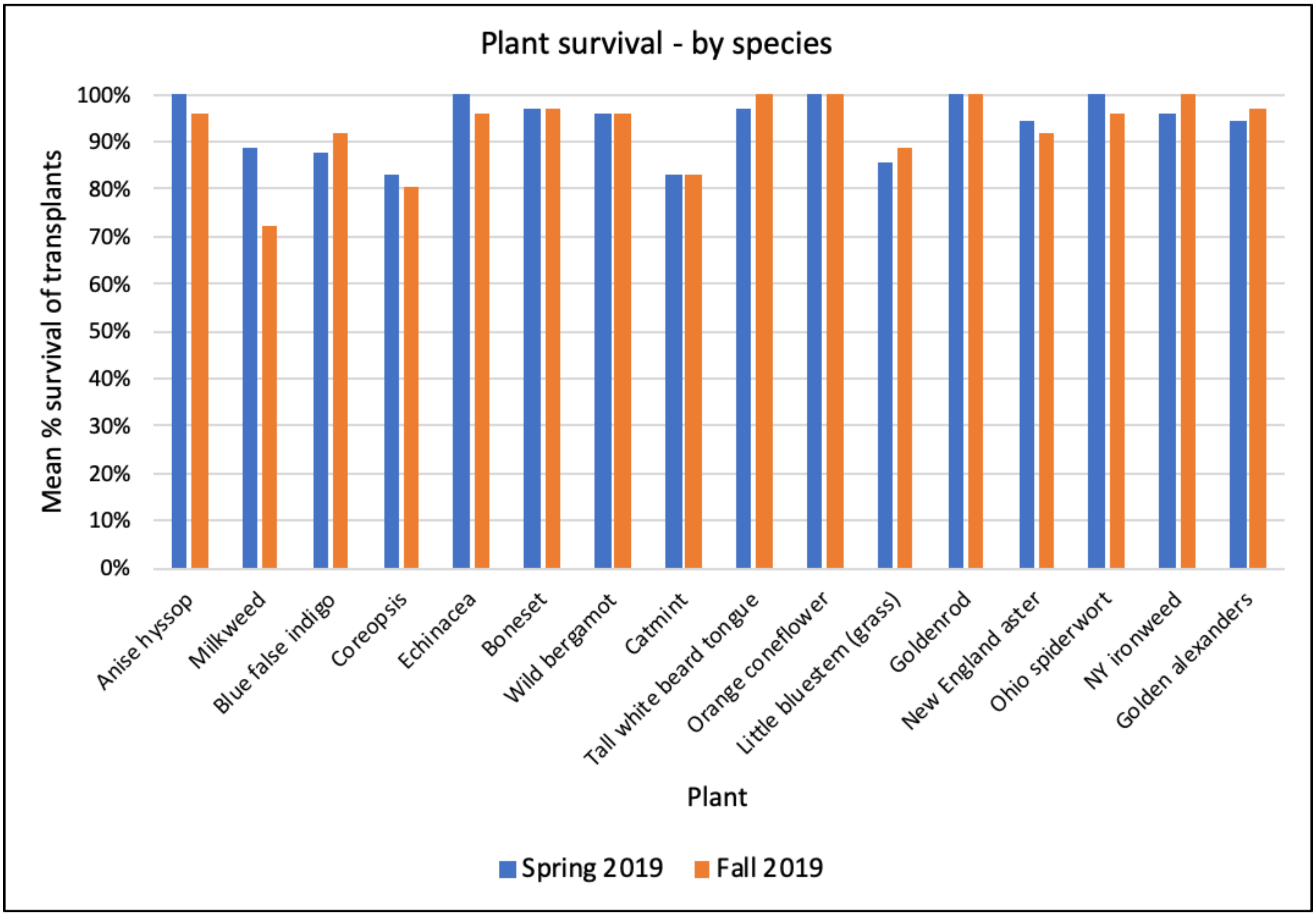

Figure 4. Percent of transplanted wildflowers surviving in all transplanted treatments (A, B, and D) by species. Survival was assessed in both Spring and Fall 2019. Each bar shows the mean across 12 plots for each plant species.

Bloom (Objective 3)

At least one species bloomed each month from May through September in 2019 (Table 4 and Fig. 6). Blue false indigo did not bloom in 2019, but most plants survived. Only three species of wildflowers planted by seed in Spring or Fall 2018 bloomed in 2019 (Table 5 and Fig. 5). Other intentionally seeded species were also identified in treatments C, F, and G, but did not bloom in 2019 including: wild bergamot, tall white beard tongue, asters (species uncertain), golden alexanders, and either echinacea or orange coneflower. The foliage of these last two plants looks very similar. Many weed species also bloomed throughout the summer, and many of them provided pollen and nectar for pollinators and natural enemies (Table 6 and Fig. 7).

Table 4. Months when each transplanted wildflower species bloomed during 2019 in treatments A, B, and D. An X indicates that species bloomed in that month.

Wildflower	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Golden alexanders (*Zizia aurea*)	X	X			
Catmint (*Nepeta faassinii*)		X	X	X	X
Lanceleaf coreopsis (*Coreopsis lanceolata*)		X	X		
Tall white beard tongue (*Penstemon digitalis*)		X	X		

Wildflower	May	Jun	Jul	Aug	Sep
Ohio spiderwort (*Tradescantia ohiensis*)		X	X		
Anise hyssop (*Agastache foeniculum*)			X	X	X
Echinacea (*Echinacea purpurea*)			X	X	X
Orange coneflower (*Rudbeckia fulgida* var. *fulgida*)			X	X	X
Boneset (*Eupatorium perfoliatum*)			X	X	X
Wild bergamot (*Monarda fistulosa*)			X	X	
Common milkweed (*Aclepias syriaca*)			X		
NY ironweed (*Vernonia noveboracensis*)				X	X
Showy goldenrod (*Solidago speciosa*)					X
New England aster (*Symphyotrichum novae-angliae*)					X
Blue false indigo (*Baptisia australis*)					

Table 5. Months when direct seeded wildflowers bloomed in treatments C, F, and G during 2019. An X indicates that species bloomed in that month.

Common name	May	Jun	Jul	Aug	Sep
Lanceleaf coreopsis (*Coreopsis lanceolata*)		X	X		X
Blackeyed susan (*Rudbeckia hirta*)			X	X	X
Partridge pea (*Chamaecrista fasciculata*)				X	X

Figure 5. Blooming direct seeded wildflowers.

Figure 6. Wildflower species transplanted in treatments A, B, and D. *Blue false indigo image courtesy of Ansel Oommen, Bugwood.org.

Figure 7. Examples of blooming weeds (not planted intentionally) that provided pollen and nectar resources to arthropods.

Table 6. Months during 2019 when different weeds were in bloom. An X indicates that weed bloomed in that month.

Weed	May	Jun	Jul	Aug	Sep
Campion	X	X	X	X	X
Chamomile	X	X	X	X	X
Clover	X	X	X	X	X
Dandelion	X	X	X	X	X
Vetch	X	X	X	X	X
Viola	X	X	X	X	X
Mustard	X	X	X		X
Deadnettle	X	X			
Speedwell	X				
Henbit	X				
Asters		X	X	X	X
Buckwheat		X	X	X	X
Oxalis		X	X	X	X
Plantain		X	X	X	X
Wild lettuce		X	X	X	X

Weed	May	Jun	Jul	Aug	Sep
Cinquefoil			X	X	X
Indian hemp			X	X	X
Redshank			X	X	X
Chickweed			X	X	
Galinsoga			X		X
Geraniums			X		
Sandwort			X		
Grass				X	X
Horse weed				X	X
Lambsquarters				X	X
Ragweed				X	X
Black bindweed				X	
Chicory					X

Weed control (Objective 3)

Weed control continues to be the biggest challenge to establishing habitat for beneficial arthropods. Bryan Brown completed weed assessments in May (Fig. 8) and September (Fig. 9) of 2019. By far, the plots that were mulched in Spring 2018 (treatment B) had the fewest weeds compared to beneficial habitat plants. In May there were still relatively few weeds in the plots where we tried to deplete the weed seed bank in the soil through solarization (treatment F) or repeated herbicide and tillage (treatment G). By September 2019, the spring transplant treatments looked even better.

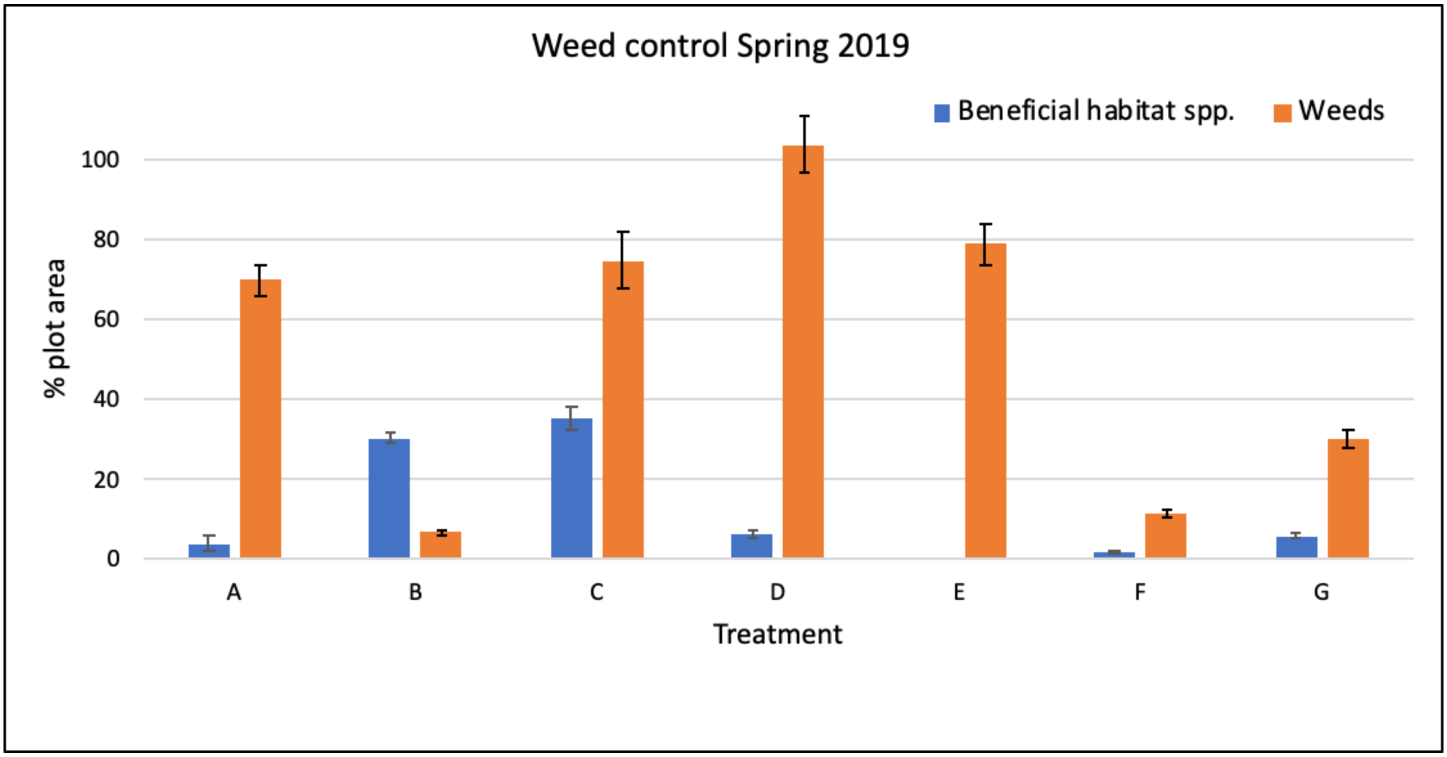

Figure 8. Weed control achieved in plots in Spring 2019, expressed as percent of the total plot area covered by either weeds (orange) or species that had been planted to support beneficial arthropods (blue). Cover was assessed on 16 May 2019. Each bar represents the average of four plots per treatment. Error bars show one standard error above and below the mean.

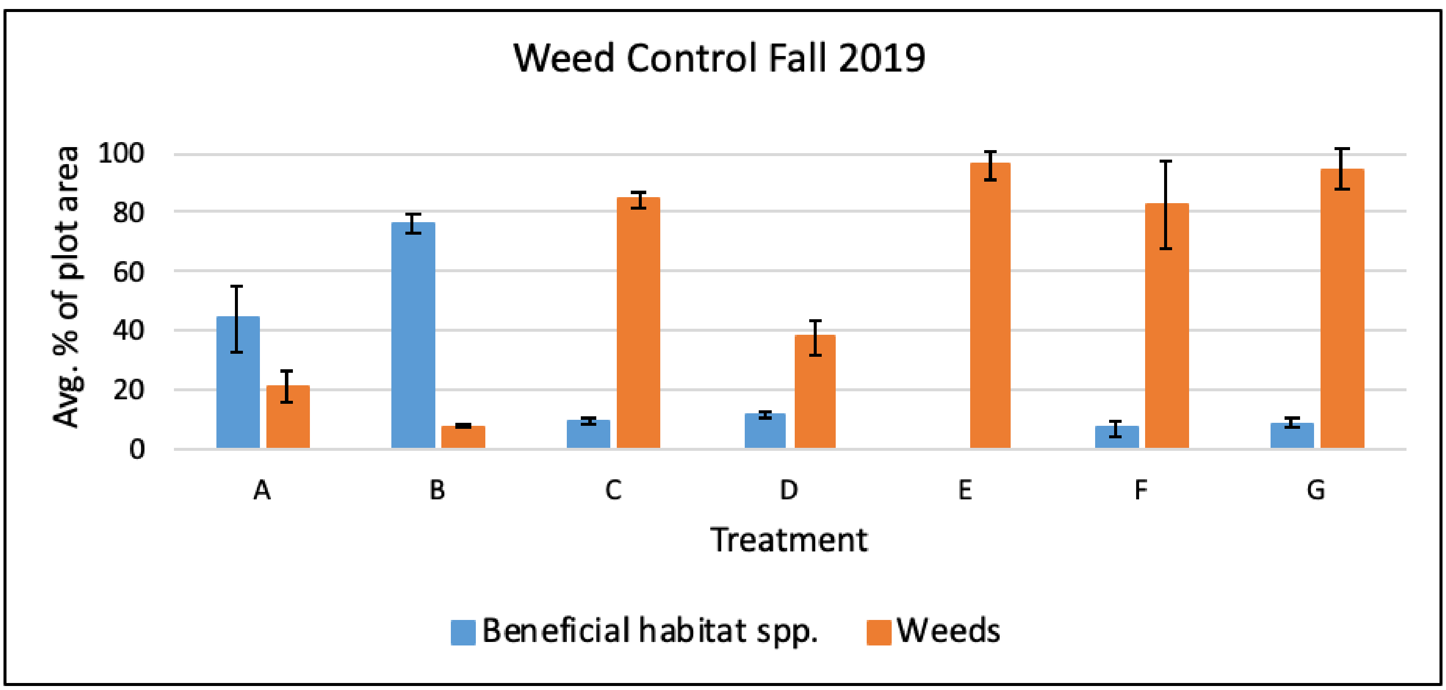

Figure 9. Weed control achieved in plots in Fall 2019, expressed as percent of the total plot area covered by either weeds (orange) or species that had been planted to support beneficial arthropods (blue). Cover was assessed on 24 September. Each bar represents the average of four plots per treatment. Error bars show one standard error above and below the mean.

Arthropod sampling (Objective 4)

All types of traps were successful at capturing arthropods, relative to the types of arthropods they were designed to catch. For example, bees were primarily caught in pan traps, while carabid beetles were mostly caught in pitfall traps. Some arthropods were frequently caught in more than one type of trap (e.g., spiders and harvestmen, tarnished plant bugs, leafhoppers, syrphid flies). Numbers and types of arthropods captured varied depending on date and sampling method (Fig. 10). Very few butterflies were counted during Pollard walks, and none were seen until the late July sampling date (25 July 2019). Butterflies observed included viceroys, painted ladies, red admirals, cabbage whites, and clouded sulphurs (data not shown).

While we are still completing identification of collected arthropods, we have so far identified 19 genera of bees and over 80 genera of other arthropods and counted well over 2,000 individuals. The great majority of species found were neither pests nor beneficials. When evaluated as groups, there are some differences in the numbers of arthropods captured by plot type (Figs. 11 and 12 as examples) but it is too early in the project to draw conclusions about specific habitat establishment methods attracting specific beneficial (or pest) arthropods. We did identify some pests; notably tarnished plant bugs, leaf hoppers and slugs. However, we did not see appreciable damage caused by these pest insects. We used the arthropods we collected to create sample vials used at field demonstrations and other face-to-face events. Also, we preserved an example of many of the arthropod species we found as a reference collection.

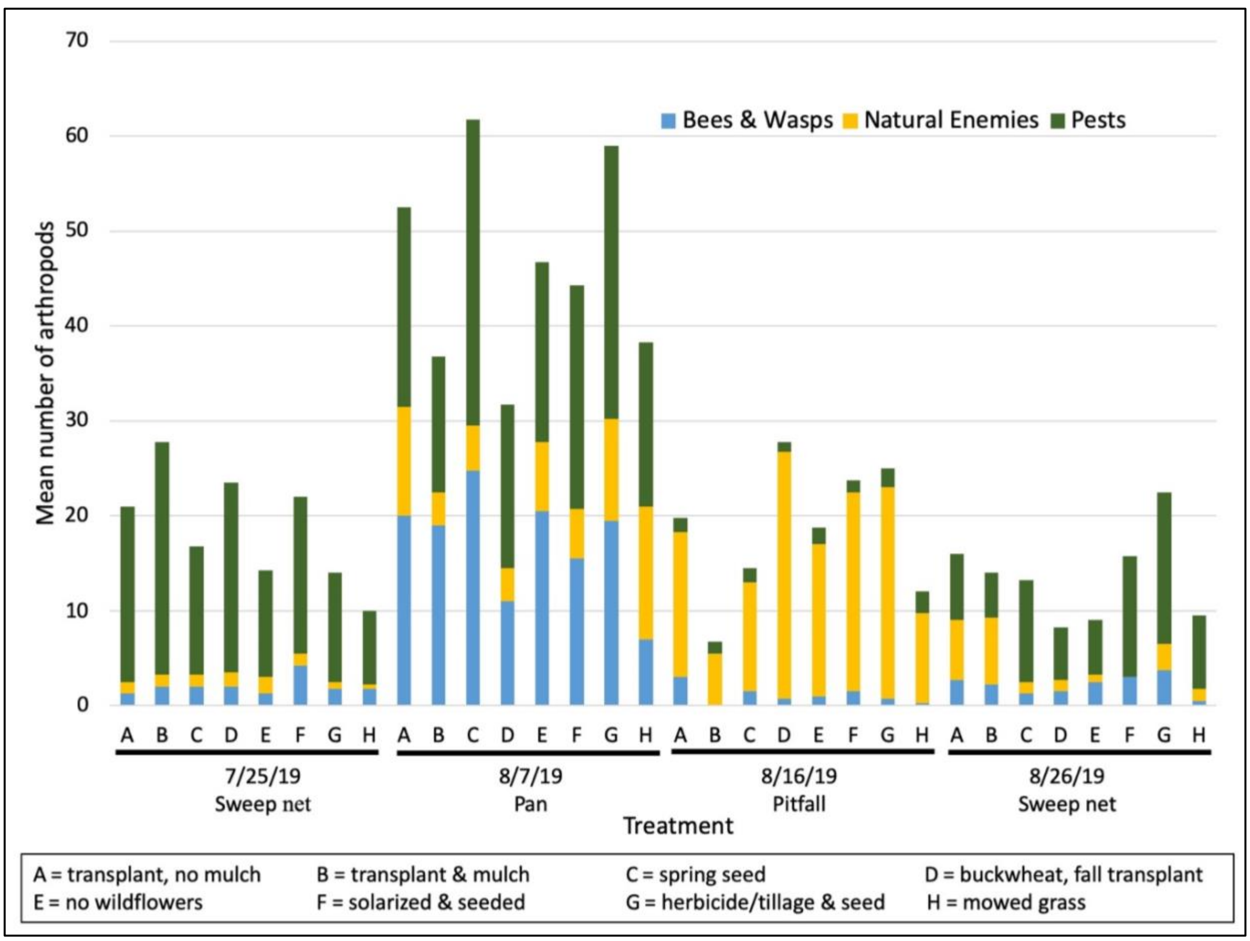

Figure 10. Preliminary summary of types of arthropods (bees and wasps, natural enemies, or pests) collected during one month of sampling in 2019. Each bar shows the average number of arthropods sampled from that treatment (letters A-H) on each date (and with each sampling method). Arthropod groups that did not fall into one of these three categories are not shown.

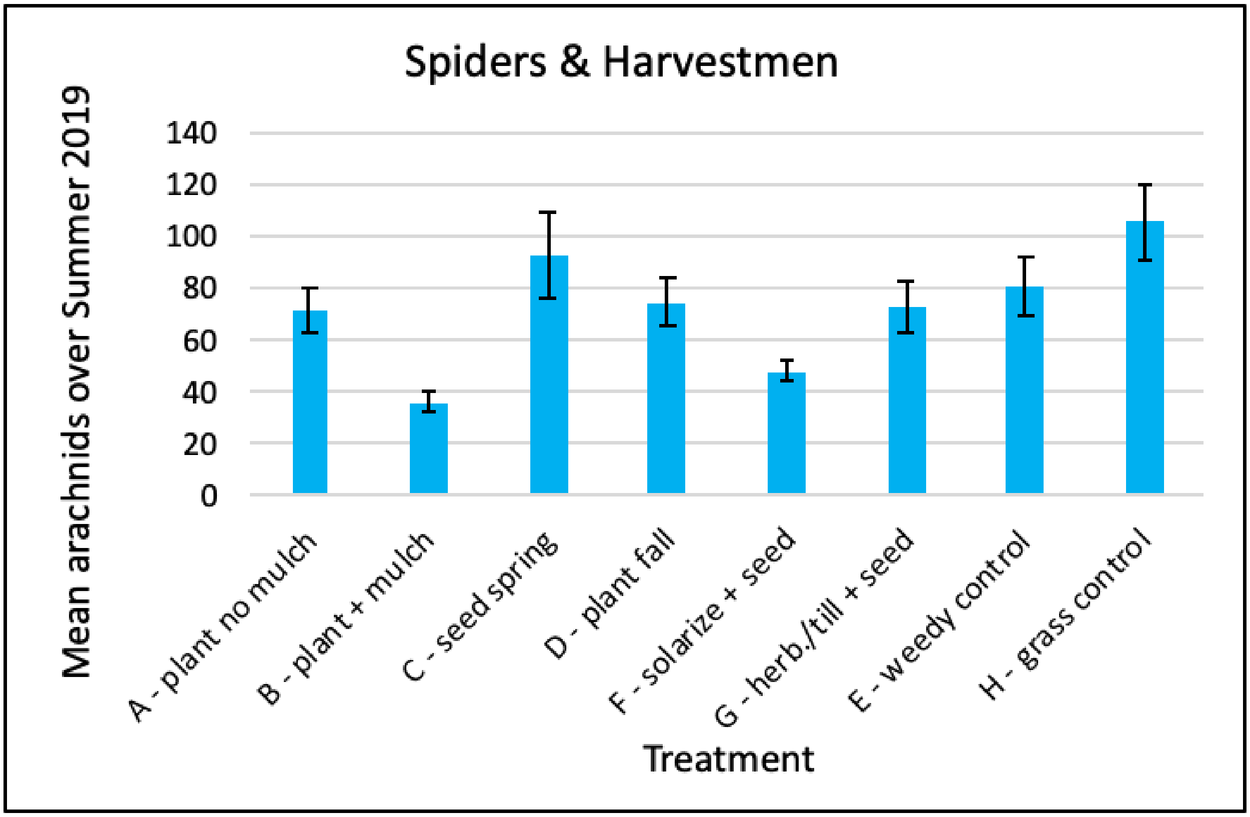

Figure 11. Number of spiders and harvestmen collected from each habitat establishment treatment summed over the course of Summer 2019. Each bar represents the mean of four replicated plots with an error bar showing one standard error above and below the mean.

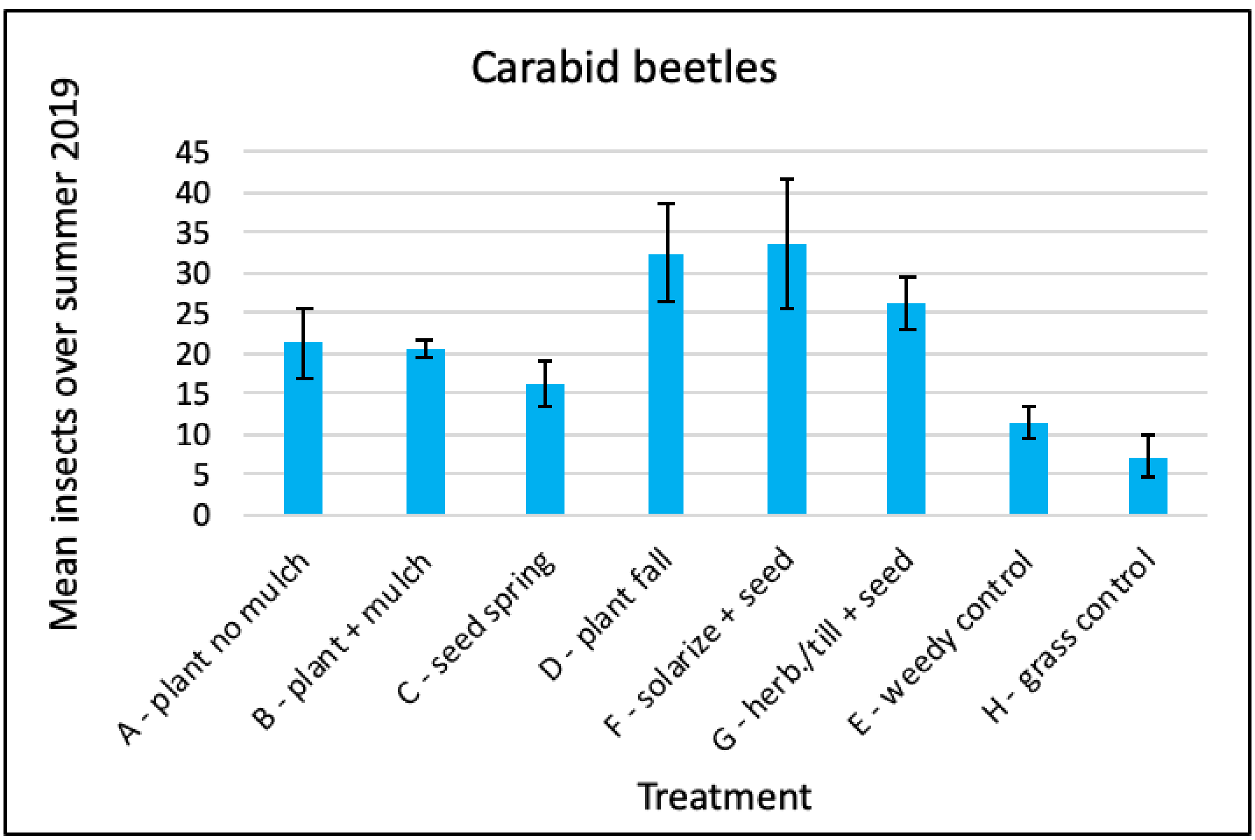

Figure 12. Number of carabid beetles collected from each habitat establishment treatment summed over the course of Summer 2019. Each bar represents the mean of four replicated plots with an error bar showing one standard error above and below the mean.

Next steps

Due to the COVID-19 pandemic, we will postpone the arthropod sampling originally planned for the 2020 season. Plots will continue to be maintained and assessments of plant establishment success and bloom times will continue. We hope to continue arthropod sampling in 2021.

Impacts and Outcomes

For growers

Approximately 187 growers who attended four meetings learned new information about installation and benefits of beneficial insect habitat. We learned more about why they felt they should install beneficial habitat (Fig. 13) and what the barriers were to doing that (Fig. 14). There was also an increase in their intent to install beneficial habitat, based on the amount of time they were willing to invest in creating it (Fig. 15). The number who indicated that they would not invest any time decreased from over 30% at the beginning of the meeting to approximately 5% at the end of the meeting.

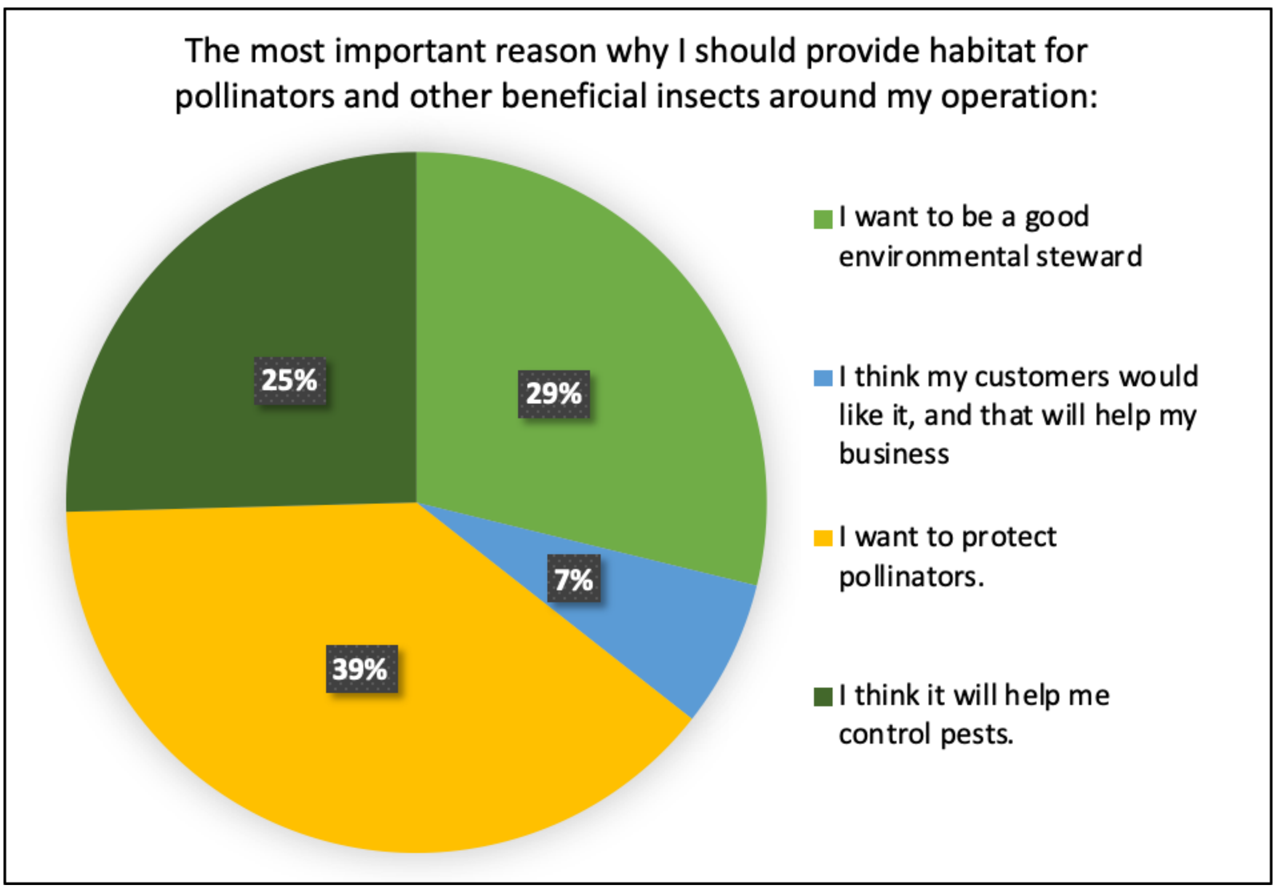

Figure 13. What motivates growers to create habitat for beneficial arthropods. Data represent approximately 187 responses collected at four meetings.

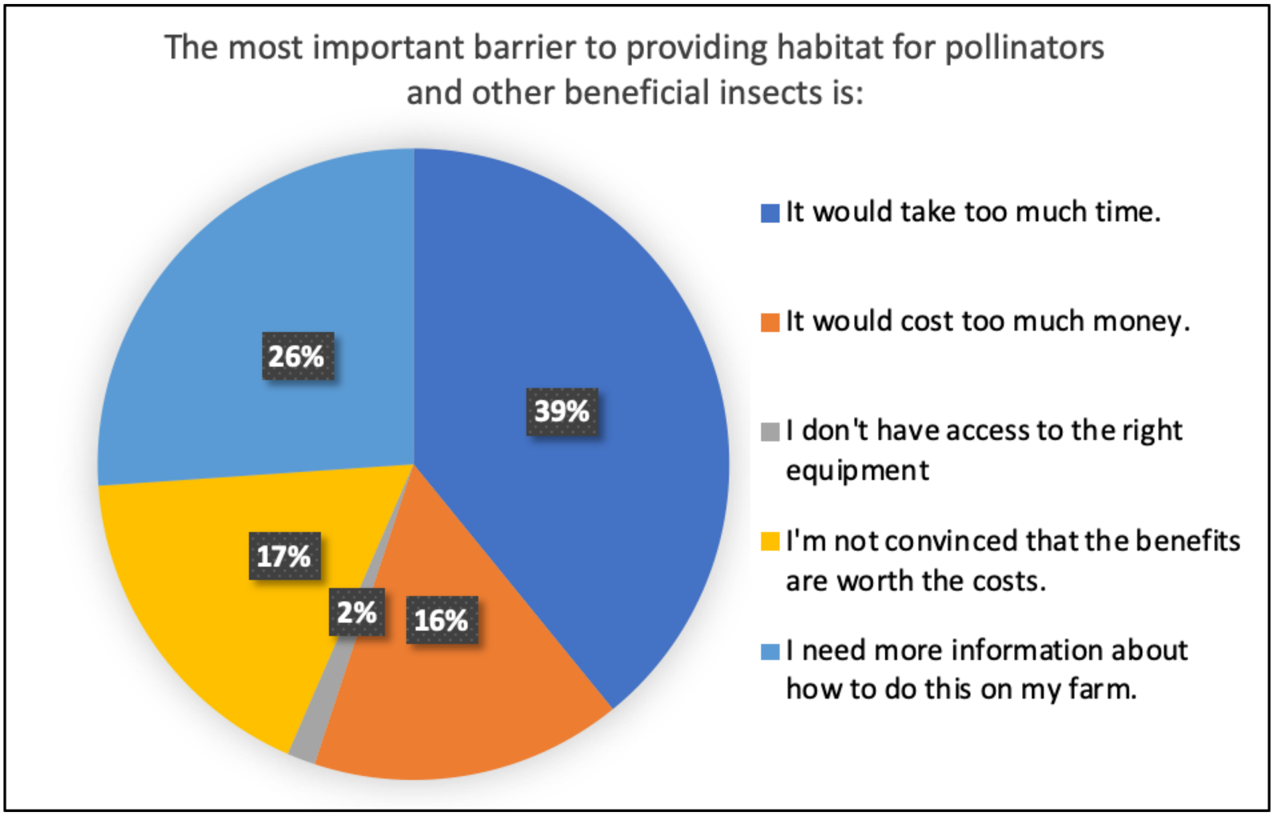

Figure 14. Barriers to growers establishing habitat for beneficial arthropods. Data represent approximately 187 responses collected at four meetings.

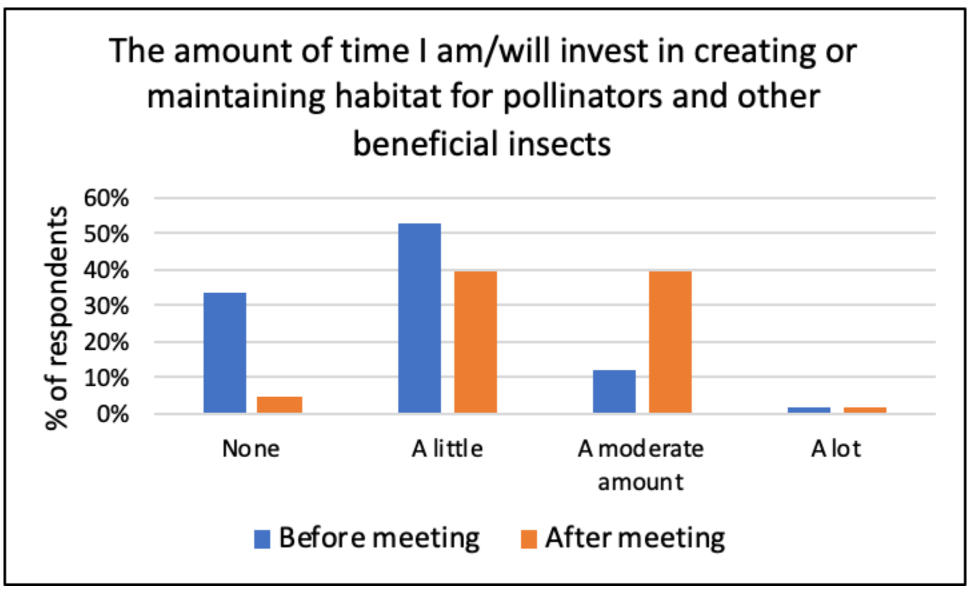

Figure 15. Grower intention to change the amount of time they invest in creating or maintaining habitat for beneficial arthropods after participating in outreach meetings. Data represent approximately 187 responses collected at four meetings.

For Gardeners

Outreach to gardeners was just beginning in 2019, and we will hopefully have more impacts to report in 2020. A public Open House held on September 25, 2019 was attended by 13 people, four of whom indicated that they would be likely to create or maintain habitat for pollinators or beneficial arthropods. One attendee commented, "Great project! Thank you! I hope you have another open house next year."

Project Location

The demonstration plots are located in Ontario County, however, the results could be applicable throughout New York State.

Resources Developed in 2019

The following blog posts were written about this project as both updates on the project, and resources for stakeholders who may want to create habitat for beneficial arthropods:

Dunn, A.R. "Not too early to start planning for pollinator habitat." *ThinkIPM*. New York State Integrated Pest Management Program, Cornell University, 6 February 2019. Web, accessed 6 February 2019.

Dunn, A.R., Eshenaur, B., Lamb, E., Brown, B., Marvin, D. "Demonstrating creation of habitat for beneficial insects – Year 1." Annual project report published on eCommons. Web, accessed 15 March 2019.

Dunn, A.R. "Creating habitat for beneficial insects: Starting Year 2" *Biocontrol Bytes*. New York State Integrated Pest Management Program, Cornell University, 31 May 2019. Web, accessed 1 June 2019.

Dunn, A.R. 2019. Creating habitat for beneficial insects: How are things growing? Biocontrol Bytes blog. Cornell University, 20 December 2019. Accessed 20 December 2019. https://blogs.cornell.edu/biocontrolbytes/2019/12/20/creating-habitat-for-beneficial-insects-how-are-things-growing/

Additional photos are available showing the process of establishing these plots, habitat plants in bloom, what the plots looked like at various times during the 2019 growing season, and what arthropods were seen. Some are available in NYS IPM Flickr albums, or contact Amara Dunn (arc55@cornell.edu) if you are looking for a specific image.

An Instagram account was started in June 2019 (@biocontrol.nysipm) to increase visibility of this project with a more diverse group of stakeholders. It is managed by Amara Dunn.

Funding

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Literature Cited

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Grab, H., Danforth, B., Poveda, K., and Loeb, G. 2018. Landscape simplification reduces classical biological control and crop yield. Ecological Applications 0(0):1-8.

McCabe, E., Loeb, G., and Grab, H. 2017. Responses of crop pests and natural enemies to wildflower borders depends on functional group. Insects 8:73. doi:10.3390/insects8030073