Comparing The Abundances of Pests and Natural Enemies Across A CRP and Unmanaged Land Plot to Assess Unintended Consequences of Pollinator Habitats.

Maia Leach
Department of Entomology - Purdue University - West Lafayette, IN 47907

Abstract

The Conservation of Reserve Program (CRP) was established in 1985, with the goal to reestablish valuable land cover while providing and increasing habitat for endangered and threatened species (USDA 2022). The Conservation Reserve Program (CRP) also has a practice called the CP42-Pollinator Habitat which aims to improve and restore habitat for both economically and ecologically significant pollinator species, although this has many advantages and has proved beneficial, little research has been done about the potential of unintended effects of pollinator habitats (USDA, 2013). To determine if there are unintended effects of pollinator habitats, such as increasing pest or natural enemy populations in the plot, a comparison of abundances of agricultural pest and natural enemies between a CRP-CP42 plot and an unmanaged land plot was done by using Mann-Whitney tests. These methods were used to answer the research questions: Are there economically important agricultural pests or natural enemies in CRP pollinator plots compared to unmanaged land, and does the landscape/agriculture monoculture influence these patterns? Our results show that there was a large difference in abundance of tachinid flies, flower flies, thrips and aphids in the pollinator plot compared to the unmanaged land while the results from the Mann-Whitney showed significance in the tachinid flies and thrips across the sites, showing that there may be unintended effects of the pollinator plot while landscape influences these patterns.

Introduction

At a global scale, pollinators impact food supply as pollinator-dependent crops contribute to 35% of overall crop production (Porto et al. 2020). Eighty-seven of the 115 major crops grown worldwide rely on pollination, and nearly 90% of all wild flowering plant species somewhat depend on animal pollination services (Porto et al. 2020). There has been a 45% decline in insect abundance over the last four decades causing worry about how this will affect ecosystems (Schwagerl 2016). Populations of pollinators are declining at an alarming rate due to alterations in their food and nesting habitats because of the expansion of agricultural practices (Das et al. 2018). Agricultural intensification has been a driving factor in the worldwide loss of biodiversity, due to the conversion of complex natural ecosystems to simplified managed ecosystems (Tscharntke et al. 2005). This conversion of the ecosystems is due to intensification of resource use which involves more agrochemicals being used while eliminating biodiversity for the sake of food and fiber production (Tscharntke et al. 2005). Specifically, the U.S. uses neonicotinoids on about 95% of corn and canola crops, which is one of the leading causes of the large declines in major pollinator insect species (Das et al. 2018). Insects not only play a huge role in biodiversity and agriculture, but they play huge roles in ecosystems as well. Insects make up 66% of all animal species, which makes them a crucial part of every ecosystem (Jankielsohn, 2018). Insects' main ecological functions are cycling elements such as carbon and nitrogen in various forms between different parts of the environment, pollination, predation/parasitism, and decomposition which are all vital tasks to keeping ecosystems functioning and balanced

(Jankielsohn, 2018). Due to all the important roles insects play in biodiversity, agriculture, and ecosystems it is essential that they are protected, and programs are in place to do so such as the Conservation Reserve Program.

The Conservation Reserve Program (CRP) provides subsidies to agricultural producers to take erodible and environmental sensitive land out of production and install resource conserving practices for periods of 10 years (Stubbs, 2014). The CRP requires both enrollment and eligibility to be part of the program. There are two kinds of enrollment, general sign-up, and continuous sign-up (Stubbs, 2014). General sign-up involves landowners offering eligible land for enrollment for 10 years while continuous sign-up is designed to enroll environmentally desirable land into CRP through specific conservation practices or resource needs which extends to 15 years (Stubbs, 2014). For eligibility, the USDA considers multiple land types for enrollment. These land types include highly erodible cropland, marginal pastureland including appropriate vegetation for water quality, and grasslands (Stubbs, 2014). The Conservation Reserve Program provides a way to counteract the damage that agricultural practices do on environmentally sensitive land while cultivating land to native animals and insects to establish and maintain populations (USDA, 2020). The CRP has contributed to several environmental benefits including reducing soil erosion, improved water quality using wetlands and field buffers, increased wildlife habitat, and reduced fertilizer use (Stubbs, 2014). The Conservation Reserve Program also has a practice specific to pollinator habitats called the CP42-Pollinator Habitats. CP42 was introduced in 2008, in response of the threat to declining pollinator populations on domestic agricultural production (USDA, 2015). The CP42 was made to target habitat for ecologically and economically significant pollinator species (USDA, 2015). The other main purposes of this practice is to provide beneficial habitat for pollinators and other wildlife species, and providing nesting, places for egg laying, and pollen and nectar sourced for pollination (Stubbs, 2015). This practice includes using a mixture of at least nine species of pollinator friendly wildflower and legume species, including grass, while having at least three species in each blooming period (USDA 2013). This practice has many advantages but not many have researched the potential unintended effects of the program.

The objective of this study was to study if established pollinator habitats increased the pest populations or natural enemy populations as unintended effects, by looking at the abundances of major pest and natural enemy taxa at a pollinator plot (CP42) and an unmanaged land plot. Due to CP42 plots being within or adjacent to agricultural landscapes, the major crops of Indiana were chosen before processing samples. The major crops of Indiana needed to be based off acreage so to do this, the National Agricultural Statistics Service (USDA-NASS) was used to determine the major crops of Indiana. These crops included corn, soybeans, wheat, watermelon, and field pumpkins. Due to the differences in management of the two land plots, it is expected that the beneficial insects would be more abundant in the CP42 plot while pests would increase as well due to the location and land cover. The two research questions addressed in this study include are there economically important agricultural pests or natural enemies in CRP pollinator plots compared to unmanaged land, and does the landscape/agriculture monoculture influence these patterns?

Materials and Methods

Picking these major crops then allowed for a comprehensive list of common pest and natural enemies associated with these crops to be made and utilized when processing the samples. When choosing the major pest and natural enemies, they were determined by most common or widespread based off the major crops that were picked (APHIS, 2022; Jones, 2015). The samples being sorted were from a CP42 Pollinator site (POL) and a former row crop field which was no longer being used for agriculture but was not enrolled in any formal conservation practice (UM). Insects in these samples were collected from pan traps in the fields. The pan traps consisted of three different colors, blue, yellow, and white, to be more attractive to various pollinator species while the pan traps were filled with a solution of water and dish soap which were put out for 24-36 hours twice a month. To sort samples, the insects were sorted by family or order rather than species names, using both the comprehensive list made of the common natural enemies and pests associated with each crop and online sources as well to view pictures of the insects to aid in identifying. To count the insects, hand counters were used to help with keeping count of the insects as they were picked out of the samples and places into microtubes.

Statistics

Excel and JMP software were used to analyze the date from the sorting. Excel was used to make a graph comparing the abundances of the major insects found across each site while JMP was used to run Mann-Whitney Tests. Mann-Whitney U Tests are used to compare whether there is a difference in the dependent variable for two independent groups. Which compares whether the distribution of the independent variable is the same for two groups

(Figure 1)

Results

The most abundant natural enemy from the collection was *tachinidae* also known as the tachinid fly while the major pest was *thysanoptera* also kniwn as thrips, as they both had the largest abundance. *Syrphidae*, flower fly, and *aphidoidae*, aphids, had the second largest totals being another major beneficial and pest insect found in the collection. Most beneficial and pest insects were found only in the POL site. The POL site had a subtotal of 437 beneficials and 555 pests showing a large difference compared to the 30 beneficials and the 54 pests found in the UM site. Some beneficials were strictly found in the POL site such as ground beetles, ichneumonid wasps, lacewings, and pirate bugs. The POL site also exclusively included pests such cucumber beetles, European corn borers, grasshoppers, Japanese beetles, spider mites, squash bug, and stink bugs.

The POL site had the largest abundance of each insect taxon compared to the UM site (Figure 2), having the largest abundances of tachinid fly and thrips, while also having the largest difference in abundance in these insects compared to UM. The UM site had closer numbers in abundance of the flower fly and aphid numbers with the closest numbers regarding aphids. Thrips had the largest abundance in the POL site having a 418-difference compared to the UM site.

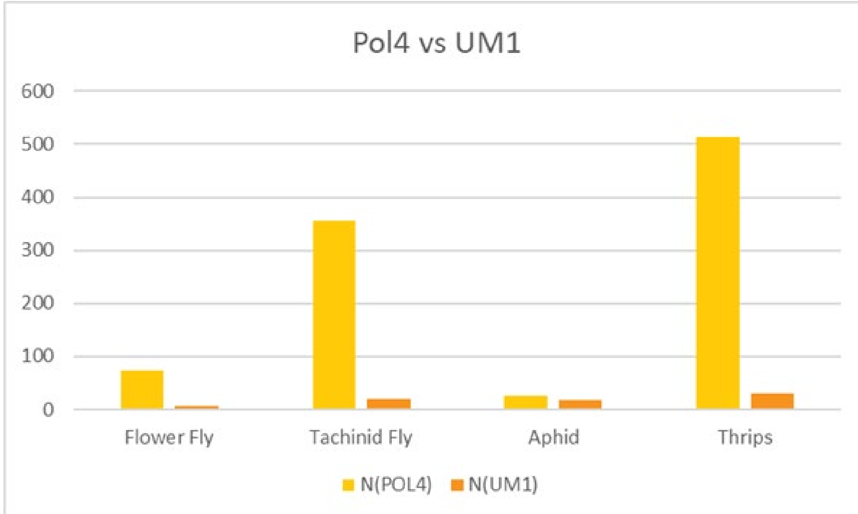
After this, Mann-Whitney tests were used to compare the abundance of the four major insect taxa between sites. Tachinid flies showed significance with a P = 0.0002, and thrips also showing significance with a P = 0.0011 (Table 2). While aphids and flower flies did not show significance, meaning the difference in the insect abundances were not due to the difference in land management.

(Summary table of common pests and natural enemies based off list of major crops of Indiana)

Insect	Type	Count (POL)	Count (UM)	Total
Reduviidae	Beneficial	0	1	1
Nabis capsiformis	Beneficial	1	1	2
Syrphidae	Beneficial	74	7	81
Ichneumonidae	Beneficial	1	0	1
Neuroptera	Beneficial	3	0	3
Orius	Beneficial	2	0	2
Melyridae	Beneficial	0	1	1
Tachinidae	Beneficial	355	20	375
Subtotal		**437**	**30**	**467**
Aphidoidea	Pest	27	17	44
Diabrotica undecimpunctata	Pest	1	0	1
Ostrinia nubilalis	Pest	1	0	1
Caelifera	Pest	1	0	1
Carabidae	Pest	1	0	1
Mayetiola destructor	Pest	0	6	6
Popillia japonica	Pest	5	0	5
Tetranychidae	Pest	2	0	2
Anasa tristis	Pest	1	0	1
Halyomorpha halys	Pest	3	0	3
Thysanoptera	Pest	513	31	544
Subtotal		**555**	**54**	**609**

(Table 1)

(Graph comparing abundances of each major insect across sites)



(Figure 2)

(Summary of P values from Mann-Whitney tests conducted, insects showing significance are bolded)

Taxa	2-sample test	1-way test
Syrphidae	0.148	0.143
Tachinidae	**0.0002**	**0.0002**
Aphidoidea	0.8677	0.8459
Thysanoptera	**0.0011**	**0.0011**

(Table 2)

Discussion

Because the POL site is a CP42 site which includes various wildflower and legume species there could be a strong correlation as to why there are large amounts of tachinid flies in these plots. Tachinid flies are attracted to members of *Daucus carota* which was not documented in the POL site , but most importantly they are attracted to various kinds of wildflowers such as *leucanthemum x superbum* commonly known as shasta daisies, aster, and coreopsis, (Walliser, 2016). Since some of these are major types of wildflowers often seen in many wildflower gardens it makes sense as to why tachinid flies are so prevalent in the POL site. Although this is an advantage as tachinid flies can be strong beneficial insects, this alternatively could be a major reason why the thrip abundance in the POL site is so large. Since thrips are phytophagic meaning they eat plant tissue while being present in forbs and grasses, the POL site having requiring such diverse plant species could be the cause of the large thrip populations. They eat plant tissue, pollen, leaves, twigs, buds, while also consuming flower heads of daises which is the common wildflower used in pollinator gardens which is a main attractant of the Tachinid fly (USDA, 2004). Since there are dynamic mixtures of pollinator friendly wildflowers in each blooming period in the POL site this provides more food for the thrips, proving a proficient habitat for them. Because the UM site is unmanaged land not registered with the CRP, it was not required have the type of diverse plant community especially in every blooming period that a pollinator habitat has. This may cause that area to be less attractive to these insects causing lower abundances of the beneficial insects as they had the lowest numbers across the UM site. This in turn could be why the tachinid fly and thrips showed significant differences between sites. As this test compares values across two independent variables which were the POL and UM site, it showed that the sites were significantly different from each other in terms of these insects. From the results and the landscape of each site, this research showed there may be increases of both natural enemies and pets due to pollinator gardens as there were significant abundances of a thrips which is a common crop pest. The landscape does play a role in this, as the landscapes of the two sites are different with the POL site being more favorable for thrips due to the vegetation.

A limitation to this research was the way the insects were collected from the sites; the insects were collected from pan traps which are more favorable for collecting pollinators than some of the major pest and beneficial insects that were being looked for in the samples. For tachinid flies and aphids, easy trap, tephri-trap, and olipe traps which are good methods for mass-trapping (Tschorsnig, 2008). When trapping thrips, other methods could include sticky cards, and LEDs and LED clip attachments (Chen et.al 2004). Another method for trapping flower flies, could have been malaise traps along with pan traps as pan traps are a sufficient choice as well. Ground beetles, a beneficial that only had a count of 1 in the POL site could have been trapped with malaise traps and pitfall traps which were proven proficient in a recent study (Skvaria, 2017). Malaise traps, pitfall traps, and funnel traps are common methods of mass trapping that could be utilized in future studies. Perhaps using these types of methods in another trial would allow for some expansion of agricultural pest and beneficials that may be in both sites to get a more accurate representation of insect populations in that area.

Something else to be considered is the method of identifying the insects in the samples, the identifying for this research did not go down to species. This caused complications when it came to tachinid flies. Tachinid flies can be both a beneficial and pest insect depending on the species due to them being parasitoids as some lay their eggs inside the host causing the larvae to kill the host insect, opposed to some tachinid species that lay their eggs directly onto the host not killing the host. *Voria ruralis* is a species that lays eggs on a caterpillar and the maggots develop within the host which is something that should have been considered when identifying the tachinid flies down to species (Wisconsin Horticulture, 2022). Grouping all the tachinid flies into the "beneficial" group could have heavily skewed data and may not have been representative of the pest populations across these sites. So, in further research, identifying down to species would be beneficial to avoid this problem and allow for more specific analysis to be done.

Indiana is the tenth largest farming state in the nation, cultivating nearly 15 million acres of farmland in 2017 (ISDA, 2017). This emphasizes the lack of land available for conserving ecosystems in Indiana alone which is why programs such as CRP is essential (ISDA, 2017). Because the CRP is used to try to counteract the damage agricultural practices do, the benefits of the programs and programs similar to it. Other programs similar to the CRP with similar goals are The Conservation Reserve Program Enhancement Program (CREP), Emergency Conservation Program (ECP), Farmable Wetlands Program (FWP), and the Grassland Reserve

Program (GRP) (USDA, n.d.). Since these programs have multiple benefits and work to increase biodiversity, soil, and water quality, not many look for any potential consequences such as increasing pests or unintended positive effects such as increasing natural enemies. This research fills the gap of assessing any potential unintended effects of pollinator gardens as it is not commonly being looked for in other studies. Because there are many differing conservation reserve programs, this research could be applied to get data on similar unintended effects found in the other programs to get representative data for each site. A reassessment of the same plots could be applied as well using new trapping and identification methods to get a more accurate representation of the pests and natural enemies as well.

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