Difference in Insect Abundance in Conservation Reserve Program Lands

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Abstract

The abundance of insects has severely declined the past couple of decades around the world. The Conservation Reserve Program (CRP) is program meant to improve ecologically sensitive farmland by growing non crop intensive plants which are meant to reduce soil erosion and help build wildlife habitat. The 2008 Farm Bill introduced a new practice under the Conservation Reserve Program (CP42) which specifically targets native pollinator conservation. However, over a decade after its formation, there has been no quantitative evaluation of how effective these habitats are for insect conservation. A comparison between CP42 habitat and a wildlife CRP habitat was done to investigate which fields supported higher insect abundance to see which one would be more useful in helping curve the problems insects face. Samples were collected at two time points in July and August 2020 using tri-color pan traps, then identified to order. The collected data showed that non-pollinator insects were more abundant at the pollinator habitat. The CP42 site also had higher levels of insect diversity. To improve insect abundance to promote their usefulness in the ecosystem as food sources and ecosystem service providers it may be best to plant pollinator-oriented seed mixes.

Introduction

The number of insects in the world are decreasing at a rapid rate. The amount of aerial insect biomass has decreased by over 70% in the last 30 years (Hallman et al., 2017). The loss in abundance and diversity of insects can be attributed to factors such as habitat loss and fragmentation, pollution, invasive species, and climate change (Kehoe et al., 2020). This decrease in insect populations could have dire consequences on ecology and on society. A reduction of insect abundance could have a major impact on other groups of animals such as amphibians, reptiles, and birds because these groups and others rely on insects as a food source. Insects also provide important ecosystem services that would have considerable economic impacts if lost. Ecosystem services such as pollination, biological pest control, herbivory, detrivory, and nutrient cycling are conducted by insects and have been estimated to be worth $57 billion every year in the United States (Hallman et al., 2017). If these services were absent, farmers may be forced to compensate by renting managed honeybee colonies to help with pollination, increased insecticide use to take care of pests, and increased fertilizer to restore soil nutrients. Insect pollinated crops, which represent about 84% of all commercial crops and one third of food production, may have lower food yield if pollination decreased which would lower the amount of fruit produced (Allsopp, de Lange, & Veldtman, 2008).

The Conservation Reserve Program (CRP) was created in 1985 by the Food Security Act. This program was initially designed to help conserve land and stop soil loss on highly erodible farmland. The program has been successful in reducing soil erosion, but also has other positive impacts such as reducing sedimentation and nonpoint-source agricultural runoff in water bodies, improving water quality and retention, and developing wildlife habitat (Dunn et al., 1993). The CRP program is competitive because it has a cap on how many people can enroll. Farmers enroll in the program by signing a contract with the USDA which lasts for ten years. The land that is being enrolled also must meet certain qualifications such as being environmentally sensitive. Farmers are paid an annual rent per acre, which for Indiana averaged at $179 in 2020 (NASS, 2020), and receive half the cost of maintaining permanent plant cover. The program may help farmers in another way by removing land used for food production the amount of food produced goes down which means the price of food should increase which will make the farmers crops more valuable (Dunn et al., 1993). In 2008, a pollinator practice was added to the CRP (CP42) which was designed specifically to support native pollinator populations through particular management regulation and installation of native flowering plant communities (Farm Bill, 2008). The minimum amount of land that can be entered into the program must be at least half an acre. The seed mix planted for the CP42 site must have at least nine species of flowering plants, three for each bloom period (early, mid, and late summer) as well as between 25% and 50% grass cover. Management of the land can be done to incorporate some disturbance, but it cannot be during the summer due to ground dwelling animals (NCRS Indiana, 2020a). In contract, the permanent wildlife habitat site is required to have five species of native grasses, forbs, or legumes and 20% tree or shrub cover ((NCRS Indiana, 2020b).

There has been previous work focusing on the relationship of CRP land and Lepidoptera, specifically on if buffer zones support butterflies and on monarchs (Davros et al., 2006; Lukens et al., 2020). There has also been research done looking at honeybees (*Apis mellifera*) on CRP lands to see how how honeybees perform on them and if they benefit by being near them (Otto et al., 2018; Ricigliano et al., 2019; McMinn-Sauder et al., 2020). There is a paper that looks at a range of insect taxa in terms of how it will support game bird populations (Burger et al., 1993). This project will also be looking at general insect taxa, but it will be focused on the abundance and diversity of them for the benefit of more than just game birds. This research is important to see how non-pollinator insects are performing on CRP lands.

This project compares the relative abundance and diversity of insect orders between CRP lands that are managed for wildlife and ones that are managed for pollinators. The outcome is predicted to be that there will be a higher abundance and diversity of insects at the pollinator focused field because it is specifically oriented towards insects. Even though it is oriented towards pollinators and not all insects it may have more insects because of the attraction of other insects to the pollinator insects such as predatory insects. There is also more likely of being a greater degree of resources and cover for insects because the plants selected are meant to work well with insects.

Methods

Specimens were collected with pan traps which consisted of a stake with three differently colored bowls filled with water and dish detergent (Fig. 1). The bowls were blue, white, and yellow a scheme commonly used to attract pollinators (Roberts and King 2016, Campbell and Hanula 2007). The bowls were set out for 24-36 hours after which the contents of the bowls were collected into a sealed plastic bag and labeled. Samples were collected from two CRP sites, one CP42, and one managed for wildlife. The wildlife site (approx. 40ha) was sampled using five transects of four stakes, each 5m apart (Fig. 2). The pollinator site (Fig. 3) was larger (approx. 55ha) and was sampled using 14 transects of three stakes each, with 5m between.

All the samples were brought back to Purdue University and were stored in 95% ethanol in a freezer. The pollinators from all the samples were separated out for use in other analyses and all remaining insects were retained as bycatch. Bycatch from all the pan traps that were collected from the wildlife site were counted (*n* = 20 traps). Because the pollinator site was larger and had more traps, a subset of traps throughout the site were processed (*n* = 21 traps) to make it more comparable with the wildlife site. The traps from the wildlife site were collected on July 8thand August 5th, 2020. The traps from the pollinator site were collected on July 17th and August 14th, 2020. This allowed for comparison between the sites in the same month and within the site between the two months. The bycatch was identified to order based on morphological characters (Johnson & Triplehorn, 2004). Each order from each sample was put into its own microtube with 95% ethanol and labeled.

For statistical analysis, data were grouped by location and month of collection. A mixed effects analysis was performed per site comparing the significance between the July and August collection. A second mixed effects model was performed to compare by site and month. This was done with each column representing a different time point to match values across a row with a P value of 0.05.

Figure 1. A pan trap with the stake and three colored bowls

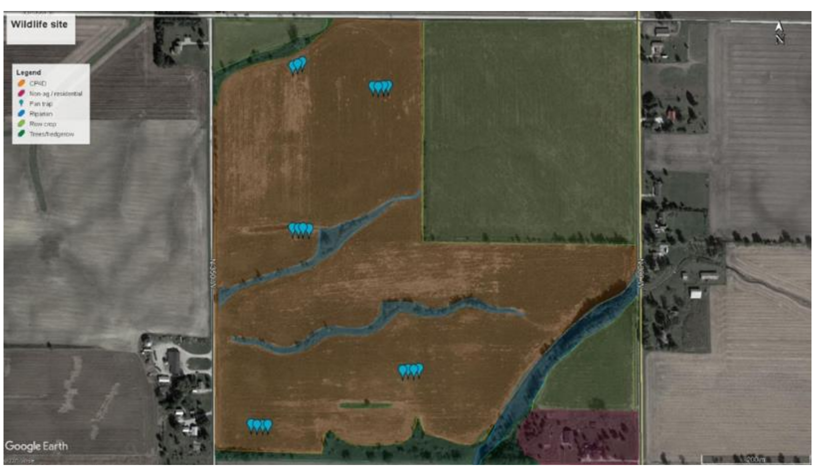

Figure 2. Wildlife site with the blue dots each representing a pan trap

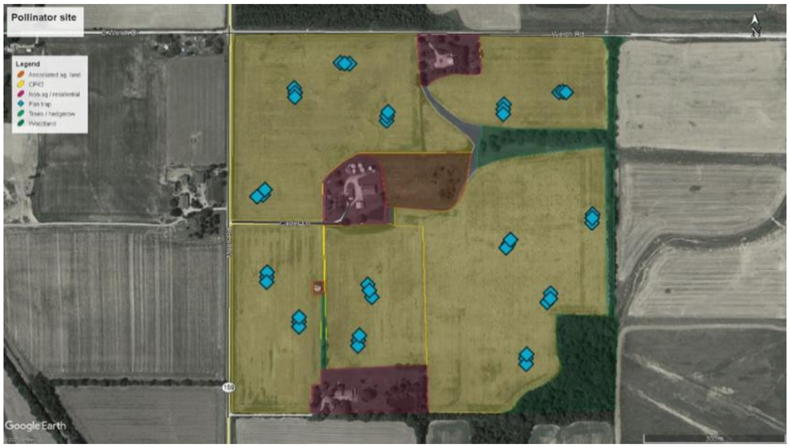

Figure 3. Pollinator site with the blue dots each representing a pan trap

Results

The total number of insects collected as bycatch from the pollinator site was 1,071 while the wildlife site had 521 insects collected (Table 1). In terms of order diversity, the pollinator site had 8 orders, two more than what was present in samples from the wildlife site (Table 1). For the July collection the wildlife site was highest in Hemiptera (*n* = 180) and the pollinator site was highest in Coleoptera (*n* = 146) (Fig. 4). For the August collection Diptera were more numerous at both sites, but especially abundant at the pollinator site (*n* = 646). The number of Hymenoptera (non-pollinator species), and Thysanoptera also increased at both sites in August, while Coleoptera abundance decreased (Fig. 5).

Both sites came back being statistically significant based on the time collected within each site, the wildlife site had a p value of 0.0378 and the pollinator site had a p value of 0.0001. The July collection came back as not statistically significant between the sites, but the August collection came back as statistically significant between sites with a p value of 0.0001.

Table 1. Total count of specimens (to order) collected at each site per sampling period.

Wildlife	Hemiptera	Diptera	Coleoptera	Hymenoptera	Orthoptera	Thysanoptera	Psocoptera	Neuroptera
7/8/2020	180	96	31	3	2	1	0	0
8/5/2020	29	149	8	13	1	8	0	0
Total	209	245	39	16	3	9	0	0
Total Insects	521	n=20						
Pollinator	Hemiptera	Diptera	Coleoptera	Hymenoptera	Orthoptera	Thysanoptera	Psocoptera	Neuroptera
7/17/2020	31	104	146	6	0	1	2	0
8/14/2020	49	646	36	24	1	21	2	2
Total	80	750	182	30	1	22	4	2
Total Insects	1071	n=21						

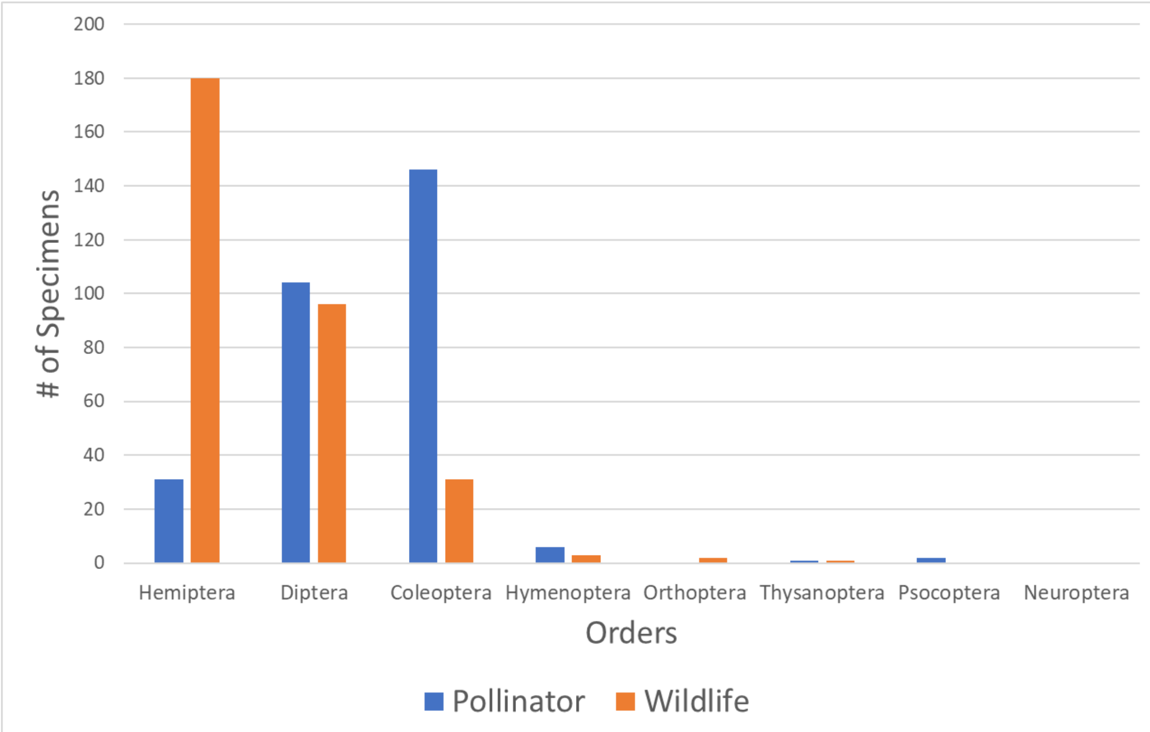

Figure 4. Abundance by order of specimens collected per site, July 2020.

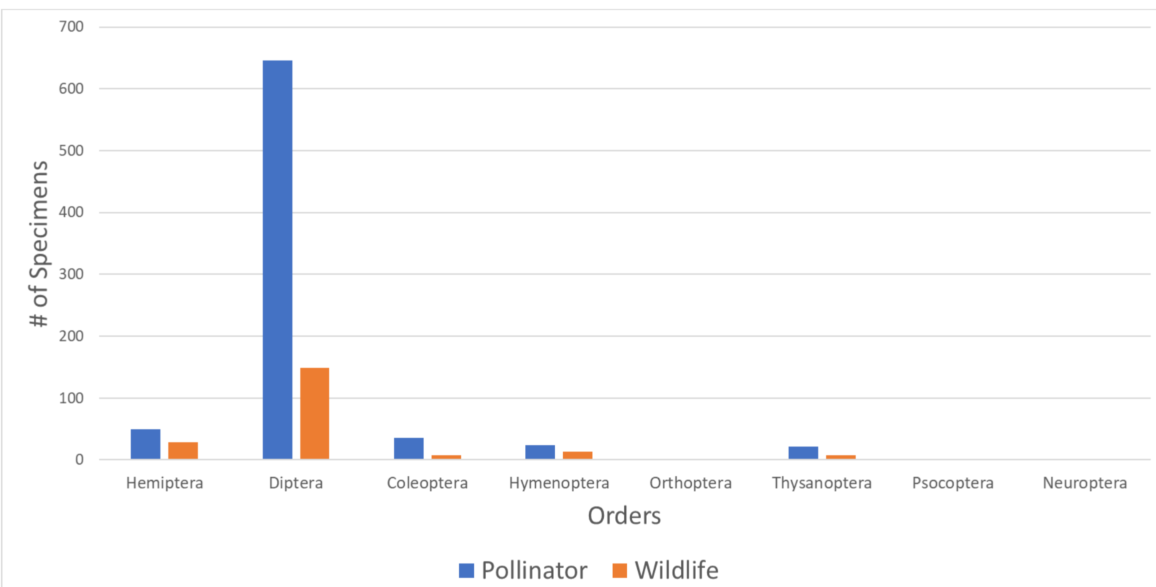

Figure 5. Abundance by order of specimens collected per site, August 2020.

Discussion

The results of the research align with the hypothesis that there would be a higher abundance and diversity of insects at the pollinator site than the wildlife site. The pollinator site is focused on attracting and propagating pollinator species and not insects as a whole, but some of those pollinators may serve as umbrella species, meaning that other insects will also be attracted to the site and have the resources to live there (Branton & Richardson 2011). One of the reasons for the increased insect abundance and diversity at the pollinator site may be due to the higher number of flowering plants. Flowering plants can provide food sources and shelter to non-pollinator insects such as beneficial predators (Lu et al., 2013). The difference in the number of insects between July and August could be due to a change in resources needed by insects as they move from one stage of their life to another such as from larvae to adult (Carey et al., 2017). The data suggests that the abundance and diversity of many insect taxa, not just pollinators, is improved by using a pollinator-oriented seed mix rather than a grass dominated mix. Both sites had about the same number of flowering species though, just a difference in their frequency. The wildlife site had about an even amount of flowering plants to grasses coverage, and the pollinator site had about ¾ flowering plants and ¼ grasses (Bistline-East, unpublished data). The plants at the wildlife site were also much taller than those at the pollinator site, which may be beneficial for ground-dwelling vertebrates but make foraging and dispersal difficult for insects. Hemiptera however, were in higher abundance at the wildlife site, perhaps because there is a higher abundance of grasses at the wildlife site which the suborder Fulgoromorpha prefers (Brambila & Hodges 2004).

Positive implications of these findings could be that with the increased use of CP42 sites, the abundance and diversity of insects could go up which will hopefully increase insect populations across the United States. With increased insect populations the number of animals that feed on them such as birds, in which about 60% feed upon insects, may also increase in population size (Hallman et al., 2017). Ecological services may also increase with CP42 sites by having more pollinators near agricultural fields to pollinate plants and more beneficial predators to control insect pest populations. The opposite possibility is that these sites also increase the pest insect populations which could then cause problems in the nearby agricultural fields. Because the CP42 fields are not sprayed with insecticides the insect predators of these pests should also be abundant and hopefully keep those pest populations in check.

Future research should aim to identify the specimens further and group them into functional groups. This would allow for observation of which ecological services are being performed and their change depending on the site type and time of year. The change in pest insect populations should also be investigated to see if CP42 sites increase their populations and whether this may have any impact on adjacent crop production.

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