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A Survey of Insects Collected from Wild Flowering Plants at One Site in Michigan

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Abstract

The goal of this project was to document the wild flowering plants and the insect diversity present during a one season survey of an unmanaged habitat. Adult insects were collected from June to September 2020. A total of 58 families from 9 orders (Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Mantodea, Neuroptera, Odonata, Orthoptera) of insects were collected or observed. The insects collected were from multiple functional groups including: fungivores, herbivores, nectarivores, pollinivores, and predators. The type and number of insect orders as well as the number of functional groups suggests that insect diversity was attained at the time of this survey. It was also noted that as plant diversity increased so did insect diversity.

Introduction

It is long known that plants are the primary producers in an ecosystem. The flow of energy is passed on to herbivores, the primary consumers, and then onto secondary and tertiary consumers. Wild flowering plants can grow from seeds that have been dormant in the soil for many years or they can be carried in by wind, birds or other animals. As these plants move into an area, the organisms that rely on these plants for survival will follow. These plants then serve as the backbone of ecosystems for many insects and other organisms.

Insects rely on wild flowering plants for food such as nectar, pollen, and plant material. The plants also provide shelter and a location for harboring eggs as well as the nutrition needs for the larvae. These wildflowers can be annuals, biennials and perennials. They come in all shapes and sizes and colors. As the diversity of the wildflowers increases, the diversity of insects can also increase (Siemann *et al.*, 1998; Haddad *et al.*, 2011; Blaauw & Isaacs, 2012; Mata *et al.*, 2021).

According to Loreau and de Mazancourt (2013), biodiversity is critical to the long-term sustainability of ecosystems. It is essential to the stability of the ecosystem process through time. Per Loreau and de Mazancourt, the importance of biodiversity includes the reduction of outbreaks and overpopulations as well as protection from species decimation from disease, habitat stressors, extreme weather events, etc. There is also evidence that biodiversity enhances the efficiency for using resources and recycling essential nutrients. Another important aspect of biodiversity per Triplehorn & Johnson (2005) is that many beneficial insects, including natural enemies, require access to alternate hosts, overwintering habitats, and a constant food supply in order to survive. These requirements are more likely to be fulfilled with a diversity of flowering plants which then provides the resources necessary to support a wide array of insect requirements. As such it is important to understand what factors affect the biodiversity process.

The study site was abandoned farmland and serves to demonstrate the natural succession of an ecosystem. The goal of this project was to document the wild flowering plants and the insect diversity that occurred in a one season survey on unmanaged habitat at one area location.

Materials and Methods

This is a survey of adult insects that were taken from wild flowering plants. The study site was a 160-acre farm located in Fennville, Allegan County, Michigan at 42°34'57.4"N 86°06'35.1"W, 42.582602, -86.109758 (See Figure 1).

Figure 1. Satellite view of study site.



This study site was chosen because it had not been disturbed for three consecutive growing seasons: 2018, 2019 and 2020. There was no cultivation of the land or spraying of pesticides or use of any fertilizers during this timeframe. This study site was not a restoration project. No seeds of wildflowers were planted during this time. The last crop grown at the study site was 2017. The crop was soybean, *Glycine max* L. Merrill that were Roundup Ready 2 Yield® (Monsanto now Bayer). The seeds were treated with a neonicotinoid, Poncho® Votivo® (BASF). Roundup® herbicide was applied to the soybean crop in 2017. Prior to 2017, this acreage had been a series of crops, alternating between cherries, peaches, plums, pears, soybeans, wheat, corn, pumpkins and hay for over 82 years.

This site also contained a 15-acre wooded area. The wildflowers growing in the woods such as the common trilliums *Trillium grandiflorum* (Michx.) jack in the pulpit *Arisaema triphyllum* (L.), yellow trout lily *Erythronium americanum* (Ker Gawl.) and may-apple *Podophyllum peltatum* (L.) were not considered for this survey because of their continued existence prior to 2018. Staghorn sumac *Rhus typhina* (L.) that was growing along the northern property line was also not considered in this survey due to its existence prior to 2018. The site also contained 3 ponds approximately 50' x 200' each. There were seasonal wet areas near the ponds.

Wild flowering plants were randomly distributed throughout this study area often in clumps or patches. These were all noncultivated flowering plants that came up on their own after the 2017 planting season where Roundup® herbicide had been sprayed that would have killed all nonresistant plants including

these. The height of the plants ranged from 6 inches to 6 feet and specimens were gathered from this habitat range.

Adult insects were collected from various flowering plants during the months of June, July, August and September (2020). Collection times were generally late afternoon to early evening and the weather ranged from warm and sunny to cool and cloudy. Collection methods included sweep net, aspirator and hand-picking. Specimens were frozen in containers and re-sealable freezer bags and date labeled for later identification.

Results and Discussion

Table 1 shows plant species and insect families surveyed in this study. There was a total of 44 plant species collected. For plants, the genus *Trifolium* could be found for most of the summer from 7 Jun to 23 Aug. The other plant species collected had a much shorter bloom period generally ranging over one to four weeks. There was a total of 59 insect families from nine orders identified (see Table 2). The nine orders of insects included: Coleoptera, Diptera, Lepidoptera, Hemiptera, Hymenoptera, Mantodea, Neuroptera, Odonata and Orthoptera. The most abundant insect family identified was the plant bug (Family Miridae), number collected = 80, followed closely by the leafhopper (Family Cicadellidae), number collected = 70.

Table 1. Plants and Insects Surveyed

Collection Dates	Plant Species	Insect Order	Insect Family	Total Individuals Collected or Observed
4-Jun-20	Frost Aster (<i>Symphyotrichum pilosum</i> G.L. Nesom)	Lepidoptera	Tiger Swallowtail Butterfly (Family Papilionidae)	1
	Wild Blue Phlox (<i>Phlox divaricata</i> L.)	Hymenoptera	Mason Bee (Family Megachilidae)	5
	Common blue violet (<i>Viola papilionacea</i> Purch)	Coleoptera	Blister Beetle (Family Meloidae)	5
		Coleoptera	Ladybird Beetle (Family Coccinellidae)	2
7-Jun-20	Red clover (<i>Trifolium pratense</i> L.)	Diptera	Crane Fly (Family Tipulidae)	1
	Dandelion (<i>Taraxacum officinale</i> Weber)	Hymenoptera	Halictid Bee (Family Halictidae)	5
	White Clover (<i>Trifolium repens</i> L.)	Coleoptera	Rubarb Curculio (Family Curculionidae)	1
	Wild Blue Phlox (<i>Phlox divaricata</i> L.)	Diptera	Green Soldier Fly (Family Stratiomyomorpha)	2
		Odonata	Narrow-winged Damselfly (Family Coenagrionidae)	3
Lepidoptera	Spicebush Swallowtail Butterfly (Family Papilioninae)	1		
13-Jun-20	Common yarrow (<i>Achillea millefolium</i> L.)	Hymenoptera	Common Eastern Bumble Bee (Family Apidae)	1
	Dandelion (<i>Taraxacum officinale</i> Weber)	Coleoptera	Ladybird Beetle (Family Coccinellidae)	3
	Red clover (<i>Trifolium pratense</i> L.)	Diptera	Flower Fly (Family Syrphidae)	23
	White Clover (<i>Trifolium repens</i> L.)	Coleoptera	Tortoise Beetle (Family Chrysomelidae)	3
	Wild Blue Phlox (<i>Phlox divaricata</i> L.)	Hemiptera	Green Peach Aphid (Family Aphidae)	13
	Early Buttercup (<i>Ranunculus fascicularis</i> Bigelow)	Hemiptera	Plant Bug (Family Miridae)	33
		Coleoptera	Green Leaf Beetle (Family Chrysomelidae)	9
		Diptera	Gray Muscid Fly (Family Muscoidae)	5
		Diptera	Fruit Fly (Family Tephritidae)	7
		Hymenoptera	Black Ant (Family Formicidae)	2
		Hymenoptera	Black Osmia Bee (Family Megachilidae)	2
		Hemiptera	Ebony Bug (Family Thyreocoridae)	19
		Odonata	Vesper Bluet Damselfly (Family Coenagrionidae)	9
	Diptera	Anthomyiid Fly (Family Anthomyiidae)	15	
Diptera	Green-tailed Fly (Family Stratiomyidae)	3		

(Table 1 Continued)

		Hemiptera	Scentsless Plant Bug (Family Rhopalidae)	7
		Hymenoptera	Green Sweat Bee (Family Halictidae)	2
15-Jun-20	Red clover (<i>Trifolium pratense</i> L.)	Hemiptera	Leafhopper (Family Cicadellidae)	17
	White Clover (<i>Trifolium repens</i> L.)	Hymenoptera	Green Sweat Bee (Family Halictidae)	6
	Dandelion (<i>Taraxacum officinale</i> Weber)	Hymenoptera	Black <i>Osmia</i> Bee (Family Megachilidae)	2
	Wild Blue Phlox (<i>Phlox divaricata</i> L.)	Coleoptera	Snout Beetle (Family Curculionidae)	2
	Early Buttercup (<i>Ranunculus fascicularis</i> Bigelow)			
25-Jun-20	Early Buttercup (<i>Ranunculus fascicularis</i> Bigelow)	Hemiptera	Plant Bug (Family Miridae)	9
	Dead Nettle (<i>Lamium amplexicaule</i> L.)	Odonata	Yellow Dragonfly (Family Libellulidae)	2
	Red clover (<i>Trifolium pratense</i> L.)	Coleoptera	Small Black Ground Beetle (Family Carabidae)	3
	White Clover (<i>Trifolium repens</i> L.)	Hemiptera	Green Peach Aphid (Family Aphidae)	13
		Hemiptera	Leafhopper (Family Cicadellidae)	11
		Diptera	Longlegged Fly (Family Dolichopodidae)	2
		Hymenoptera	Honey Bee (Family Apidae)	10
		Lepidoptera	American Copper (Family Lycaenidae)	1
30-Jun-20	Bushy Aster (<i>Aster dumosus</i> L.)	Diptera	Syrphid Fly (Family Syrphidae)	7
	Birdsfoot trefoil (<i>Lotus corniculatus</i> L.)	Lepidoptera	White Cabbage Butterfly (Family Pieridae)	2
	Canada Thistle (<i>Cirsium arvense</i> (L.) Scop.)	Hymenoptera	Honey Bee (Family Apidae)	3
	Purple Coneflower (<i>Echinacea purpurea</i> L.)	Coleoptera	Thistle Tortoise Beetle (Family Chrysomelidae),	1
	Red clover (<i>Trifolium pratense</i> L.)	Diptera	Flesh Fly (Family Sarcophagidae)	5
	Early Buttercup (<i>Ranunculus fascicularis</i> Bigelow)	Hemiptera	Ebony Bug (Family Thyreocoridae)	9
		Coleoptera	Soldier Beetle (Family Cantharidae)	2
		Hemiptera	Harlequin Bug (Family Pentatomidae)	1
5-Jul-20	Wild Carrot (<i>Daucus carota</i> L.)	Coleoptera	Japanese Beetle (Family Scarabaeidae)	3
	Field Bindweed (<i>Convolvulus arvensis</i> L.)	Coleoptera	Soldier Beetle (Family Cantharidae)	15
	Dandelion (<i>Taraxacum officinale</i> Weber)	Hemiptera	Boxelder Bug (Family Rhopalidae)	1
	Canada Thistle (<i>Cirsium arvense</i> (L.) Scop.)	Hymenoptera	Honey Bee (Family Apidae)	23
	Chicory (<i>Cichorium intybus</i> L.)	Coleoptera	Firefly (Family Lampyridae)	4
	Common Groundsel (<i>Senecio vulgaris</i> L.)	Coleoptera	Golden Tortoise Beetle (Family Chrysomelidae)	1

(Table 1 Continued)

	White Clover (<i>Trifolium repens</i> L.)	Hymenoptera	Black Net-Winged Beetle (Family Lycidae)	1
	Common Milkweed (<i>Asclepias syriaca</i> L.)	Hymenoptera	Black Ant (Family Formicidae)	2
	Red clover (<i>Trifolium pratense</i> L.)	Hymenoptera	Mud-Dauber Wasp (Sphecid Wasps) (Family Specidae)	1
	Field Sowthistle (<i>Sonchus arvensis</i> L.)	Diptera	Green Blow Fly (Family Calliphoridae)	2
		Coleoptera	Snout Beetle (Family Curculionidae)	2
		Coleoptera	White Clover Weevil (Family Brentidae)	3
		Diptera	Margined Calligrapher Fly (Family Syrphidae)	5
		Diptera	Syrphid Fly (Family Syrphidae)	17
		Hemiptera	Small Milkweed Bug (Family Lygaeidae)	1
		Diptera	Flesh Fly (Family Sarcophagidae)	3
		Diptera	Green Metallic Long-legged Fly (Family Dolichopodidae)	2
		Hemiptera	Leafhopper (Family Cicadellidae)	7
		Hemiptera	Ebony Bug (Family Thyreocoridae)	17
		Hemiptera	Shield-Backed Bug (Famiy Scutelleridae)	1
		Hemiptera	Froghopper (Family Cercopidae)	3
		Diptera	Fruit Fly (Family Tephritidae)	3
		Diptera	Crane Fly (Family Tipulidae)	5
		Hemiptera	Small Milkweed Bug (Family Lygaeidae)	3
11-Jul-20	Common Mullein (<i>Verbascum thapus</i> L.)	Coleoptera	Japanese Beetle (Family Scarabaeidae)	16
	Cut-leaved evening-primrose (<i>Oenothera laciniata</i> Hill)	Odonata	Damselfly (Family Coenagrionidae)	6
	Common mallow (<i>Malva neglecta</i> Wallr.)	Coleoptera	Ladybird Beetle (Family Coccinellidae)	7
	Common Milkweed (<i>Asclepias syriaca</i> L.)	Hemiptera	Green Peach Aphid (Family Aphidae)	19
	White Clover (<i>Trifolium repens</i> L.)	Diptera	Big-headed fly (Family Pipunculidae)	1
		Diptera	Green Metallic Long-legged fly (Family Dolichopodidae)	2
		Hymenoptera	Black Ant (Family Formicidae)	2
		Lepidoptera	Orange Sulfur Butterfly (Family Pieridae)	2
12-Jul-20	Tall Morning-Glory (<i>Ipomoea purpurea</i> L.)	Hemiptera	Small Milkweed Bug (Family Lygaeidae)	9
	Common Milkweed (<i>Asclepias syriaca</i> L.)	Coleoptera	Red Milkweed Beetle (Family Cerambycidae)	7
	Yellow woodsorrel (<i>Oxalis stricta</i> L.)	Coleoptera	Green Dock Beetle (Family Chrysomelidae)	1
	Curly Dock (<i>Rumex crispus</i> L.)			
	Red Sorrel (<i>Rumex acetosella</i> L.)			

(Table 1 Continued)

14-Jul-20	Busy Aster (<i>Aster dumosus</i> L.)	Hemiptera	Ebony Bug (Family Thyreocoridae)	13
	Wild Carrot (<i>Daucus carota</i> L.)	Hemiptera	Plant Bug (Family Rhopalidae)	15
	White Clover (<i>Trifolium repens</i> L.)	Hemiptera	Green Peach Aphid (Family Aphidae)	21
	Common Milkweed (<i>Asclepias syriaca</i> L.)	Hemiptera	Leafhopper (Family Cicadellidae)	7
	Harry vetch (<i>Vicia villosa</i> Roth)	Diptera	Green Metallic Long-legged Fly (Family Dolichopodidae)	5
	Horsenettle (<i>Solanum carolinense</i> L.)	Hymenoptera	Acrobat Ant (Family Formicidae)	9
		Diptera	Thick-Headed Fly (Family Conopidae)	2
		Diptera	Flower Fly (Family Syrphidae)	7
		Coleoptera	Red Milkweed Beetle (Family Cerambycidae)	4
30-Jul-20	Blue Vervain (<i>Verbena hastata</i> L.)	Coleoptera	Japanese Beetle (Family Scarabaeidae)	13
	Common Milkweed (<i>Asclepias syriaca</i> L.)	Lepidoptera	Monarch Butterfly (Family Nymphalidae)	6
	Common Mullein (<i>Verbascum thapsus</i> L.)	Hemiptera	Plant Bug (Family Miridae)	17
	Yellow toadflax or Butter and Eggs (<i>Linaria vulgaris</i> Mill.)	Hymenoptera	Bumble Bee (Family Apidae)	6
	Field pennycress (<i>Thlaspi arvense</i> L.)	Orthoptera	Red-legged Grasshopper (Family Acrididae)	8
	Chicory (<i>Cichorium intybus</i> L.)	Coleoptera	Red Milkweed Beetle (Family Cerambycidae)	3
	Horsenettle (<i>Solanum carolinense</i> L.)	Neuroptera	Green Lacewing (Family Chrysopidae)	5
1-Aug-20	Wild Carrot (<i>Daucus carota</i> L.)	Coleoptera	Japanese Beetle (Family Scarabaeidae)	10
	Red clover (<i>Trifolium pratense</i> L.)	Coleoptera	Seven-spotted Ladybird Beetle (Family Coccinellidae)	1
	Narrow-leaved Vervain (<i>Verbena simplex</i> L.)	Hemiptera	Plant Bug (Family Miridae)	5
	Canada Goldenrod (<i>Solidago canadensis</i> L.)	Coleoptera	Shining Flower Beetle (Family Phalacridae)	2
	Common Milkweed (<i>Asclepias syriaca</i> L.)	Hemiptera	Harlequin Bug (Family Pentatomidae)	2
	Red Sorrel (<i>Rumex acetosella</i> L.)	Diptera	Flesh Fly (Family Sarcophagidae)	5
	Blue Vervain (<i>Verbena hastata</i> L.)	Diptera	Green Blow fly (Family Calliphoridae)	1
		Hymenoptera	Green Halictid Bee (Family Halictidae)	1
		Hemiptera	Buffalo Treehopper (Family Membracidae)	1
		Hymenoptera	Black Ant (Family Formicidae)	4
		Coleoptera	Snout Beetle (Family Curculionidae)	2
		Diptera	Fruit Fly (Family Tephritidae)	6
		Diptera	Margined Calligrapher Fly (Family Syrphidae)	3
		Hemiptera	Leafhopper (Family Cicadellidae)	5
		Hymenoptera	Chalcidoid Wasp (Family Eucharitidae)	1

(Table 1 Continued)

		Orthoptera	Tree Cricket (Family Gryllidae, Subfamily Occanthinae)	3
		Coleoptera	Firefly (Family Lampyridae)	1
		Hemiptera	Stinkbug (Family Pentatomidae)	1
		Coleoptera	Roove Beetle (Family Staphylinidae)	1
		Diptera	Robber Fly (Family Asilidae)	2
		Coleoptera	Flea Beetle (Family Chrysomelidae)	8
		Coleoptera	Green Dock Beetle (Family Chrysomelidae)	1
		Hymenoptera	Carpenter Bee (Family Apidae)	3
		Mantodea	Praying Mantis (Family Mantidae)	2
8-Aug-20	Wild Carrot (<i>Daucus carota</i> L.)	Hymenoptera	Bumble Bee (Family Apidae)	7
	Canada Thistle (<i>Cirsium arvense</i> (L.) Scop.)	Lepidoptera	Ermine Moth (Family Yponomeutidae)	2
	Boneset (<i>Eupatorium perfoliatum</i> L.)	Lepidoptera	Clouded Sulphur Butterfly (Family Pieridae)	5
	Prickly lettuce (<i>Lactuca serriola</i> L.)	Hemiptera	Leafhopper (Family Cicadellidae)	11
	Canada Goldenrod (<i>Solidago canadensis</i> L.)	Diptera	Goldenrod Gall Fly (Family Tephritidae)	1
	Purple loosestrife (<i>Lythrum salicaria</i> L.)	Coleoptera	Checkerboard Beetle (<i>Propylea</i>) (Family Coccinellidae L.)	1
	Common Milkweed (<i>Asclepias syriaca</i> L.)			
	Red Sorrel (<i>Rumex acetosella</i> L.)			
	Blue Vervain (<i>Verbena hastata</i> L.)			
17-Aug-20	Narrow-Leaved Vervain lanveder (<i>Verbena simplex</i> L.)	Lepidoptera	Eastern Tailed Blue Butterfly (Family Lyeanidae)	2
	Mayweed chamomile (<i>Anthemis cotula</i> L.)	Lepidoptera	Cabbage Butterfly (Family Pieridae)	3
	Canada Goldenrod (<i>Solidago canadensis</i> L.)	Hemiptera	Green Peach Aphid (Family Aphidae)	19
	Red clover (<i>Trifolium pratense</i> L.)	Hemiptera	Leafhopper (Family Cicadellidae)	13
	Velvetleaf (<i>Abutilon theophrasti</i> Medicus)	Hymenoptera	Carpenter Bee (Family Apidae)	2
	Common Milkweed (<i>Asclepias syriaca</i> L.)	Coleoptera	Green Dock Beetle (Family Chrysomelidae)	1
	Curly Dock (<i>Rumex crispus</i> L.)			
19-Aug-20	Boneset (<i>Eupatorium perfoliatum</i> L.)	Coleoptera	Goldenrod Soldier Beetle (Family Cantharidae)	4
	Narrow-Leaved Vervain lanveder (<i>Verbena simplex</i> L.)	Lepidoptera	Pearl Crescent Butterfly (Family Nymphalidae)	2
	Canada Goldenrod (<i>Solidago canadensis</i> L.)	Hemiptera	Plant Bug (Family Miridae)	16
	Common Milkweed (<i>Asclepias syriaca</i> L.)	Diptera	Goldenrod Gall Fly (Family Tephritidae)	1
			Ground Beetle (Family Carabidae)	2

(Table 1 Continued)

23-Aug-20	Canada Goldenrod (<i>Solidago canadensis</i> L.)	Hymenoptera	Cuckoo Bee <i>Sphcodes</i> (Family Halictidae)	3
	Boneset (<i>Eupatorium perfoliatum</i> L.)	Coleoptera	Goldenrod Soldier Beetle (Family Cantharidae)	13
	Alsike clover (<i>Trifolium hybridum</i> L.)	Lepidoptera	Goldenrod Gall Moth (Family Tortricidae)	1
	Dasy Fleabane (<i>Erigeron annuus</i>)	Lepidoptera	Ailanthus Webworm Moth (Family Attevidae)	2
	Common Milkweed (<i>Asclepias syriaca</i> L.)	Lepidoptera	Pearl Crescent Butterfly (Family Nymphalidae)	3
	Curly Dock (<i>Rumex crispus</i> L.)	Lepidoptera	Painted Lady Butterfly (Family Nymphalidae)	3
		Hymenoptera	Cellophane Bee (Family Colletidae)	2
		Hymenoptera	Carpenter Bee (Family Apidae)	3
		Hymenoptera	Northern Paper Wasp (Family Vespidae)	5
		Hemiptera	Assassin Bug (Family Reduviidae)	2
		Diptera	Goldenrod Gall Fly (Family Tephritidae)	1
28-Aug-20	Tall Tickseed (<i>Coreopsis tripteris</i> L.)	Hymenoptera	Yellowjacket Wasp (Family Vespidae)	2
	Canada Goldenrod (<i>Solidago canadensis</i> L.)	Hymenoptera	Mason Bee (Family Megachilidae)	7
	Common Mullein (<i>Verbascum thapsus</i> L.)	Diptera	Syrphid Fly (Family Syrphidae)	11
		Coleoptera	Goldenrod Soldier Beetle (Family Cantharidae)	9
		Coleoptera	Locust Borer (Family Cerambycidae)	2
		Lepidoptera	Gray Hairstreak Butterfly (Family Lycaenidae)	4
		Lepidoptera	Goldenrod Gall Moth (Family Tortricidae)	1
		Lepidoptera	Pearl Crescent Butterfly (Family Nymphalidae)	5
		Hymenoptera	Cellophane Bee (Family Colletidae)	3
		Hymenoptera	Bumble Bee (Family Apidae)	4
		Hymenoptera	Honey Bee (Family Apidae)	9
		Hymenoptera	Sweat Bee (Family Halictidae)	5
		Hemiptera	Leafhopper (Family Cicadellidae)	9
		Coleoptera	Goldenrod Leaf Miner (Family Chrysomelidae)	3
		Lepidoptera	Monarch Butterfly (Family Nymphalidae)	3
		Hymenoptera	Northern Paper Wasp (Family Vespidae)	5
7-Sep-20	Wild onion (<i>Allium Canadense</i> L.)	Orthoptera	Spur-Throated Grasshopper (Family Acrididae)	3
	Canada Goldenrod (<i>Solidago canadensis</i> L.)	Coleoptera	Goldenrod Soldier Beetle (Family Cantharidae)	6
		Coleoptera	Locust Borer (Family Cerambycidae)	1
		Lepidoptera	Ailanthus Webworm Moth (Family Attevidae)	2

(Table 1 Continued)

		Hymenoptera	Cellophane Bee (Family Colletidae)	3
		Hymenoptera	Northern Paper Wasp (Family Vespidae)	9
		Hemiptera	Assassin Bug (Family Reduviidae)	1
19-Sep-20	Ox-eye Daisy (<i>Leucanthemum vulgare</i> Lam.)	Coleoptera	Goldenrod Soldier Beetle (Family Cantharidae)	9
	Canada Goldenrod (<i>Solidago canadensis</i> L.)	Hymenoptera	Cellophane Bee (Family Colletidae)	2

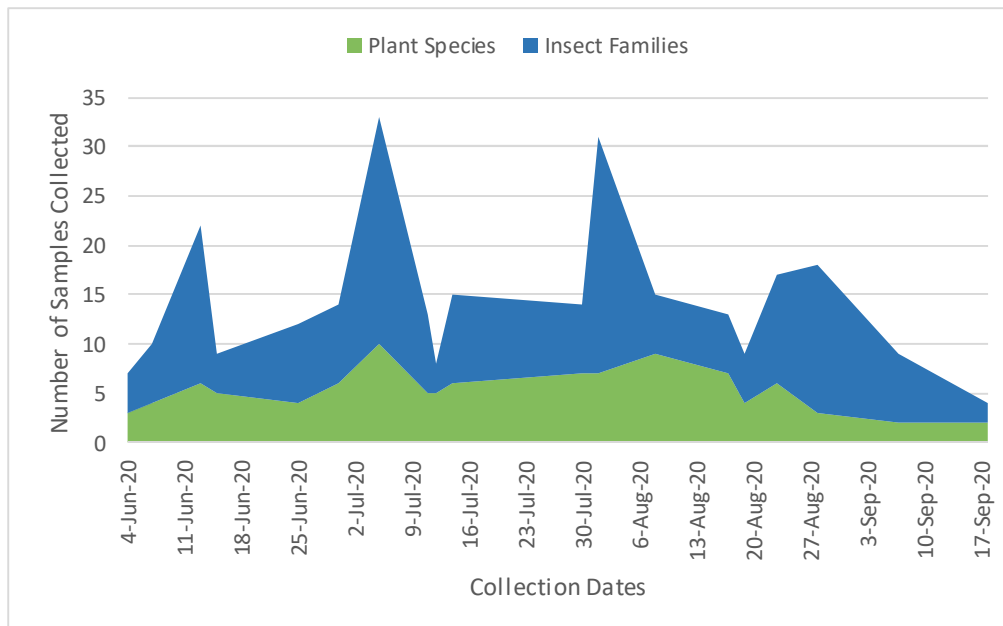
Table 2. Insect Orders and Families collected.

Insect Orders	Insect Families			
Coleoptera	Brentidae Cantharidae Carabidae Cerambycidae	Chrysomelidae Coccinellidae Curculionidae	Lampyridae Lycidae Meloidae	Phalacridae Scarabaeidae Staphylinidae
Diptera	Anthomyiidae Asilidae Calliphoridae Conopidae	Dolichopodidae Muscoidea Pipunculidae	Sarcophagidae Stratiomyomorpha Stratiomyidae	Syrphidae Tephritidae Tipulidae
Hemiptera	Aphidae Cercopidae Cicadellidae	Lygaeidae Membracidae Miridae	Pentatomidae Reduviidae Rhopalidae	Scutellerida Thyreocoridae
Hymenoptera	Apidae Colletidae	Eurcharitidae Formicidae	Halicidae Megachilidae	Specidae Vespidae
Lepidoptera	Attevidae Lycaenidae	Lyeamidae Nymphalidae	Papilionidae Pieridae	Tortricidae Yponomeutidae
Mantodea	Mantidae			
Neuroptera	Chrysopidae			
Odonata	Coenagrionidae	Libellulidae		
Orthoptera	Acrididae	Gryllidae		

It is difficult to measure biodiversity due to ambiguous definitions. One researcher, Daniel Janzen, (Kaiser, 1997) attempted an all taxa biodiversity inventory in Costa Rica in 1997 but eventually had to abandon the effort. Other researchers have tried to measure biodiversity indicators. Per Speight *et al.*, (2008), a few insects stand out as being frequently recommended as biodiversity indicators: tiger beetles (Cicindelidae), ground beetles (Carabidae) and butterflies (Lepidoptera). Another group of insects that has been promoted as a potential indicator are ants (Formicidae). While tiger beetles were not found in this survey, found in this study were 3 recognized biodiversity indicators, the Carabidae, the Lepidoptera and the Formicidae. Additionally 6 other orders were collected or observed. Gerlach *et al.*, (2012) supports the use of different insect functional roles as a bioindicators for monitoring environmental stress or biodiversity at a site. Some of the insect functional roles and their families found in this survey include: fungivores (i.e. Scarabaeidae, Formicidae), herbivores (i.e. Miridae, Chrysomelidae, Scarabaeidae, Formicidae, Curculionidae), nectarivores (i.e. Scarabaeidae, Nymphalidae, Cantharidae), pollinivores (i.e. Apidae, Halictidae), and predators (i.e. Mantidae, Carabidae, Reduviidae, Formicidae, Chrysopidae). Using both the type and number of insect orders as well as the number of functional groups found in this survey as bioindicators for diversity would suggest that insect diversity was attained during this study period.

Another interesting aspect of insect biodiversity is the concept that as plant diversity increases so does insect diversity. Siemann *et al.*, (1998), in field experimental tests, found that increasing plant diversity significantly increases arthropod diversity mainly via effects of plant diversity on herbivores and predators. Haddad *et al.*, (2011) produced long term evidence, over 11 years, that higher plant diversity increased the stability of a diverse arthropod community. In a field plot study conducted in Fennville, Michigan, Blaauw & Isaacs (2012) showed that with larger wildflower plantings there was increased natural enemy density, and biological control of sentinel prey, without increasing herbivore density. Mata *et al.*, (2021), in a study done in urban greenspaces conducted in Melbourne, Australia, found that indigenous plants promoted insect biodiversity. Their findings highlighted the key role of multi-layered vegetation in sustaining high insect biodiversity in urban areas, with indigenous midstorey and canopy representing key elements needed to maintain rich and functionally diverse indigenous insect communities. Similar findings are supported in this study (see Figure 2). When there were more plants in bloom, there tended to be more insect families. When there were fewer plants in bloom, there were fewer insect families.

Figure 2. Number of Plant Species vs. Insect Families.



Strengths of the study include: 1. Numerous collection dates, 2. Quantity of insects collected, 3. Number of plants and insects identified, all of which help provide a large sample size.

Potential weaknesses of the study include: 1. A lack of documentation of specific weather conditions on collection dates but there were no seasonal weather extremes during the study period. 2. Dynamic insect mobility. There were times that insects were not found on different plants where they might have been expected to be but their movement is very fluid and unpredictable. Adding complexity to the picture, the identification of insect families found on different wildflowers does not establish an insect-host plant relationship; the insect may only be a temporary visitor, resting or perhaps seeking prey, i.e. predatory beetles such as Carabidae do not use the milkweed as a host plant but for seeking prey. As a temporary visitor the insect habits may be less predictable, and they may or may not be found on any collection date. 3. Inability to follow this study site over future years as this site has been returned to farmland.

Recommendations for future projects would be to follow an undisturbed site over a series of years in order to show succession over a longer time frame.

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