Invertebrate Community Surveys of Grass Margins and Crop Fields 2019

Prepared for

Delta Farmland and Wildlife Trust
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Executive Summary

This study assessed effects of the Delta Farmland & Wildlife Trust's grass margin program on invertebrate communities. Specifically, invertebrate relative abundance was sampled in both field interiors and adjacent grass margins throughout summer of 2019. The study quantified total abundance across taxa, as well as abundance for key beneficial and pest taxa.

Five organic crop fields and their adjacent grass margins were the focus of this study. Insect abundance was assessed using three trapping methods (pit, pan, and sweep) to capture a wide variety of taxa. Insects were then identified at the Order level (and where possible, Family level).

The study found a general trend towards higher total abundance of all invertebrate taxa combined in grass margin sites versus in crop fields (but a small sample size precluded a statistically significant result). This was supported at the Order level as well, with nearly all captured orders showing a similar trend towards higher abundance and diversity in grass margins. Of particular importance at the Family level, a few taxa known to be beneficial to agriculture had higher abundance in grass margins, while pest taxa had similar levels in grass margins and field interiors.

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1 Introduction

The Delta Farmland and Wildlife Trust (DF&WT) annually preserves over 3,500 acres of farmland in stewardship co-operation with local farmers. These stewardship programs involve the planting of hedgerows, grass margins, grassland set-asides, and winter cover crops in order to meet a series of stewardship goals, which include but are not limited to:

- Habitat preservation for a wide variety of wildlife
- Reduced soil erosion and increased soil fertility
- Temperature control for livestock
- Improved crop pollination
- Biological pest control
- Increased crop yields

This study attempts to identify, quantify, and characterize the effects of the grass margin program on invertebrate communities, both within field interiors and within grass margins. In general, it is believed that diversity of vegetation species and structure (which grass margins provide) increases abundance and diversity of beneficial insects, lowers abundance of pest insects, and improves the beneficial/pest insect ratio (minimizing risk of pest outbreaks). This study attempts to achieve its goals by:

- Monitoring invertebrate relative abundance as it changes through the growing season
- Identifying correlations between habitat type and both beneficial and pest insects respectively

2 Background

2.1 Role of Invertebrates in Overall Biodiversity

Insects[1] compose over 50% of all described species in terms of taxonomic diversity, and this enormous contribution in terms of both absolute abundance and diversity makes them a significant driver of other ecosystem processes (Schowalter, 2006). They are significant sources of food for a wide variety of species, but they can also transmit disease. They direct the flow of energy and nutrients in ecosystems

[1] This survey also includes several species of terrestrial arthropods that are invertebrates but do not technically meet the taxonomic criteria to be “insects”, such as arachnids and millipedes. However, since their ecological roles, size, and body plans are similar, this report uses the terms “insect” “invertebrate” and “arthropod” interchangeably for linguistic flavour, despite them having distinct taxonomic criteria and classifications. Most species described fall in the “insect” category, with a few exceptions as noted.

through their roles as herbivores, pollinators, detritivores, and predators (Schowalter, 2006). As many other species rely on insects through their diet, the presence and abundance of insects are indicators of an ecosystem's health and ability to support other forms of life.

Perhaps a better metric of ecosystem health is insect diversity, rather than total insect abundance (i.e., an ecosystem containing small numbers of a hundred different invertebrate species is "healthier" than ecosystem containing enormous numbers of a single species). This relates to two key ecological metrics related to stability: resistance and resilience.

A stable ecosystem is one that is resistant to significant change. All ecosystems are constantly undergoing stress: invasive species colonize new areas, climate patterns shift, diseases are introduced and spread, predation goes through boom and bust cycles. An ecosystem built upon interactions between a large diversity of insect species can "afford" to lose a few without collapsing the series of complex interactions that allows an ecosystem to function. In an ecosystem containing dozens of species of wild bees, one species contracting a parasite and going extinct locally still allows for all of the local flowers to be pollinated. In an ecosystem containing an abundance of only one species of bee, contracting a parasite can be disastrous for all local plant species, as well as any wildlife species that depend on those plant species.

Similarly, a resilient ecosystem is one with the ability to "bounce back" after a significant change. Continuing with our bee analogy, a local extinction of a single species of wild bee in a diverse ecosystem may be only a temporary setback. The other species of wild bees are more likely to expand their own territories and niches, and soon restore ecosystem function. In an ecosystem highly dependent on a single species of bee, the local extinction of a species may be an irrecoverable event.

These principles hold true for higher order species as well (birds, mammals). A diverse invertebrate community means a diverse array of food sources, which tends to translate into diverse communities of higher order species as well. A diverse community of higher order species also increases ecosystem stability and resilience.

For these reasons, although this report does pay special attention to invertebrates and their benefits/detriments to agriculture, it should be recognized that invertebrate abundance and diversity has value in and of itself.

2.2 Agriculturally Beneficial Invertebrates

In general, certain groups of invertebrates can be considered beneficial to agriculture based on their behaviour or life history strategies. For example, most species within a certain family might prey on nuisance pest species (while one or two species within the same family do not, or are actually harmful). Still, these groupings can be helpful to identify general trends within the insects on site, and how their presence might affect the growth of local crops.

Members of the Carabidae family of beetles, often called ground beetles, are generally considered a helpful group of insects based on their predacious habits of a wide variety of other invertebrates. Most are medium to large, with long legs, and seldom fly (Haggard & Haggard, 2006). They are fast moving, active hunters. They are also considered very sensitive to human disturbance and insecticides (Haggard & Haggard, 2006).

Members of the family Araneae (spiders) are well known for their predacious habits, feeding indiscriminately on most other invertebrates. For this reason, they are generally considered agriculturally beneficial, although this depends to some extent on the nature of their prey.

The easily recognized ladybird beetles, or ladybugs (Family Coccinellidae) are well known as beneficial insects, due to their habit of feeding on aphid colonies. For this reason, they are commonly used as a biological control (Haggard & Haggard, 2006), especially by gardens. Their distinctive red and black spotted colouring make the adults a familiar sight.

Members of the Hymenoptera (excluding families Apidae (bees), Vespidae (wasps), and Formicidae (ants) are commonly parasitoids, meaning they lay their eggs in the host bodies of others insects, eventually resulting in the death of those organisms. Commonly, parasitoid Hymenoptera use Lepidopteran larvae (caterpillars) but may choose beetles, spiders, or other invertebrates also. For this reason, parasitoid larvae are considered generally beneficial, but this depends to some extent on their host of choice. A study in Ireland found that the presence and abundance of parasitoid Hymenoptera was a strong indicator of overall invertebrate diversity (and therefore ecosystem health), due to the presence of a wide variety of hosts being necessary to support several species of parasitoid Hymenoptera (Anderson et al., 2010).

Pollinators are a diverse group of insects whose role in the ecosystem is well understood. Species in this group might include bees, wasps, flies, beetles, or any other species that visits multiple flowers and

spread pollen.[2] A meta-analysis of pollinator studies in US found that visitation rate and crop yield could be strongly tied to the diversity of pollinators on site (Garibaldi, et al., 2014). Although the ecological importance of this is seldom understated, the economic benefits can be enormous as well.

Family Staphylinidae, or rove beetles, are predator species that provide an additional control against pest insect outbreaks (Haggard & Haggard, 2006).

2.3 Agricultural Pests

Agricultural pests are usually well-known and understood by agriculturalists due to their economic impacts. Typically, economic impacts (loss of crop health or productivity) are caused by these pests feeding on crop species or acting as vectors for disease.

Thrips (order Thysanoptera) are very small, slender, four-winged insects that feed on plant leaf tissue, and in some cases, spread disease (Washington State University, 2019).

Larval members of the beetle family Elateridae (click beetles) are commonly called wireworms, due to their slender, hard bodies (Haggard & Haggard, 2006). They live most of their lives under the soil, feeding on the roots of plants. For this reason, the presence of adult click beetles can be an important indicator of their problematic larvae.

A series of other insects are also considered pests for their eating habits, including: aphids, leafhoppers, froghoppers, grasshoppers, and larval members of the order Lepidoptera (caterpillars). Many members from these groups are known to actively feed on living plant tissues, as well as have a tendency to form large colonies if left unchecked.

2.4 Field Margins and Insects

Field margins adjacent to crop fields serve a variety of purposes, but specifically regarding invertebrates, the intended purpose is that they serve as a safe refuge and habitat for beneficial insects, so that the overall ratio of beneficial to pest insects remains balanced, preventing pest outbreaks. A Danish study from 2004 found that mechanical crop field treatments may reduce populations of predator arthropods (spiders, carabid beetles, and rove beetles specifically) by between 25 and 60% either through direct

[2]A group of pollinators not included in our "agriculturally beneficial" category are the Lepidopterans, butterflies and moths. Although the adult members of this insect order certainly spread pollen and therefore ecological and economic yield, the larvae are generally considered agricultural pests due to their vegetarian feeding habits.

mortality or relocation (Thorbek & Bilde, 2004). This reinforces the need for buffer zones that can act as refuge for these beneficial insects.

A study in California focused on field margins with native hedge species and their effectiveness as pollinator habitat. They found that hedgerows were up to seven times better at hosting native pollinators than weedy margins (Morandin & Kremen, 2013). This excellent hosting of native pollinators resulted in the hedgerows becoming population "sources", able to export native bees to the surrounding areas.

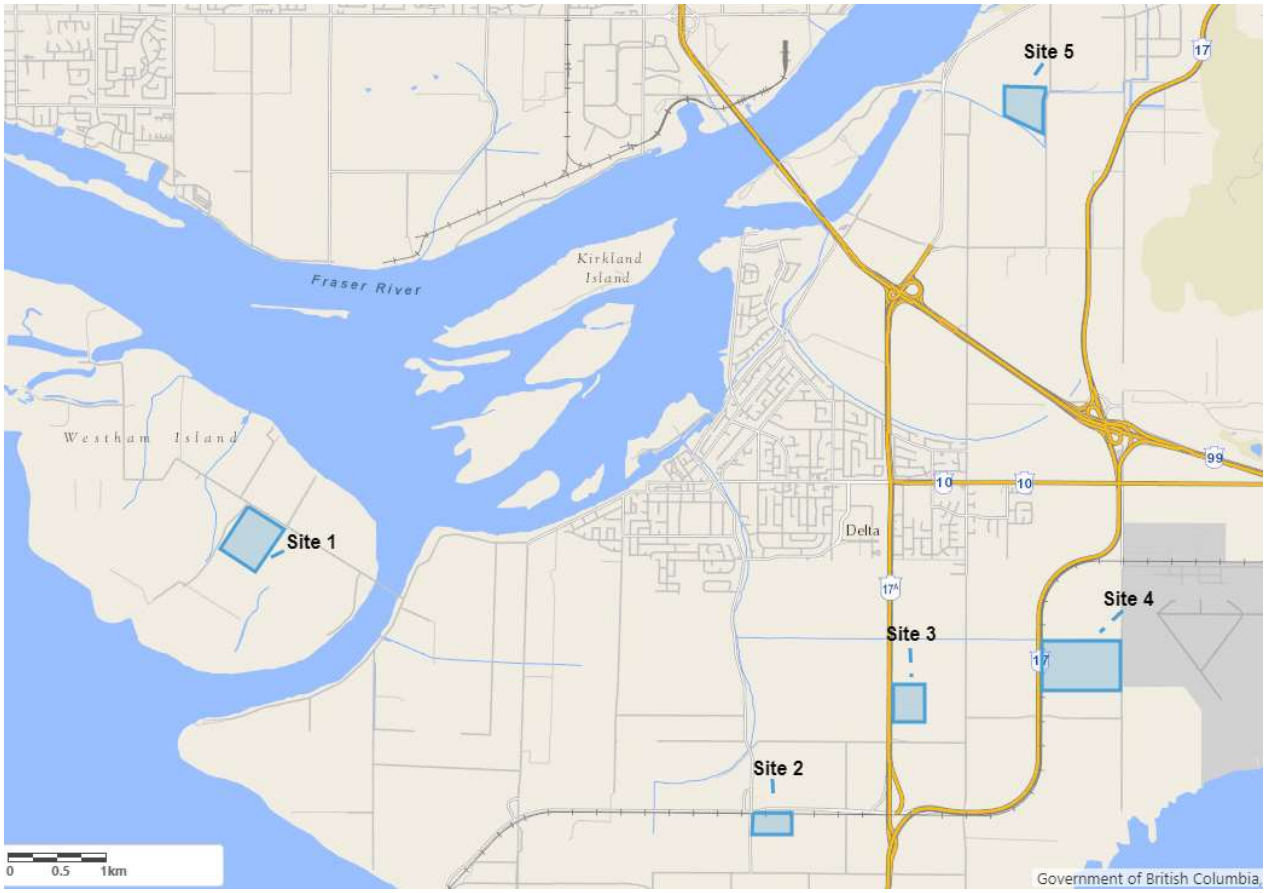
A German study from 2002 found that overall species diversity of invertebrates was higher in field margins compared to the adjacent crop fields (Denys & Tscharntke, 2002). This study also suggests that age of field margins is a factor in positive predator/prey ratios - the diversity/abundance of invertebrates at higher trophic levels (predators) take longer to establish, meaning that mowing of field margins should be avoided.

3 Sampling Methods

3.1 Site Descriptions

All sites were existing participants in the DF&WT Grass Margin Program, and used an organic farming regime. Site selection also attempted to represent the geographic range of Delta to minimize any local geographic effects.

	Site 1	**Site 2**	**Site 3**	**Site 4**	**Site 5**
UTM (Zone 10N)	489690E, 5436935N	494500E, 5433818N	496084E, 5435050N	497806E, 5435285N	497403E, 5441306N
Location	Westham Island	Deltaport Way and 53rd	Adjacent Hwy 17A	Adjacent 72nd Street	North Delta
Crop Type	Corn (Organic)	Corn (Organic)	Grassland Set-aside (Fallow)	Corn (Organic)	Peas (Organic)
Grass Margin Vegetative Species	Assorted Fescues, Common Horsetail, Reed Canary Grass, Orchard Grass	Reed Canary Grass (dominant)	Creeping Fescue (monoculture)	Orchard Grass, Tall Fescue	Reed Canary Grass, Vetch, Pineapple Weed, Common Horsetail
Margin Orientation	North/South	East/West	North/South	East/West	North/South



3.2 Trapping and Sampling Plan

Sampling was conducted using three distinct trapping methods: pitfall traps, windowpane/pan traps, and sweep netting. Trap designs and trapping methods are derived and modified from the standards outlined by the Resource Inventory Standards Committee (Resource Inventory Committee, 1998). These three methods were chosen to represent the broadest range of available taxa within each study area, while being relatively easy to construct with available materials. Pit traps were chosen to capture ground-based taxa. The windowpane/pan combination traps were constructed to both through flight interception and active attraction to their brightly coloured pans. Sweep netting was selected to capture taxa that sat on vegetation or were poor fliers, but did not dwell primarily on the ground.

At each of the five sites studied, sweep netting was conducted in both the grass margin and at a distance 50m from the edge in the interior of the crop. Netting was conducted using 20 sweeps, at approximately 3 seconds per sweep, with a 180° arc, while walking slowly parallel to the orientation of the field margin. Insects were then collected and frozen for later identification.

Pit traps were constructed using red “solo” cups and plywood covers, roughly 20cm square. Windowpane traps were built using wooden stakes, yellow plastic trays, and 30 cm square Plexiglas sheets, suspended between the two stakes to act as flight interception panels. Traps were filled with a 20% propylene glycol solution and left for 72 hours. Multiple sampling periods were conducted between June and August 2019. Both the pitfall traps and windowpane/pan traps were arranged according to the sampling design outlined in Figure 1.

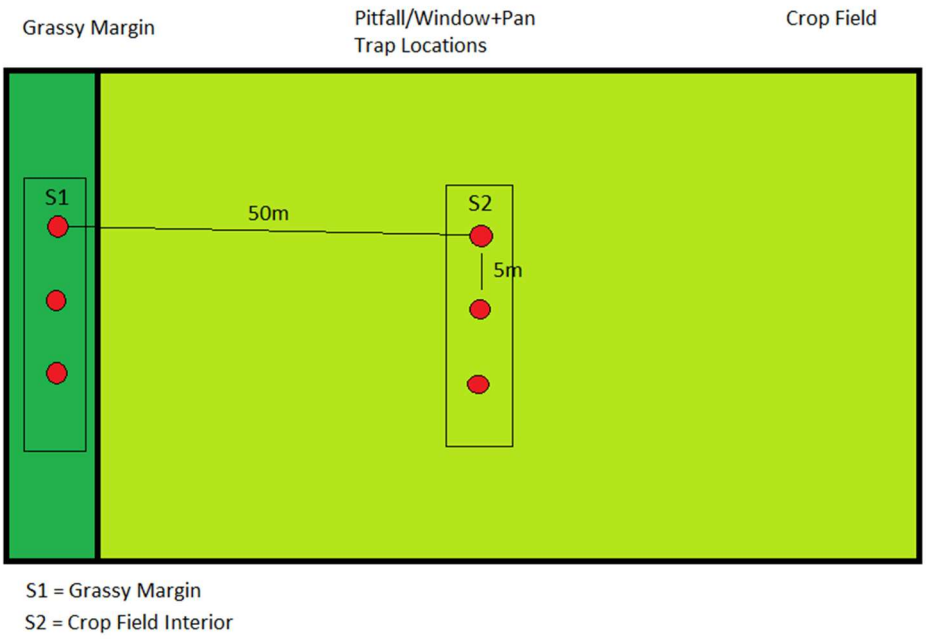


Figure 1 - Sampling Design for Pit/Pan Traps, Invertebrate Community Survey, Delta Farmland and Wildlife Trust, 2019

Data from the pitfall traps and windowpane/pan traps were averaged to provide mean values per trap, e.g.: insects/pitfall trap, members of family Apidae/pan trap.

3.3 Sampling Periods

Sampling Period 1 - June 10 - 13, 2019	Sites 2, 4 not sampled (no field access). No sweep net data.
Sampling Period 2 – June 25 - 28, 2019	Site 2 not sampled (no field access). No sweep net data.
Sampling Period 3 – July 6 - 9, 2019	Site 2 sweep netting conducted only (limited field access).
Sampling Period 4 – July 22 - 25, 2019	
Sampling Period 5 – August 6 - 9, 2019	Sites 1, 3, 5 sweep netting only (to equalize sample size).
Sampling Period 6 – August 13 - 16, 2019	
Sampling Period 7 – August 19, 2019	Sweep net only at all sites (to equalize sample size).

3.4 Means and Analysis

At each site, insects collected from the three pit traps in each stratum were averaged to create a mean insects/trap value. This sampling procedure was repeated every 2 weeks, with some aberrations due to field access challenges. Once the sampling procedure was completed at the end of the summer, the average insect/trap values from each sampling period were averaged again, to provide a temporal average at each site. Finally, data from site within each stratum was averaged again to create a grand mean, and a 95% confidence interval created based on the variability of this final set of data.

Data from the pan traps followed an identical averaging procedure. Data from sweep netting did not require the first step (only one sweep net performed rather than 3 traps) but was otherwise identical.

After collection and entry of data into a spreadsheet, SPSS software was used to conduct a mixed design two-way repeated measures ANOVA for three separate analyses, which consisted of analyzing the change over several summer sampling periods in the total abundance of all invertebrate orders, and testing to attribute those changes to vegetation type, time period, or site specific effects.

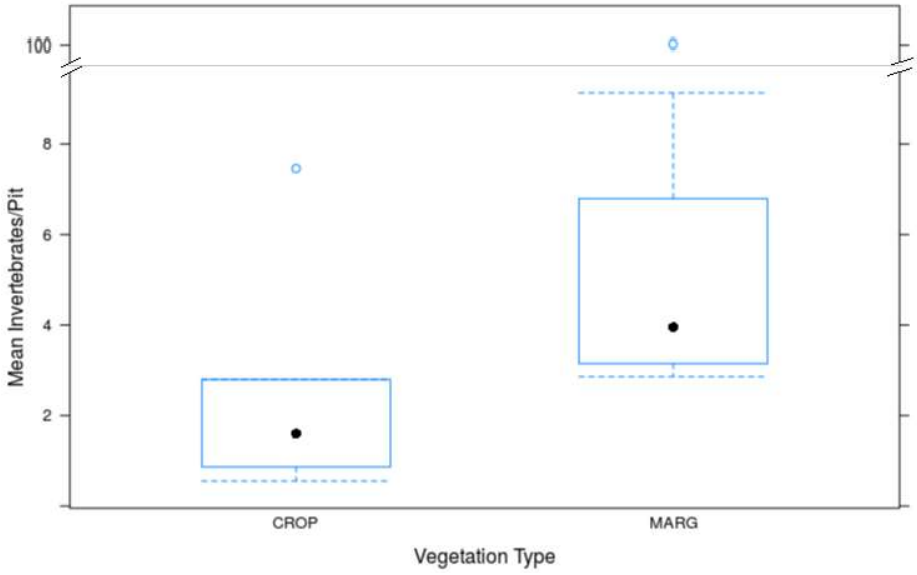
4 Results

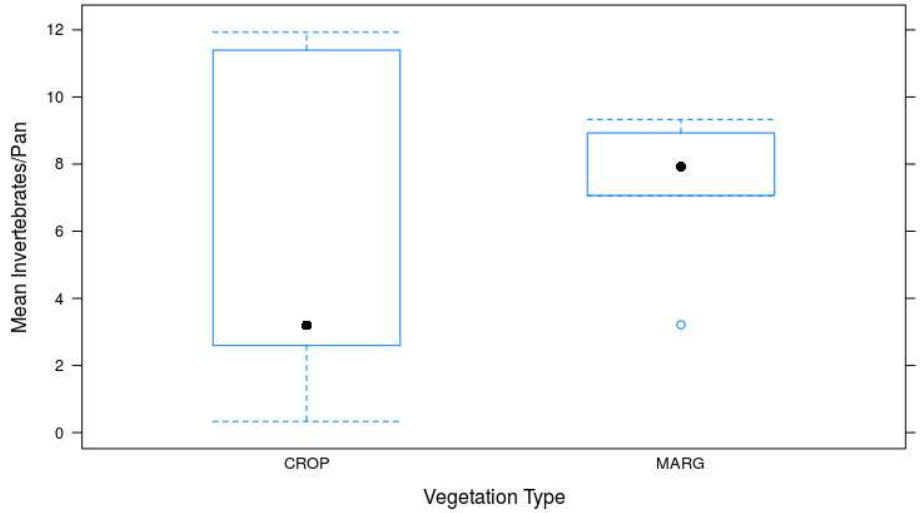
4.1 Summarized Results for Total Invertebrates, Over All Sampling Periods

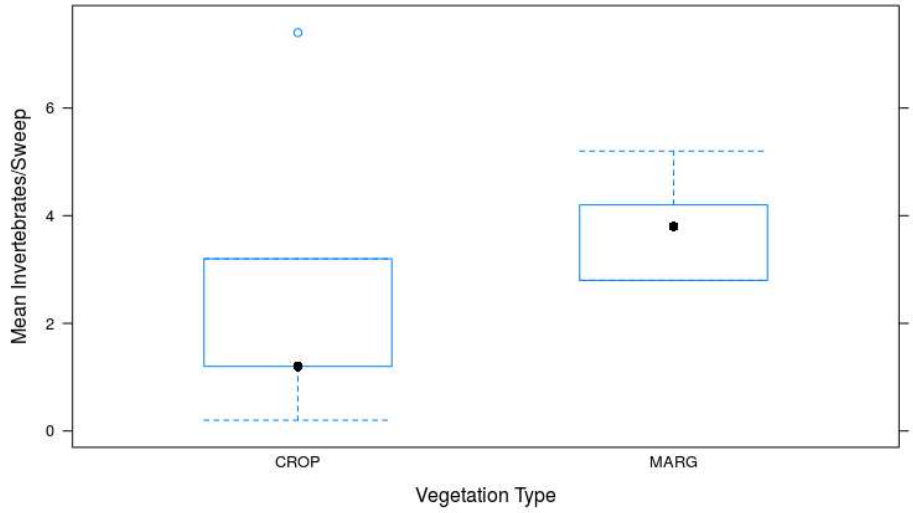
Pit Traps: Mean Total Number of Invertebrates	Crop	Margin
Site 1	0.864	9.130
Site 2	0.553	3.440
Site 3	7.462	100.258
Site 4	1.598	4.462
Site 5	2.798	2.858
Mean w/95% confidence interval	**2.655 ± 2.474**	**24.030 ± 37.415**
Standard Deviation	2.823	42.684

Pan Traps: Mean Total Number of Invertebrates	Crop	Margin
Site 1	3.196	7.930
Site 2	0.333	3.213
Site 3	11.928	9.332
Site 4	2.594	7.062
Site 5	11.394	8.930
Mean w/95% confidence interval	**5.889 ± 4.715**	**7.293 ± 2.145**
Standard Deviation	5.380	2.445

Sweep Netting: Mean Total Number of Invertebrates	Crop	Margin
Site 1	1.2	2.8
Site 2	0.2	2.8
Site 3	7.4	4.2
Site 4	1.2	5.2
Site 5	3.2	3.8
Mean w/95% confidence interval	**2.64 ± 2.52**	**3.76 ± 0.89**
Standard Deviation	2.875	1.014


100
8
6
4
2
Mean Invertebrates/Pit
CROP
MARG
Vegetation Type


12
10
8
6
4
2
0
Mean Invertebrates/Pan
CROP
MARG
Vegetation Type


6
4
2
0
Mean Invertebrates/Sweep
CROP
MARG
Vegetation Type

4.2 Summarized Results By Order (or Class)

Means followed by (Standard Deviation)

Pit Traps: Mean Number of Invertebrates by Order	Crop Mean (SD)	Margin Mean (SD)
Acari (subclass, Mites and Ticks)	0.000	0.013 (0.030)
Areneae (Spiders)	0.302 (0.274)	0.635 (0.441)
Coleoptera (Beetles)	1.533 (2.440)	1.785 (0.893)
Diptera (Flies)	0.253 (0.300)	0.160 (0.248)
Hemiptera (True Bugs)	0.093 (0.138)	0.492 (0.423)
Hymenoptera (Bees, Wasps, Ants)	0.253 (0.263)	17.923 (36.807)
Isopoda (Class, Wood Lice)	0.040 (0.036)	2.841 (5.538)
Lepidoptera (Butterflies and Moths)	0.026 (0.059)	0.053 (0.087)
Polydesmida (Class, Millipedes)	0.000	0.013 (0.030)
Stylommatophora (Snails, Slugs)	0.000	0.026 (0.036)
Thysanoptera (Thrips)	0.040 (0.060)	0.035 (0.051)
Unclassified	0.013 (0.030)	0.053 (0.087)

Pan Traps: Mean Number of Invertebrates by Order	Crop Mean (SD)	Margin Mean (SD)
Acari (subclass, Mites and Ticks)	0.013 (0.030)	0.000
Areneae (Spiders)	0.053 (0.056)	0.093 (0.111)
Coleoptera (Beetles)	2.025 (2.521)	2.390 (1.649)
Diptera (Flies)	2.435 (2.592)	2.850 (1.599)
Hemiptera (True Bugs)	0.212 (0.237)	0.253 (0.109)
Hymenoptera (Bees, Wasps, Ants)	0.880 (1.080)	1.309 (0.699)
Isopoda (Class, Wood Lice)	0.000	0.040 (0.089)
Lepidoptera (Butterflies and Moths)	0.075 (0.069)	0.093 (0.101)
Polydesmida (Class, Millipedes)	0.000	0.000
Stylommatophora (Snails, Slugs)	0.000	0.000
Thysanoptera (Thrips)	0.178 (0.140)	0.254 (0.314)
Unclassified	0.000	0.013 (0.030)

Sweep Netting: Mean Number of Invertebrates by Order	Crop Mean (SD)	Margin Mean (SD)
Acari (subclass, Mites and Ticks)	0.000	0.000
Areneae (Spiders)	0.000	0.040 (0.089)
Coleoptera (Beetles)	0.600 (1.020)	2.080 (1.254)
Diptera (Flies)	0.520 (0.642)	0.120 (0.179)
Hemiptera (True Bugs)	0.920 (1.188)	1.000 (0.707)
Hymenoptera (Bees, Wasps, Ants)	0.080 (0.179)	0.120 (0.110)
Isopoda (Class, Wood Lice)	0.000	0.000
Lepidoptera (Butterflies and Moths)	0.440 (0.876)	0.240 (0.261)
Polydesmida (Class, Millipedes)	0.000	0.000
Stylommatophora (Snails, Slugs)	0.000	0.000
Thysanoptera (Thrips)	0.000	0.080 (0.179)
Unclassified	0.040 (0.089)	0.000

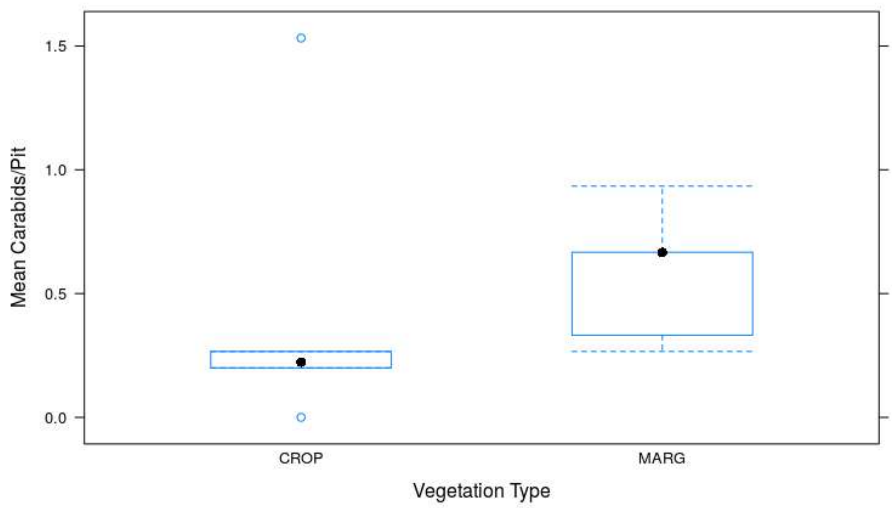
4.3 Selected Results by Family (or Order)

Results displayed selectively due to the relative agricultural importance of the following invertebrate groups, either as beneficial insects or pests. Results are only presented from trap type if likely to capture those taxa; for example, data for carabid beetles is only presented from pit traps (as they were not captured in pan traps or sweep nets).

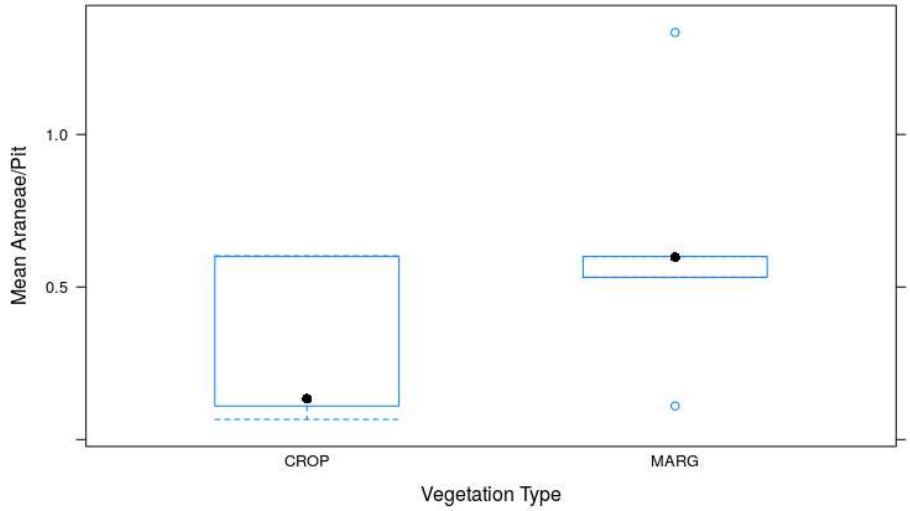
Results were selected and presented if:

a) Significant numbers of a family were captured in at least one vegetation type
b) Members of that family have known roles in agriculture as beneficial insects or pest insects.

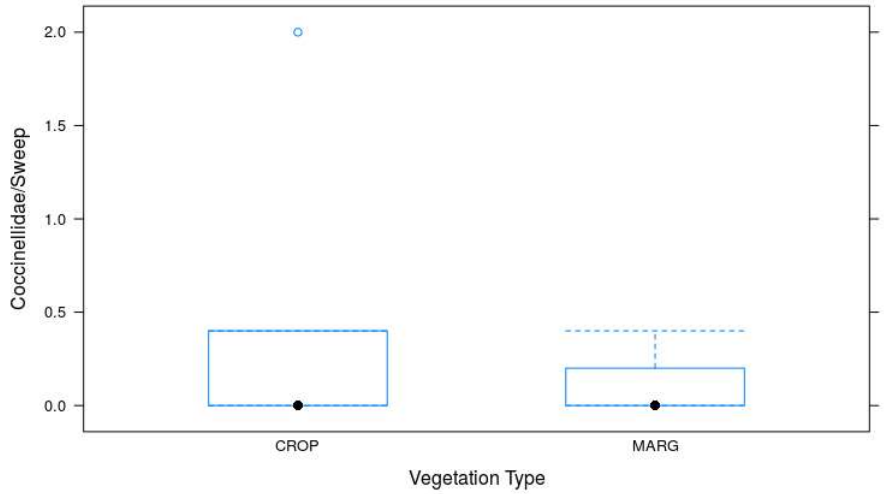
Family Carabidae (Carabid Beetles, beneficial)



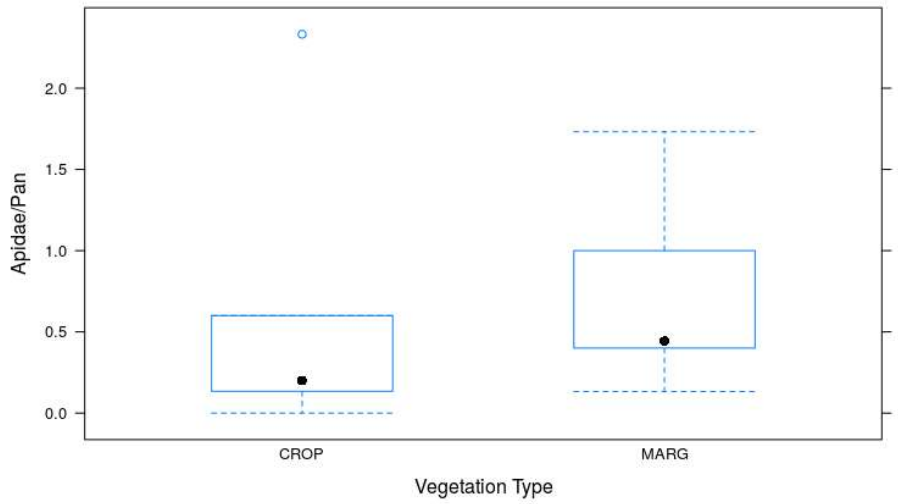
Order Araneae (Spiders, beneficial)



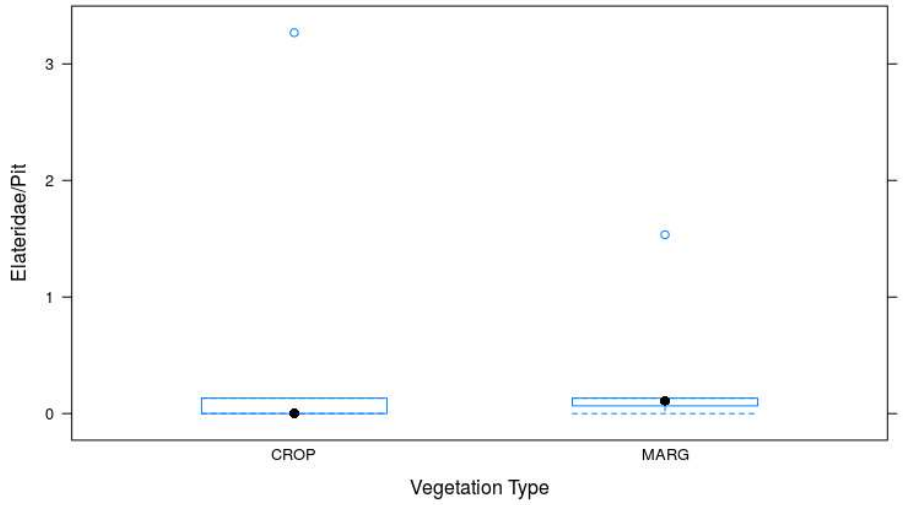
Family Coccinellidae (Lady Beetles, beneficial)



Family Apidae (Bees, beneficial)



Family Elateridae (Click Beetles, pests)



5 Analysis

5.1 Total Invertebrates by Trap Type

Data were analyzed using a mixed design two-way ANOVA with repeated measures (α = 0.05) Likely due to the small sample size and large variability of the data, this set of statistical testing was unable to detect any significant differences between vegetation types.

5.1.1 Pit Data (Total Invertebrates)

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	10470.078	1	10470.078	1.852	.222	.236
VegType	6758.180	1	6758.180	1.195	**.316**	.166
Error	33921.299	6	5653.550			

5.1.2 Pan Data (Total Invertebrates)

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	2175.229	1	2175.229	24.980	.001	.757
VegType	24.992	1	24.992	.287	**.607**	.035
Error	696.625	8	87.078			

5.1.3 Sweep Data (Total Invertebrates)

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	512.000	1	512.000	22.031	.002	.734
VegType	15.680	1	15.680	.675	**.435**	.078
Error	185.920	8	23.240			

6 Discussion

6.1 Total Invertebrates

All three trapping methods (pit, pan, and sweep net) showed a greater relative abundance of total invertebrates in the grass margins as compared to the crop fields. However, small sample size and large variability within groups preclude definitively attributing this effect to vegetation type, as well as creating fairly large confidence limits surrounding our estimate of means.

Multiple factors can be credited with the large amount of variability within groups. The grass margin at Site 3 had an unusual soil substrate, consisting partially of decomposing wood and a porous structure. For this reason, pit traps at this site intermittently trap enormous quantities of order Isopoda (wood lice) and family Formicidae (ants), depending on the micro site the pit trap was placed in.

Sites 1, 2, and 4 were all corn crop fields, and had consistently lower invertebrate diversity and abundance than their counterpart fields at site 3 (grassland set-aside) and site 5 (pea crop). Site 3 often had similar or higher amounts of insect abundance when compared with its adjacent grass margin, and this effect became more pronounced later in the growing season as various plant species began to grow tall, diversify in structure, and flower.

Site 5, the pea crop, had very high levels of insect abundance and diversity while the pea crop flowered and fruited, but these levels dropped precipitously after harvest in late July. The adjacent grass margin did not see an increase in insect abundance at this time, suggesting insects from the crop field either were destroyed during harvest or relocated elsewhere. In any case, they did not use the grass margin as new habitat or shelter.

6.2 Invertebrates by Order

11 unique invertebrate orders were detected by the survey. Of these, nearly all had higher abundances in the grass margins than the adjacent crop fields. Exceptions include slightly higher levels in crop fields of orders Diptera (flies) and Thysanoptera (thrips) as detected by the pit traps, and slightly higher levels of Diptera (flies) and Lepidoptera (butterflies and moths) as detected by the sweep net. The higher levels of a very select group of orders in the crop fields indicate not only lower abundance of total invertebrates in the crop fields, but also a loss in diversity.

6.3 Invertebrates by Family

Most invertebrates were not identified to the level of family, and of the taxa that were, few had enough discrete individuals to provide meaningful comparisons between crop fields and grass margins. Exceptions to this include families Carabidae (carabid beetles) and order Araneae (spiders), both of which have known agricultural benefits as predators and showed apparent trends towards higher abundance in the grass margins. Members of family Apidae (bees) may have a higher abundance in grass margins as compared to crop fields, though the effect is smaller and somewhat more variable. Members of family Coccinellidae (lady beetles) and Elateridae (click beetles) did not show a preference between crop fields and grass margins.

6.4 Survey Limitations

Although there are identifiable trends towards higher abundance and diversity of invertebrates of various taxa in grass margins when compared to crop fields, the small sample size and survey length make statistical support of these trends unlikely.

All crop fields selected were under an organic growing regime; it is not clear that any trends identified by this survey extend to a traditional agricultural regime. Similarly, since only corn, pea, and grassland set-aside crop types were selected for study inclusion, conclusions may not extend to other local crop types (blueberry and potato, to give local examples).

Although the trapping methods used were intended to capture as many available taxa on site as possible, some taxa were present on site but never captured in any of the trap types. For example, members of orders Orthoptera (grasshoppers) and Odonata (dragonflies) were anecdotally observed at various sites, but never captured. It is possible that there were other taxa present but not successfully captured as well.

Regarding identification – I am reasonably confident that identification to the Order level was largely correct, but especially at the Family level, there may have been errors of inexperience. For this reason, conclusions found in this report should be taken as a guide to general trends in invertebrate abundance and diversity, rather than a precise estimation of “true levels” or means.

Finally, although this report does identify several trends in invertebrate abundance and diversity, it makes no attempt to qualify the biological significance of those results, as they are beyond its scope and

my experience level. For example, members of order Araneae (spiders) were caught in pit traps at roughly twice the rate in grass margins as compared to crop fields (roughly 0.6/trap vs 0.3/trap). This result may or may not represent a biologically significant change that would reduce pest insect populations or provide significant food sources for birds or small mammals.

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Appendix A – Materials List

This list contains (to the author's recollection) a complete list of materials, supplies, and tools required to undertake a similar or identical survey.

~60 wooden stakes, pre-installed with hooks for plexiglass and trays

~30 plexiglass sheets

~30 plastic trays, yellow

Spare box of metal hooks

Several hundred zip-ties

Several hundred coffee filters

Several hundred Ziploc bags

6-10 L Propylene Glycol

4L water jugs, for premixing propylene glycol/water solution at 1:4 ratio.

~30 red solo cups or similar

~30 wooden covers, with feet and chicken wire pre-attached

1x pair good scissors or wire-cutters

1x Sharpie

1x tree-planting shovel or similar

1x small fish-tank cleaning net or similar

1x miniature sledgehammer or mallet

1x large bug-catching net

Small plastic cups/containers with lids for sample storage

**A note on repairs – several stakes have had their metal hooks broken or bent, and need to be replaced. Several yellow plastic trays need holes drilled in them for hooks.

Appendix B – Recommendations List

1) Future summer internships running the same study should take place June-August instead of May-July; difficulties surrounding planting and mechanical weeding schedules caused unexpected delays.
2) Take an inventory of current available supplies, calculate required supplies based on study design, and purchase materials before starting the survey
3) For data comparison purposes, if future surveys wish to better answer the same question, a similar study design should be followed.
4) However, there are several shortcomings of the current design that (with good scientific rationale) a future technician might wish to explore, notably:
    a. The addition of a control crop field that does not have a field margin, to better understand dispersal and range of certain invertebrate types. For example, the current study does not address whether having a grass margin attached to a crop field results in increased pollination when compared to crop fields without grass margins.
    b. Surveys that explored hedgerows with woody vegetation as opposed to grass margins only might capture additional taxa.
    c. The "broad" approach of the current survey (several trap types that attempt to capture the widest range of invertebrate possible) means that no taxa is specifically targeted, and therefore, not sampled at maximum efficiency. For example, order Lepidoptera is often best sampled at night with light-based traps, which the current study entirely omits. A future technician might decide that a desired approach would be to pick 1 or 2 insect orders of interest and specifically sample for those with pheromone or other targeted traps. This might yield results of more ecological or agricultural interest than the broad invertebrate abundance/diversity focus of the current study.

Appendix C – Results and Data Analysis with Site 3 (GLSA) omitted as outlier

As the vegetation in the field interior of Site 3 was substantially different than at any other crop field in the study (consisting primarily of set-aside vegetation rather than agricultural crops) results for total invertebrates presented here with Site 3 omitted, followed by a reanalysis of the data in SPSS.

Pit Traps: Mean Total Number of Invertebrates	**Crop**	**Margin**
Site 1	0.864	9.130
Site 2	0.553	3.440
~~Site 3~~	~~7.462~~	~~100.258~~
Site 4	1.598	4.462
Site 5	2.798	2.858
Mean w/95% confidence interval (Site 3 excluded)	**1.453 ± 0.978**	**4.972 ± 2.793**
Standard Deviation	0.998	2.850

Pan Traps: Mean Total Number of Invertebrates	**Crop**	**Margin**
Site 1	3.196	7.930
Site 2	0.333	3.213
~~Site 3~~	~~11.928~~	~~9.332~~
Site 4	2.594	7.062
Site 5	11.394	8.930
Mean w/95% confidence interval (Site 3 excluded)	**4.379 ± 4.739**	**6.784 ± 2.450**
Standard Deviation	4.836	2.500

Sweep Netting: Mean Total Number of Invertebrates	**Crop**	**Margin**
Site 1	1.2	2.8
Site 2	0.2	2.8
~~Site 3~~	~~7.4~~	~~4.2~~
Site 4	1.2	5.2
Site 5	3.2	3.8
Mean w/95% confidence interval (Site 3 excluded)	**1.45 ± 1.23**	**3.65 ± 1.11**
Standard Deviation	1.258	1.136

Omitting Site 3 produces slightly lower p-values, indicative of a "stronger" effect correlated with the vegetation type variable. In particular, the net data produces a marginally statistically significant result using α = 0.05, with a p-value of 0.041. I would caution against putting too much stock in this result, however – it's not clear that this data would meet all of the assumptions required by the ANOVA test, such as normally distributed data. With a sample size of only 4, it's hard to know if the data comes from a normally distributed population.

Pit Data (Total Invertebrates, Site 3 Omitted)

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	392.770	1	392.770	13.579	.021	.772
VegType	104.347	1	104.347	3.607	**.130**	.474
Error	115.700	4	28.925			

Pan Data (Total Invertebrates, Site 3 Omitted)

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	1408.086	1	1408.086	22.492	.009	.849
VegType	37.834	1	37.834	.604	**.480**	.131
Error	250.421	4	62.605			

Net Data (Total Invertebrates, Site 3 Omitted)

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	260.100	1	260.100	36.209	.001	.858
VegType	48.400	1	48.400	6.738	**.041****	.529
Error	43.100	6	7.183			

Appendix D: Summary Data

PIT DATA (Total Invertebrates)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0.66	14.34	N/A	N/A	3.67	232.66	N/A	N/A	1.67	4.32
Sampling Period 2	0.33	8.99	N/A	N/A	2.65	8.33	3.34	5.67	4	2.99
Sampling Period 3	3.33	6.67	N/A	N/A	8.66	172.96	3.66	2.32	6.32	3.99
Sampling Period 4	0	12.99	0.67	7.33	16	80.68	0.66	6	2	2.66
Sampling Period 5	N/A	N/A	0.99	1	N/A	N/A	0	3.66	N/A	N/A
Sampling Period 6	0	2.66	0	1.99	6.33	6.66	0.33	4.66	0	0.33
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.864	9.130	0.5533333333	3.440	7.462	100.258	1.598	4.462	2.798	2.858
PAN DATA (Total Invertebrates)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	10.33	12.33	N/A	N/A	12.32	12.66	N/A	N/A	17.66	13.33
Sampling Period 2	2.99	9	N/A	N/A	3.67	1.33	4.32	4.33	11.99	5.33
Sampling Period 3	1	5.99	N/A	N/A	14.99	10.34	1.33	7.33	9.32	6
Sampling Period 4	0.99	5.33	0.33	3.66	4.67	9	0.33	6	14	7.66
Sampling Period 5	N/A	N/A	0.67	4.66	N/A	N/A	1.66	10.33	N/A	N/A
Sampling Period 6	0.67	7	0	1.32	23.99	13.33	5.33	7.32	4	12.33
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	3.196	7.93	0.3333333333	3.213333333	11.928	9.332	2.594	7.062	11.394	8.93

NET DATA (Total Invertebrates)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	2	0	2	3	3	0	0	12	0
Sampling Period 4	0	3	0	1	3	2	3	10	2	6
Sampling Period 5	3	4	0	2	14	6	1	9	0	1
Sampling Period 6	2	4	0	2	9	3	0	7	2	6
Sampling Period 7	1	1	1	7	8	7	2	0	0	6
Period Mean	1.2	2.8	0.2	2.8	7.4	4.2	1.2	5.2	3.2	3.8
PIT DATA (Carabids)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	1.33	0.67	N/A	N/A	0.67	1
Sampling Period 2	0	0	N/A	N/A	0.33	0.33	0	0.67	0	1.33
Sampling Period 3	0	0.33	N/A	N/A	6	3	1	0.33	0.33	1
Sampling Period 4	0	1.33	0.67	2	0	0.67	0	0	0.33	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0	0	0.33	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0.332	0.2233333333	0.667	1.532	0.934	0.2	0.266	0.266	0.666

PIT DATA (Araneae)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	1.67	N/A	N/A	0.67	2.33	N/A	N/A	0.67	1.33
Sampling Period 2	0	2	N/A	N/A	0	0.33	1.67	1.33	0.67	0
Sampling Period 3	0.33	2	N/A	N/A	0	0.33	1	0	1	1.33
Sampling Period 4	0	1	0	0	0	0	0.33	1	0.67	0
Sampling Period 5	N/A	N/A	0.33	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0.33	0	0	0	0.67	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.066	1.334	0.11	0.110	0.134	0.598	0.6	0.6	0.602	0.532
Pan Data (Coccinellidae)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0.33	0	N/A	N/A	0.33	0	N/A	N/A	0.33	0
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 3	0	0	N/A	N/A	0.33	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0.33
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0.67	0	0.33	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.066	0	0	0	0.132	0.134	0	0.066	0.066	0.066

Net Data (Coccinellidae)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	1	0	0	0	2	2	0	0	0	0
Sampling Period 6	0	0	0	0	4	0	0	0	0	0
Sampling Period 7	1	0	0	1	4	0	0	0	0	0
Period Mean	0.4	0	0	0.2	2	0.4	0	0	0	0
Pan Data (Apidae)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0.67	0	N/A	N/A	0.33	1.33	N/A	N/A	4	1
Sampling Period 2	0	0	N/A	N/A	0.67	0.33	1	0	2.33	1.33
Sampling Period 3	0	0.33	N/A	N/A	0.67	2.67	0	0	5.33	1.67
Sampling Period 4	0	0.33	0	1.33	1	3	0	1	0	1
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0.67	N/A	N/A
Sampling Period 6	0	0	0	0	0.33	1.33	0	0.33	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.134	0.132	0	0.4433333333	0.6	1.732	0.2	0.4	2.332	1

PIT DATA (Elateridae)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	1	0.33	N/A	N/A	0.33	0
Sampling Period 2	0	0.33	N/A	N/A	0	0	0	0	0	0
Sampling Period 3	0	0	N/A	N/A	0	0	0	0.33	0.33	0
Sampling Period 4	0	0	0	0	11.67	3.67	0	0	0	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0.33	3.67	3.67	0	0.33	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0.066	0	0.110	3.268	1.534	0	0.132	0.132	0
Net Data (Aphididae)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	0	0	0	0	11	0
Sampling Period 4	0	0	0	1	0	0	1	0	1	1
Sampling Period 5	1	0	0	0	0	0	0	0	0	0
Sampling Period 6	0	0	0	0	0	0	0	0	1	0
Sampling Period 7	0	0	1	0	0	0	0	0	0	0
Period Mean	0.2	0	0.2	0.2	0	0	0.2	0	2.6	0.2

PIT DATA (Areneae)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	1.67	N/A	N/A	0.67	2.33	N/A	N/A	0.67	1.33
Sampling Period 2	0	2	N/A	N/A	0	0.33	1.67	1.33	0.67	0
Sampling Period 3	0.33	2	N/A	N/A	0	0.33	1	0	1	1.33
Sampling Period 4	0	1	0	0	0	0	0.33	1	0.67	0
Sampling Period 5	N/A	N/A	0.33	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0.33	0	0	0	0.67	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.066	1.334	0.11	0.110	0.134	0.598	0.6	0.6	0.602	0.532
PAN DATA (Areneae)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0.67	0	N/A	N/A	0	0.33
Sampling Period 2	0	0	N/A	N/A	0	0	0.33	0	0	0.33
Sampling Period 3	0	0	N/A	N/A	0	0	0	0	0.33	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	1.33	N/A	N/A
Sampling Period 6	0	0.33	0	0	0	0	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0.066	0	0	0.134	0	0.066	0.266	0.066	0.132

NET DATA (Areneae)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	0	0	0	0	0	0	0	0	0	0
Sampling Period 6	0	0	0	0	0	0	0	1	0	0
Sampling Period 7	0	0	0	0	0	0	0	0	0	0
Period Mean	0	0	0	0	0	0	0	0.2	0	0
PIT DATA (Coleoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	5	N/A	N/A	2.33	1.33	N/A	N/A	1	1
Sampling Period 2	0	3.99	N/A	N/A	1.33	0.33	0	1.67	0.33	2
Sampling Period 3	1	2	N/A	N/A	7.67	4	1.33	0.99	2.66	1.33
Sampling Period 4	0	1.33	0.67	2.67	14.34	5.34	0.33	0.67	0.66	1.33
Sampling Period 5	N/A	N/A	0.33	0	N/A	N/A	0	0.33	N/A	N/A
Sampling Period 6	0	0	0	1.33	3.67	4	0	1.33	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.2	2.464	0.3333333333	1.333	5.868	3	0.332	0.998	0.93	1.132

PAN DATA (Coleoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0.99	3	N/A	N/A	2.66	4	N/A	N/A	10.33	8.33
Sampling Period 2	0	0.33	N/A	N/A	0	0	0.33	0.66	7	1.67
Sampling Period 3	0.67	5.33	N/A	N/A	9.66	7	1.33	1.67	0.33	1
Sampling Period 4	0.33	1.33	0	1	1	2.67	0	1	8	3.33
Sampling Period 5	N/A	N/A	0	1.33	N/A	N/A	0	0.33	N/A	N/A
Sampling Period 6	0	1	0	0.33	2.67	2.67	1.33	0.66	4	9.33
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.398	2.198	0	0.8866666667	3.198	3.268	0.598	0.864	5.932	4.732
NET DATA (Coleoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	1	0	0	0	0	0	0	0	0
Sampling Period 4	0	3	0	0	1	2	0	9	0	3
Sampling Period 5	1	0	0	0	3	2	0	6	0	0
Sampling Period 6	0	3	0	2	4	0	0	5	0	6
Sampling Period 7	1	0	0	6	4	0	1	0	0	4
Period Mean	0.4	1.4	0	1.6	2.4	0.8	0.2	4	0	2.6

PIT DATA (Diptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0.33	3	N/A	N/A	0.67	0	N/A	N/A	0	0
Sampling Period 2	0.33	0	N/A	N/A	0.33	0	0	0	2.67	0
Sampling Period 3	0	0	N/A	N/A	0.33	0	0	0.33	0	0
Sampling Period 4	0	0	0	0	1	0	0	0	0.67	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0.33	0	0	0	0.33
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.132	0.600	0	0.000	0.466	0.066	0	0.066	0.668	0.066
PAN DATA (Diptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	7.67	8.67	N/A	N/A	7.33	6	N/A	N/A	2.67	0.67
Sampling Period 2	2.33	7.67	N/A	N/A	2.33	0	2.33	2	0	0.67
Sampling Period 3	0	0	N/A	N/A	3.67	0.67	0	4	2	1.67
Sampling Period 4	0.33	2.67	0.33	1	2.67	2.67	0.33	3.67	3.33	1.67
Sampling Period 5	N/A	N/A	0	2	N/A	N/A	1.33	7.67	N/A	N/A
Sampling Period 6	0.67	4	0	0.33	18.33	8	3	2	0	1.33
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	2.2	4.602	0.11	1.11	6.866	3.468	1.398	3.868	1.6	1.202

NET DATA (Diptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	3	0	0	0	1	0
Sampling Period 4	0	0	0	0	0	0	2	0	0	0
Sampling Period 5	0	0	0	0	1	1	0	1	0	0
Sampling Period 6	1	0	0	0	2	0	0	0	0	0
Sampling Period 7	0	0	0	0	2	1	1	0	0	0
Period Mean	0.2	0	0	0	1.6	0.4	0.6	0.2	0.2	0
PIT DATA (Hemiptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0	0	N/A	N/A	0	0
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0	0.33
Sampling Period 3	0	0	N/A	N/A	0	0.33	0.33	0.33	1.66	0.33
Sampling Period 4	0	1.33	0	1.66	0	0	0	4	0	0.33
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0.33	N/A	N/A
Sampling Period 6	0	0.67	0	0.33	0.33	0	0	1	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0.400	0	0.663	0.066	0.066	0.066	1.132	0.332	0.198

PAN DATA (Hemiptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0.33	N/A	N/A	0	0	N/A	N/A	0.33	0
Sampling Period 2	0	0	N/A	N/A	0	0	0	0.33	1	1
Sampling Period 3	0	0.33	N/A	N/A	0.66	0	0	0.67	1.33	0.66
Sampling Period 4	0.33	0	0	0	0	0	0	0	0	0.33
Sampling Period 5	N/A	N/A	0	1	N/A	N/A	0.33	0	N/A	N/A
Sampling Period 6	0	0	0	0	1.33	1	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.066	0.132	0	0.3333333333	0.398	0.2	0.066	0.2	0.532	0.398
NET DATA (Hemiptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	1	0	0	0	0	0	0	11	0
Sampling Period 4	0	0	0	1	2	0	1	1	2	2
Sampling Period 5	1	4	0	0	1	2	0	1	0	0
Sampling Period 6	0	0	0	0	3	3	0	1	1	0
Sampling Period 7	0	0	0	1	1	6	0	0	0	2
Period Mean	0.2	1	0	0.4	1.4	2.2	0.2	0.6	2.8	0.8

PIT DATA (Hymenoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	2	N/A	N/A	0	174.67	N/A	N/A	0	0.33
Sampling Period 2	0	2.33	N/A	N/A	0.66	2.67	0	0	0	0.33
Sampling Period 3	1.67	2.67	N/A	N/A	0.33	167.3	0	0	1	0
Sampling Period 4	0	9.33	0	3	0.33	72.67	0	0.33	0	0.67
Sampling Period 5	N/A	N/A	0	0.67	N/A	N/A	0	2.33	N/A	N/A
Sampling Period 6	0	1.33	0	0	2	1.33	0.33	1.66	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.334	3.532	0	1.223	0.664	83.728	0.066	0.864	0.2	0.266
PAN DATA (Hymenoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	1.67	0.33	N/A	N/A	1.33	1.66	N/A	N/A	4	4
Sampling Period 2	0.33	0	N/A	N/A	0.67	0.33	1.33	0	3.66	1.66
Sampling Period 3	0	0.33	N/A	N/A	0.67	2.67	0	0.33	5.33	2.34
Sampling Period 4	0	1.33	0	1.66	1	3.33	0	1	0.67	2
Sampling Period 5	N/A	N/A	0	0.33	N/A	N/A	0	1	N/A	N/A
Sampling Period 6	0	1.67	0	0.66	0.66	1.66	0.67	1.66	0	1
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.4	0.732	0	0.8833333333	0.866	1.93	0.4	0.798	2.732	2.2

NET DATA (Hymenoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	1
Sampling Period 5	1	0	0	0	0	1	0	1	0	0
Sampling Period 6	1	0	0	0	0	0	0	0	0	0
Sampling Period 7	0	0	0	0	0	0	0	0	0	0
Period Mean	0.4	0	0	0	0	0.2	0	0.2	0	0.2
PIT DATA (Isopoda)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0.67	N/A	N/A	0	54.33	N/A	N/A	0	1
Sampling Period 2	0	0.67	N/A	N/A	0	5	0	2.67	0	0
Sampling Period 3	0.33	0	N/A	N/A	0	1	0.33	0.67	0	0.67
Sampling Period 4	0	0	0	0	0	2.67	0	0	0	0.33
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0.67	N/A	N/A
Sampling Period 6	0	0	0	0	0.33	0.67	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.066	0.268	0	0.000	0.066	12.734	0.066	0.802	0	0.4

PAN DATA (Isopoda)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0	1	N/A	N/A	0	0
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 3	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0	0	0	0	0.2	0	0	0	0
NET DATA (Isopoda)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	0	0	0	0	0	0	0	0	0	0
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	0	0	0	0	0	0	0	0	0	0
Period Mean	0	0	0	0	0	0	0	0	0	0

PIT DATA (Lepidoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	1	N/A	N/A	0	0	N/A	N/A	0	0
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 3	0	0	N/A	N/A	0.33	0	0	0	0	0
Sampling Period 4	0	0	0	0	0.33	0	0	0	0	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0.33	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0.200	0	0.000	0.132	0.066	0	0	0	0
PAN DATA (Lepidoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0.33	0	N/A	N/A	0.33	0
Sampling Period 2	0	0.33	N/A	N/A	0	0.33	0	0.67	0.33	0
Sampling Period 3	0	0	N/A	N/A	0.33	0	0	0.33	0	0
Sampling Period 4	0	0	0	0	0	0	0	0.33	0	0.33
Sampling Period 5	N/A	N/A	0.33	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0.066	0.11	0	0.132	0.066	0	0.266	0.132	0.066

NET DATA (Lepidoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	0	3	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	0	1	0	0	9	0	1	0	0	1
Sampling Period 6	0	1	0	0	0	0	0	0	0	0
Sampling Period 7	0	0	0	0	1	0	0	0	0	0
Period Mean	0	0.4	0	0	2	0.6	0.2	0	0	0.2
PIT DATA (Polydesmida)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0	0	N/A	N/A	0	0
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 3	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0.33	0	0	0	0	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0.066	0	0.000	0	0	0	0	0	0

PAN DATA (Polydesmida)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0	0	N/A	N/A	0	0
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 3	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0	0	0	0	0	0	0	0	0
NET DATA (Polydesmida)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	0	0	0	0	0	0	0	0	0	0
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	0	0	0	0	0	0	0	0	0	0
Period Mean	0	0	0	0	0	0	0	0	0	0

PIT DATA (Stylommatophora)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0	0	N/A	N/A	0	0.33
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 3	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0.33	0	0	0	0	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0.066	0	0.000	0	0	0	0	0	0.066
PAN DATA (Stylommatophora)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0	0	N/A	N/A	0	0
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 3	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0	0	0	0	0	0	0	0	0

NET DATA (Stylommatophora)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	0	0	0	0	0	0	0	0	0	0
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	0	0	0	0	0	0	0	0	0	0
Period Mean	0	0	0	0	0	0	0	0	0	0
PIT DATA (Thysanoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0	0	N/A	N/A	0	0
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0.33	0.33
Sampling Period 3	0	0	N/A	N/A	0	0	0.67	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	N/A	N/A	0	0.33	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0.000	0	0.110	0	0	0.134	0	0.066	0.066

PAN DATA (Thysanoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0	0	N/A	N/A	0	0
Sampling Period 2	0.33	0.67	N/A	N/A	0.67	0.67	0	0.67	0	0
Sampling Period 3	0	0	N/A	N/A	0	0	0	0.33	0	0.33
Sampling Period 4	0	0	0	0	0	0	0	0	2	0
Sampling Period 5	N/A	N/A	0.67	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0	0.33	3	0	0.67
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.066	0.134	0.2233333333	0	0.134	0.134	0.066	0.8	0.4	0.2
NET DATA (Thysanoptera)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	0	0	0	0	0	0	0	0	0	2
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	0	0	0	0	0	0	0	0	0	0
Period Mean	0	0	0	0	0	0	0	0	0	0.4

PIT DATA (Unclassified)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0.33	1	N/A	N/A	0	0	N/A	N/A	0	0.33
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 3	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0.066	0.200	0	0.000	0	0	0	0	0	0.066
PAN DATA (Unclassified)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	0	0	N/A	N/A	0	0	N/A	N/A	0	0
Sampling Period 2	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 3	0	0	N/A	N/A	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0.33	0	0	0	0
Sampling Period 5	N/A	N/A	0	0	N/A	N/A	0	0	N/A	N/A
Sampling Period 6	0	0	0	0	0	0	0	0	0	0
Sampling Period 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period Mean	0	0	0	0	0	0.066	0	0	0	0

NET DATA (Unclassified)	S1 CROP	S1 MARGIN	S2 CROP	S2 MARGIN	S3 CROP	S3 MARGIN	S4 CROP	S4 MARGIN	S5 CROP	S5 MARGIN
Sampling Period 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sampling Period 3	0	0	0	0	0	0	0	0	0	0
Sampling Period 4	0	0	0	0	0	0	0	0	0	0
Sampling Period 5	0	0	0	0	0	0	0	0	0	0
Sampling Period 6	0	0	0	0	0	0	0	0	1	0
Sampling Period 7	0	0	0	0	0	0	0	0	0	0
Period Mean	0	0	0	0	0	0	0	0	0.2	0