Agricultural Pest Monitoring in Bulkley-Nechako and Fraser-Fort George

Project Report 2023

Acknowledgments

Research partners

This report was produced by Meganne Harrison (a graduate student at the University of Northern British Columbia) as part of a two-year project (2022/2023) in collaboration with farmers and ranchers to monitor and identify pests of concern for the agriculture sector across the Bulkley-Nechako and Fraser-Fort George regions.

Meganne's research is being overseen by Dr. Dezene Huber (University of Northern British Columbia) and Dr. Jasmine Janes (Victoria Island University) with support from Serena Black (BC Forage Council) and a dedicated Project Oversight Committee.

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Executive Summary

Monitoring and identifying insect and spider communities within forage crop fields and adjacent areas is increasingly important as climate change and changing weather patterns have altered the usual geographic ranges of pest species and the timing of insect activity (such as natural enemies of pests) and plant emergence (van Herk et al. 2021; Smith et al. 2012; Thomson et al., 2010).The aim of this project is to identify insect and spider species in forage crops in central British Columbia so previously established and new integrated pest management (IPM) strategies and tactics and new can be used and developed to enhance crop productivity and ecosystem health.

Fourteen forage fields with perennial forage crops – including alfalfa, grasses, and clover – were selected from those provided by volunteers in the producer community, between Dunster and Telkwa. Over 600 hundred samples were collected in 2022 using pitfall traps and sweep net collections. Researchers are currently identifying species and tabulating abundance of each species using previously established guides and DNA-based methods to verify identifications. Over 200 spider web samples were collected during the same period to determine if environmental DNA (eDNA) can be extracted from spider webs to assess arthropod food webs in regional agroecosystems.

Early results indicate that insect and spider diversity is higher on forest-field interfaces (edges) and in adjacent forested areas compared to the crop fields. This is also reflected in the plant diversity at each site. Pests collected in 2022 included, but were not limited to: leafhoppers, click beetles (wireworms), leaf miner flies, and aphids. Few grasshoppers were collected or observed. Grasshoppers have generally been considered one of the primary pest species in forage fields and a second collection in summer 2023 will be required to determine whether or not 2022 represents normal current populations or if there were external factors that decreased grasshopper populations in 2022.

There were several knowledge transfer activities for communication of progress of this project and other pertinent information on pests and beneficial insects and spiders. This included a webinar in April 2022, surveys sent out to producers in March 2022, participation in the Nechako Exhibition in August 2022, and three factsheets and one video prepared for CCAP in Fall/Winter 2023. A Facebook page has been created for this project to update interested producers on the progress of the 2023 season and will launch at the same time as a series of workshops for producers on March 13 -17 in Smithers, Vanderhoof, and Quesnel.

The next steps for this project are to: complete another field season, complete lab-based assessment of 2022/2023 samples, statistically analyze the large data set, present recommendations for producers based on findings, and establish an extension network for the project for future work.

1.0 Introduction

Arthropods found in agricultural ecosystems can financially impact farmers by increasing or decreasing crop yields and can provide various ecosystem services or activities that can be beneficial (Getanjaly et al., 2015) or detrimental (Soroka et al., 2020) to crops. Effects from beneficial arthropods can align with societal values and interests by helping crop heath and increasing yields during harvest. Beneficial arthropods include pollinators that aid in the propagation of crops (Dunn et al., 2020), or predators and parasitoids that prey on pests and thus help control pest populations (Rand, 2017). Predators such as spiders, ground beetles, and rove beetles – or parasitoids such as wasps or true flies – are natural enemies to agricultural pests and help control population of levels of pest species like *Hypera postica* (alfalfa weevil) by consuming them as prey or using them as hosts early in their lifecycle for offspring.

Forage crops in British Columbia (BC), can include *Medicago sativa* (alfalfa), *Trilfolium* sp. (clover), Poaceace (grasses) and various other species which can be damaged by herbivorous insects, delaying growth and reducing biomass (Hutchins et al., 1990). Monitoring and identifying insect and spider communities within forage crop fields and adjacent areas is increasingly important as climate change and changing weather patterns have expanded and altered the usual geographic ranges of pest species (van Herk et al. 2021; Smith et al. 2012) and their natural enemies (Thomson et al., 2010). Therefore, it is becoming more important to consider encouraging communities natural enemies, like parasitoid wasps and predators, as biological controls for agricultural pests as an alternative to broad spectrum pesticides, use of which is increasing globally (Jeschke et al., 2011).

The Bulkley-Nechako and Fraser-Fort George region presents a unique agricultural landscape, but many of the pests and their natural enemies may be similar to those elsewhere. Knowing which species (pest and natural enemies) are present in forage crops in this region will allow testing of specific integrated pest management methods from elsewhere and development of new tactics and strategies. The region's agroecosystems are also unique due to their maintained forest edges, therefore novel arthropod assemblages are anticipated compared to other areas outside of BC with simpler agricultural systems (van Herk et al., 2021). If insect and spider species can be identified, previously established IPM methods and recommendations can be used in conjunction with new strategies to enhance crop productivity and ecosystem health. In addition, monitoring in this region at this time will provide a vital baseline accounting of current insect communities for better monitoring as communities change in the coming years due the rapidly changing climate.

2.0 Objectives and Scope

2.1 Scope

This project is building a baseline inventory of which insect and spider species are currently living in communities in forage crop fields along Highway 16 from Dunster to Telkwa. The overall focus is on pests and their likely natural enemies. Sampling efforts were designed so that we can learn what insect assemblages are present in crops, in adjacent forested areas, and in the interface (edge) between those areas. We also aim to determine how forest and edge communities may affect field assemblages of pests and natural enemies.

We are investigating whether maintaining forested edges can help enhance the presence of the natural enemies of the pest species in nearby fields, and which attributes of the surrounding forest or edge habitats may best contribute to an overall IPM strategy. As this work is being conducted in a rapidly changing global and regional climate, we plan to contextualize the results in terms of which pest and natural enemy species are found in the region and how that may shift in coming years.

Land management to preserve and enhance natural enemy communities has always been important and will become more important in the context of shifting temperature and precipitation patterns and related changes in cropping choices, planting, and harvesting times.

2.2 Objectives

This two-year project will lay the foundation for a pest monitoring network within the Bulkley-Nechako and Fraser-Fort George regions. Pest and beneficial insect and spider species present in and near forage crops within the region will be identified and with this information, region specific recommendations will be developed on how to mitigate crop damage using existing or new land management methods.

3.0 Methods

3.1 Site Selection

Site selection in 2022 was contingent upon producers' participation and research limitations. As researchers worked with producers, sites were selected based upon access, crop types, field size and availability. A balance between research priorities and producer needs was reached during site selection and ultimately 14 sites were selected between Dunster and Telkwa (Figure 1.). Eighteen pitfall traps were installed in each of the 14 locations and were collected repeatedly over the summer. In addition sweep net and vegetation surveys, and spider web collections were completed between May and August 2022 for a total of over 600 samples.

Figure 1. Map of 14 sites selected, which included three in Dunster, three near Prince George, two in Vanderhoof, four in Fraser Lake and two in Telkwa.

3.1.1 GIS Desktop Review

A GIS desktop review was ongoing during site selection as we were limited at the beginning of the season by the number of sites available in each area and where we could set up in the fields. If field locations were known before going out to set up, a GIS review was done to ensure variable forest edge between sites and to determine the best place logistically to access the field and set up. If there were several options in one area or site, the decision was based on the size of field, forest type, and visually assessing the amount of forest edge for the field.

3.1.2 Producer Engagement

Some sites were selected from participants who volunteered with the 2022 Pollinator Project . Producer participation was also solicitated through the BC Forage Council outreach and with surveys from volunteers. Surveys provided information on field locations and crop type, which helped narrow selection. Based on a desktop review, researchers communicated further via phone and on site with producers to determine which fields would be set up for monitoring and if the site was suitable for selection.

3.1.3 Field Selection

Fields were selected based on availability and need. We decided to concentrate on perennial hay crops after consideration of what recommendations producers might find useful. For example, most fields were hay fields (as compared to grazed fields) so yield could be considered and quantified. When possible, a variety of different sized fields and amount of forest edges were selected. When considering placement for trap

set up within a field, consideration was given to avoid areas in the field and in the forest where there was heavy disturbance (roads, trails, etc.) and for ease of safe access. Sites were also selected so each area was represented as equally as possible between McBride, Prince George, Vanderhoof, Fraser Lake and Telkwa regions.

3.2 Arthropod Surveys

Based upon previous research and what is known within the region (Powell, 2018), we expected to find certain pest species, but an initial non-targeted approach to spider and insect collection was used to ensure a complete coverage of regional arthropod assemblages for better determination of baseline and differential biodiversity. Previous studies indicated that using only one method for collecting insects and spiders are ineffective at capturing the full biodiversity baselines and measures (Spafford and Lortie, 2013). Thus we used both sweep nets and pitfall traps, as well as a more experimental spider web collection for environmental DNA analysis of web prey content. Pitfall traps were set up at each site in three different habitats. They were set up within the forage field, on the edge between the field and the forest, and within the forest itself. These traps were used to capture the ground insects and spiders that would not be adequately sampled with the sweep nets. The pitfall traps were spaced 25 m apart (except for some sites where the width of forest between fields was less than 150 wide, 5m spacing was used instead) in two transects of nine traps each. This meant a total of 18 traps at each site, six in each of the three habitats (Figure 2). The trap set-up provided redundance in case some traps were disturbed by animals. In addition it provided information several locations in the interiors of the fields and forests.

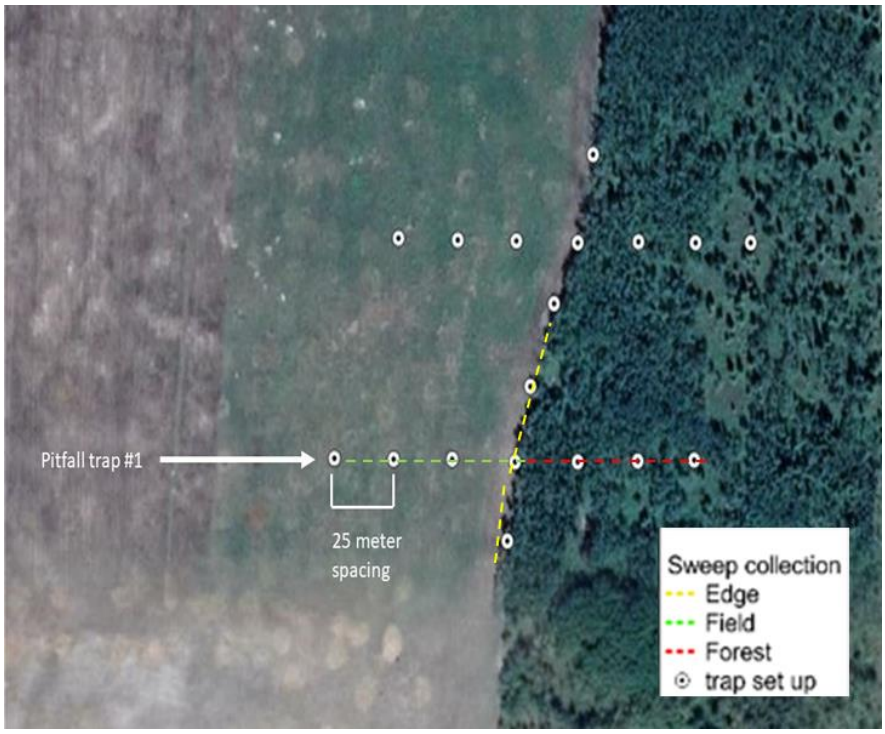

Figure 2. Example of a site set-up near Vanderhoof, BC in 2022. Eighteen pitfall traps were set up per site and three standardized sweeps of 75 m were completed on the edges, field and forest at each of three sampling periods during the summer. Spider webs were collected along the trap line transects, usually near to each pitfall trap.

Because pitfall traps tend to only catch ground-dwelling arthropods, sweep nets were used at each site within the fields, edges and adjacent forest stands to collect insects and spiders that were located higher up on the vegetation or that fly (eg. true flies, many wasps). Each site was sampled at least three times during the summer with the pitfall trap collection periods of two weeks. Each sweep survey was completed for 75m within the field, edge and forest at each trap collection period (i.e. also three times).

3.3 Vegetation Surveys

Plant surveys were done at each site within the fields, edges, and the forested areas as previous research indicates that plants influence insect species richness (Panzer and Schwartz, 1998). Plant management in adjacent areas will thus likely factor into final recommendations. At each site, 3m x 3m box plots (Figure 3) were completed near each pitfall trap between July and August where all plants within a plot were identified and counted. Species accumulation curves were created in early August with the vegetation survey data and verified that the 18 box plots per site fully captured plant diversity. Other site information was collected at this time, including soil types and slopes.

Figure 3. Example of a site set-up near Prince George, BC in 2022. 18 box plots were completed per site in the edges, field and forest between July and August.

3.4 Insect and spider identification

After field collection was completed, all samples were stored in labeled vials in ethanol. We are currently sorting and identifying specimens to taxonomic Family level using morphological keys. Once sorting and initial identification is complete for both sweep and pitfall trap samples, a second, targeted sort will be done on specific insects and spiders of interest that will be identified to genus or preferably species level through morphological keys and DNA barcoding.

3.5 Spider Web Collections

Spider webs were collected during the field season between May and August 2022. The purpose of this collection was to establish proof-of-concept for the use of spider web environmental DNA (eDNA) analysis as a method of assessing spider feeding on pest and beneficial insects in agroecosystems. Spider webs collected for eDNA analysis will provide an assessment of the efficacy web-building spiders as predators of insects. If eDNA analysis reveals that web-building spiders are effective natural predators of pest insects, then any relationships found between the presence or absence of desirable species and field site habitat characteristics could provide information valuable to the optimization of producers' integrated pest management strategies (IPM).

Spider webs were collected at every site in the fields, edges, and forested areas based on the methodology used by Gregorič et al. (2020). Webs were collected by walking along a pitfall transect per collection period and collecting one web per pitfall trap location (within 5 m of the trap) if a web was present. General notes were recorded e.g.: was there a spider present? was there feeding-related detritus in the web? What was the exact location on the transect? what was the web type (orb web, sheet, tangled)?

3.5 Data Analyses

Once a catalogue of pests and natural enemies is created, several different standard statistical tests will be run to look at the relationships and interactions between habitat types, vegetation, and arthropod communities. Analyses include but are not limited to: accumulation curves, rank abundance curves, indicator metrics. We will conduct a GIS desktop review of each site to quantify the amount of forested edge of each field and to calculate the forest edge to field size ratio for use as a variable in the statistical analysis. Spider web samples were sorted to prioritize which ones will be processed for eDNA analysis based on location of collection, condition of the web and whether the web was clean or if it had spider or other insects with it. Spider web eDNA results, if successful, will also be amenable to standard biodiversity analysis methods and will contribute to a regional species checklist.

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4.0 Preliminary Results

Between May and August over 600 samples were collected across all the sites from the pitfall traps and the sweep net surveys. An additional 200 spider webs were collected across the sites, and while processing of the hundreds of samples is ongoing there are some early emerging trends.

The early results from the 2022 field season indicate that there is more biodiversity on the edges and in forested areas compared to the interior of the fields. Fields had low diversity but higher abundance of the fewer insect species that were there, while the edges and forest interior have higher diversity (number of species) but lower abundances of each species present. Vegetative biodiversity showed the same trend.

4.1 Pests

In terms of pests found, an important finding from this season was the low levels of grasshoppers present. Grasshoppers are generally one of the most destructive crop pests in western Canada because damage and a resulting lower of crops. From informal communication with other producers and researchers the low grasshopper population was also observed in the rest of the region during the summer of 2022**.**

There was a large abundance and of leafhoppers, aphids, and click beetles. Those groups include species that have been identified as potential pests in other areas of the province. These species were more abundant in the fields as opposed to edges and forested areas.

4.2 Natural Enemies

The dominant group of predators that we found were the spiders, including a large diversity of orb weavers, wolf spiders, and hecklmesh spiders,. Other groups of spiders were also found, but to a lesser degree. There were a fair number of ground beetles found within the traps but with less diversity than the spiders. Some of the parasitoids that were collected were within the ichneumon wasp Family, with high diversity found across sites. Generally, there were more natural enemies found closer to the forested edges, and with continued identification and verification of species it remains to be seen whether this is a real trend in the data.

5.0 Knowledge transfer activities

There were several successful knowledge transfer activities that were used to communicate progress of this project and other pertinent information on pests and beneficial insects and spiders to end-users and other stakeholders. These activities were important and will continue to ensure that information and conclusions from this project are communicated and discussed and potentially implemented by stakeholders.

5.1 Factsheets

Three facts were produced in winter 2023 which will be posted to the CCAP website. One factsheet was an overview of the project, the second was an information sheet on how producers can use pitfall traps in their fields to monitor for pests. This pitfall factsheet supports an informational video that was made in 2022 and posted to CCAP website in Winter 2023. The third sheet was created to give producers knowledge on click beetles (also known as wireworms in their larval stages) which can be pests to crops in BC. These factsheets will be posted to the IAF website as part of a BNFFG Pest Monitoring Series.

5.2 Regional Extension

5.2.1 Webinars

There were several successful outreach activities throughout the year, including webinars. The BC Forage Council included integrated pest management as part of the webinar series which they coordinated (Forage Management Webinar Series) to include presentations from Keith Uloth (BC Pest Project), Dr. Dezene Huber, and Dr. Ajia White

which were recorded and posted on YouTube.The webinar series had 152 participants register to attend at least one of the webinars in the series. A range of 22 to 42 participants attended the webinars livestreams.

5.2.2 Survey

Surveys were sent out for distribution by community contacts which included : The Nechako Cattlemen's Regional Association presidents and secretaries, and RDBN Agriculture Coordinators Megan D'arcy and Michelle Rouberge. . Surveys were also included in the spring edition of Forager, which was published by BC Forage Council in April, as well as in social media posts through BCFC's network. Survey participants indicated that most producers use a mixture of control measures against pests, and are most interested in information on pest and predator biology and ecology and how to identify them.

5.2.3 Nechako Valley Exhibition

Serena Black from the BC Forage Council hosted a booth at the Nechako Valley Exhibition, and Meganne Harrison spoke to members of the community about the project. A total of 48 people (about 70% of whom were producers) stopped at the booth over the course of three days. They were interested in learning more about the project. During this exhibition, a variety of fact sheets were handed out: Grasshopper Nymph Key Hopper Threshold and Control Options, New and Emerging Pests, and European Skippers. Eighty pamphlets were handed out on grasshoppers, and 70 were handed out on the other topics. Most conversations were supportive of baseline data being collected. Members of the public (self identified as non-ranchers) expressed concerns over pesticide use in general. Ranchers expressed frustrations that neighbours were not taking any control methods, reducing the effectiveness of their actions; a sub-section (30%) expressed a desire for alternative control methods and IP tactics. They also expressed being unclear on how to determine need and timing of chemical controls.

5.2.4 Workshops

Workshops will be held between March 14-17 2023 that will include presentations from Meganne Harrison (UNBC), Serena Black (BC Forage Council) and Dr. Dezene Huber (UNBC) on an overview of the project background, progress, and tools for producers to get involved monitoring for pests in their own fields. This workshop is being presented in Smithers, Vanderhoof, and Quesnel to connect with as many regional producers as possible.

5.3 Social Media

A Facebook page is being built (Winter 2023) that will be launched the week of March 13, 2023 to help promote the project to the community. The page will keep everyone updated on the progress through weekly posts starting in April 2023 and will continue until at least August 2023. This Facebook page will be launched consecutively

with workshops scheduled the week of March 13, 2023 to connect participants to updates from the project over the season.

6.0 Future Activities

After a successful first year, 2023 will continue with a more targeted field season between May and August to capture the grasshopper population and any other species not present in the 2022 surveys (e.g. species on a two-year cycle). The lab-based assessment of the 2022 and 2023 samples will be completed and the data will be statistically analyzed to understand effects of land management on arthropod communities in the context of existing and potential IPM tactics and strategies. Based on these findings, recommendations will be written and presented to producers and further monitoring extension network will be established.

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