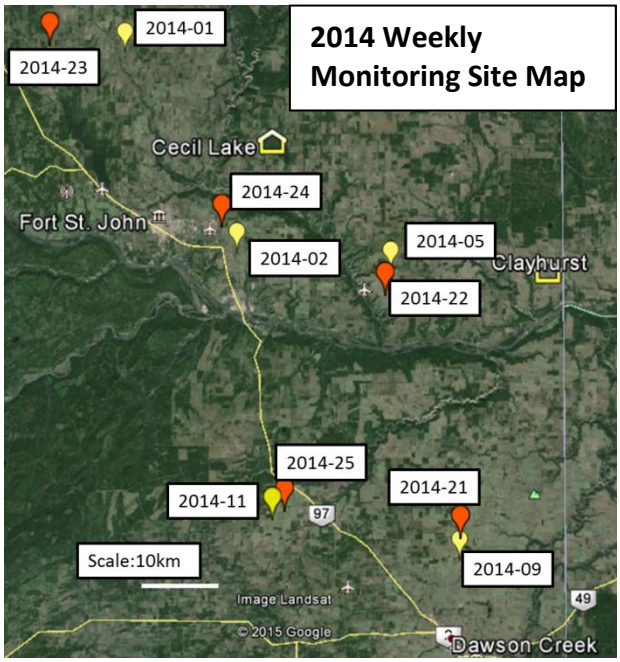
April 19, 2016 Arlan Benn

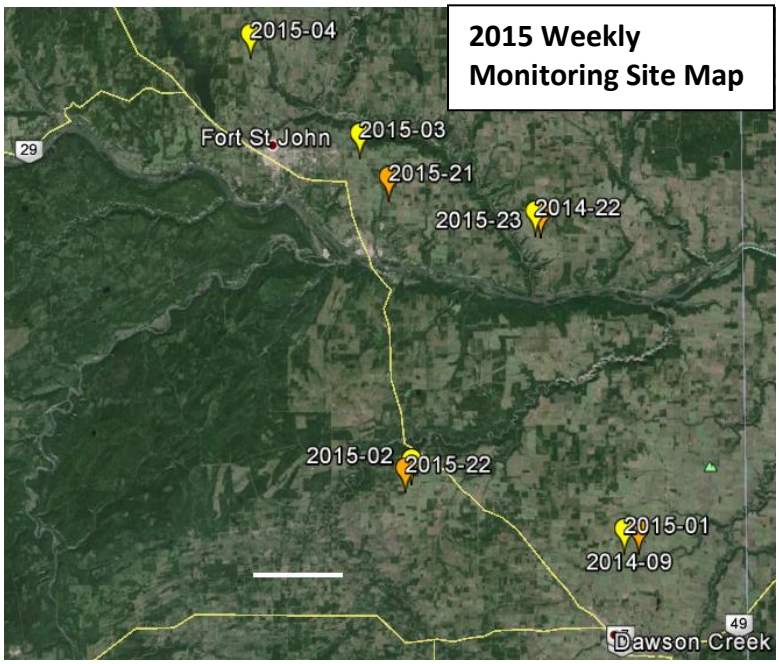
2014-2015 BC Peace Collaborative Pest Monitoring Cumulative Summary

Overview

The Collaborative pest monitoring pilot project in the BC Peace began its first field season in Spring 2014, and carried on through until Winter 2015/16. Over the course of both years, detailed field data was collected from 17 unique sites across the region; this data consisted of varying degrees of Insect population data for both pests and beneficials, weed distributions, pathogen occurrence, and weather data. All of this data is used to varying degrees by Agriculture and Agri-food Canada to produce valuable forecasting maps and create a lasting record of species distributions for the Peace region, alongside data for the entire grain-growing region of Canada. Being represented in that dataset means the Peace contributes to the direction of future prairie-wide research involving agricultural development, as well as more accurately representing the variability of pest issues across the province and the country.

The below summary should give a more detailed description of the monitoring activities and how they were adapted for the problems unique to each year, and hopefully they will illustrate the value of continuing collection efforts for the region.





Orange sites are wheat sites, yellow are Canola.

Insect Monitoring

Agriculture and Agrifood Canada (AAFC) provided insect monitoring protocols that have been well established for use across the prairies in the Prairie Pest Monitoring Network (PPMN), and these were employed with minor adjustments to details such as deployment dates, sample sizes, and trap placements where necessary, as per recommendations from AAFC in Beaverlodge. These protocols involve weekly sampling of Canola and wheat fields using a combination of target-specific pheromone-baited traps, general interception sticky cards, and sweep-net sampling at these sites. Most trap samples were processed weekly after collection when time permitted- less time sensitive material was frozen until winter.

Monitoring sites were set up in the general areas of Montney (Northwest), Clayhurst (Northeast), Baldonnel (North-central), Farmington (Southwest), and Rolla (Southeast); these areas were chosen to cover as much of the highest density grain growing areas in the BC Peace as efficiently as possible, and they constituted an approximately 250 kilometer circuit.

Diamondback moth pheromone trap (white delta trap, post-mounted), and Flea beetle sticky card (near the pin flag) setup in late April at a field to be

In Canola, flea beetle sticky cards and Diamondback moth (DBM) pheromone baited traps were deployed early in the season in the first week of May, followed by Swede Midge and Red Clover Casebearer (RCCB) pheromone traps at the end of May; RCCB is a ubiquitous and highly mobile pest, so area-wide monitoring was used at Canola sites to approximate its general distribution. Sweep sampling for *Lygus* bugs was also done periodically at these sites throughout the season. Finally, during 2014 and 2015 I was able to add BC Peace data to the annual Peace Canola survey headed by Jennifer Otani in Beaverlodge, AB again; over both years a total of approximately 50 sites from BC were included in this survey that identifies all arthropods in the sweep samples from each site. The aim of the study is twofold: to identify and quantify the diversity of beneficial insects while also quantifying key pests present during that period (mainly *Lygus,* in early July), but also to proactively scout for the establishment of an important Canola pest, the Cabbage seedpod weevil (*Ceutorhynchus obstrictus)*, which is absent from the Peace so far.

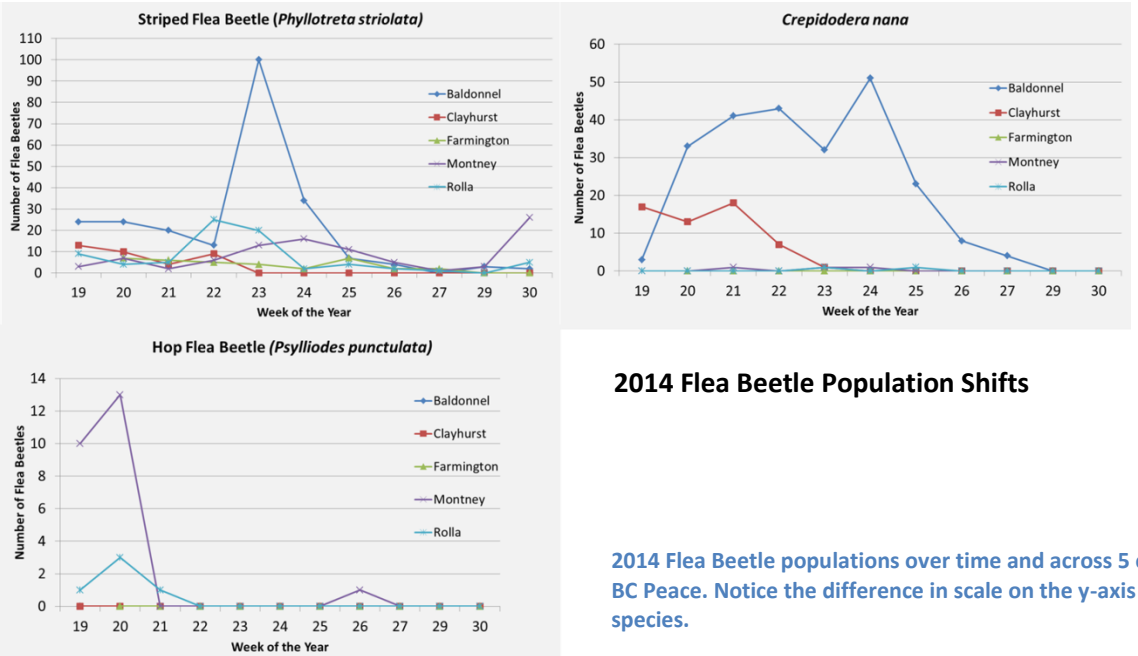
Canola survey sweep sampling in Sunset Prairie, BC. Beaverlodge research farm provided summer students to help collect BC Peace samples.

Flea Beetles

Across the prairies, the most important and abundant pest species are Crucifer (*Phyllotreta cruciferae),* Striped *(Phyllotreta striolata),* and Hops *(Psylliodes punctulata),* however, anecdotal evidence and data collected over the course of the pilot project confirmed that damage in Canola in the BC Peace is primarily caused by striped flea beetles, as is the case in the Alberta Peace. BC Peace data indicates that the non-pest species, *Crepidodera nana*, proved to actually be the most abundant flea beetle on Canola field edges (especially in 2014) at certain early points in the year, illustrating the importance of performing damage assessments to make control decisions. Sticky card monitoring is an early warning system- it can help farmers pinpoint when flea beetles are emerging across the region so they know when they need to start scouting their fields. The population data from the cards is useful in long-term scientific applications, but cannot be used to make control decisions; flea beetle feeding habits vary considerably with weather, and later stage canola (2-3 true leaf stages) is able to withstand most damage, hence well-established action thresholds of percent leaf-defoliation on cotyledon stage canola should be adhered to.

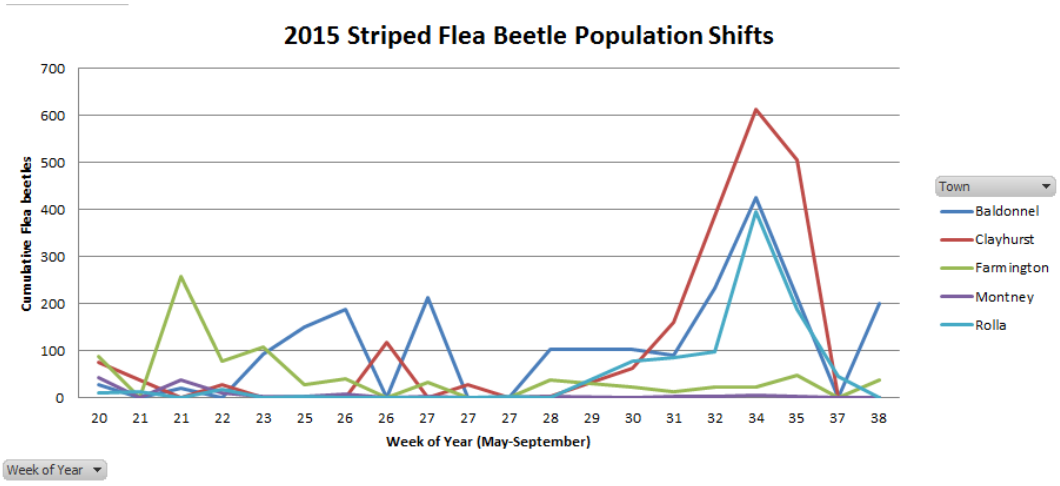
Striped flea beetles feeding on canola in Rolla- they will feed at a faster rate when spring temperatures are warm, but the crop will also develop faster; the vulnerable window is quite small so diligent monitoring

In 2015, populations shifted much further towards striped flea beetle dominance, and *C. nana* was only significant early on in Baldonnel. Early season peaks in striped and non-pest *C. nana* flea beetles occurred at roughly the same points in the season both years, but the initial striped peaks were higher in 2015. Hops flea beetles seemed to consistently peak and decline earlier than other flea beetles, and did so at a lower level.



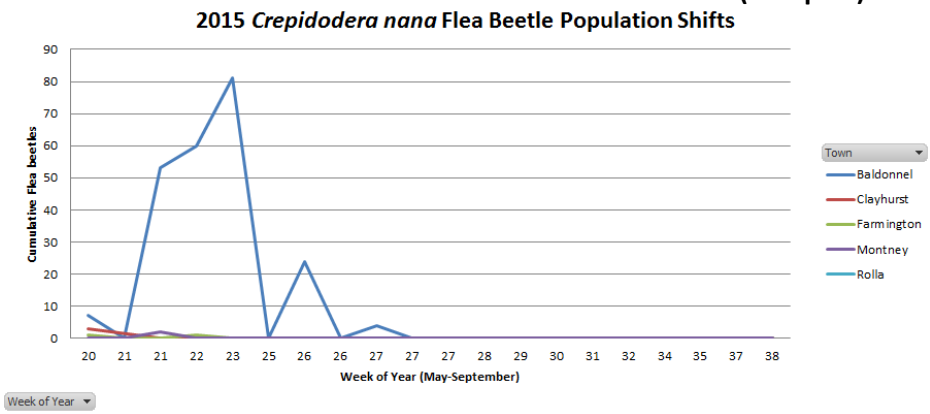
2014 Flea Beetle Population Shifts

2014 Flea Beetle populations over time and across 5 canola sites in the BC Peace. Notice the difference in scale on the y-axis for different species.

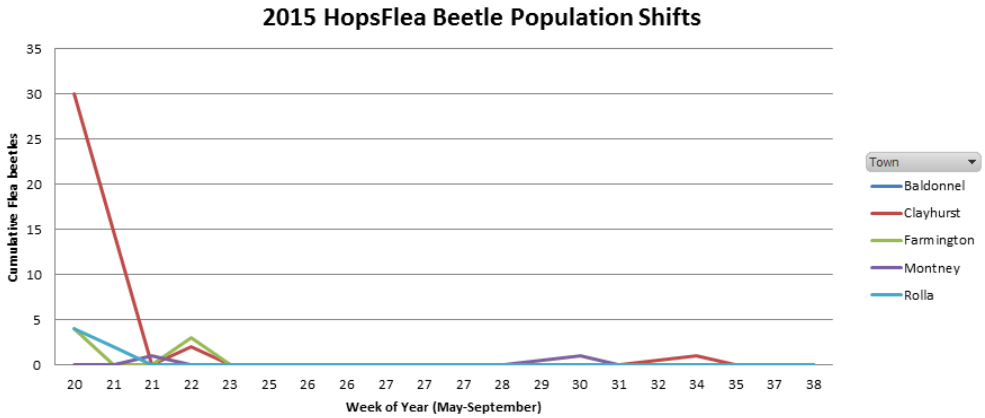


2015 Striped flea beetle populations over the season. Notice the second peak is larger as expected. This is when the second generation emerges to find overwintering grounds- overwintering mortality and migration likely causes smaller spring peaks, however the size of the fall peak can help predict the *relative* size of next spring's emerging population .

(non-pest)

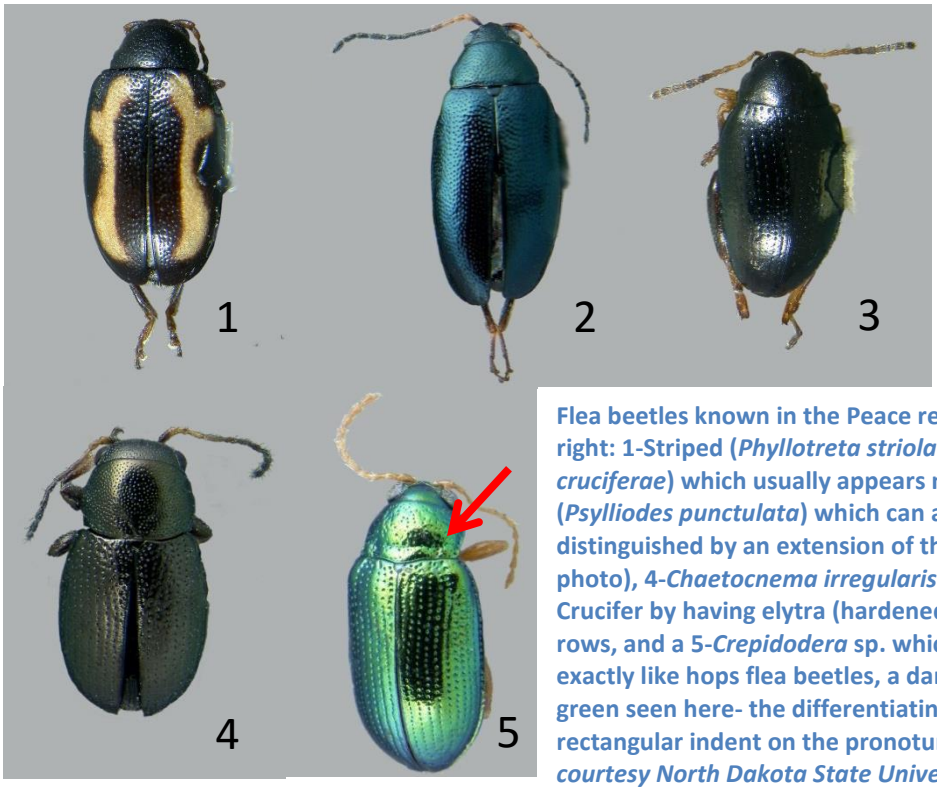


2015 *Crepidodera nana* populations over the course of the season. This is not known to be a pest species and has been observed feeding on trees along field edges.



2015 Hops flea beetle populations over the course of the season. This appears to be the second most prevalent pest species in the Peace, after striped flea beetles and likely doesn't contribute much to yield losses.

The figures above confirm that, once again, the striped flea beetle is likely the most important damage causing species in the BC Peace, but in some areas at certain times of the year, a large proportion of flea beetles present are actually non-pests. A total of two Crucifer flea beetles were detected over the course of the entire

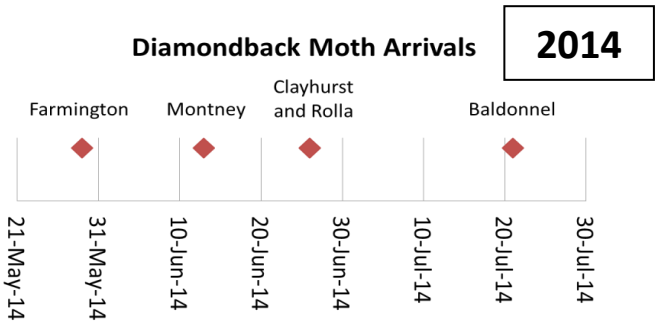


Flea beetles known in the Peace region, from top left to bottom right: 1-Striped (*Phyllotreta striolata*), 2-Crucifer (*Phyllotreta cruciferae*) which usually appears more black/bronze, 3-Hops (*Psylliodes punctulata*) which can appear more metallic, and is distinguished by an extension of the hind tibia (just visible in the photo), 4-*Chaetocnema irregularis* which is distinguished from Crucifer by having elytra (hardened wing covers) puntures in rows, and a 5-*Crepidodera* sp. which in our region is coloured exactly like hops flea beetles, a dark metallic- not the bright green seen here- the differentiating characteristic is the light rectangular indent on the pronotum (red arrow). *Images courtesy North Dakota State University Entomology department.*

monitoring project, both in Farmington, and as such were an extremely minor factor in infestations overall; this reiterates the value of population data of this nature- proper differentiation of *C. nana* from the morphologically similar *P. cruciferae*, is key to understanding the unique pest dynamics of Canola in the BC Peace.

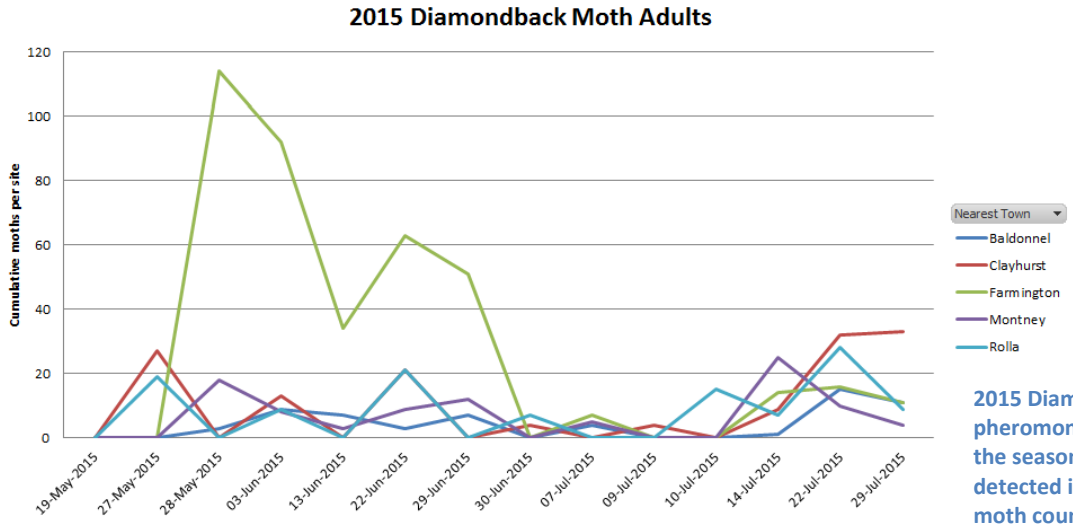
Diamondback Moths

Diamondback moth (DBM), which is not known to overwinter in the Prairies to any meaningful degree, showed slightly higher numbers this season, but was still well below threshold levels across the Peace. Annual infestations in the Peace are due entirely to populations from southern wind trajectories, and the degree and localization of infestations are dependent on when and where the wind currents come early in the season. Pheromone monitoring in the Peace allows us to track arrival times, and adult population levels throughout the season to see if they are rising towards "larval check" thresholds. The earlier the moth arrives, and if in sufficient numbers, the more time the population will have to establish and cause a problem that year. In the 2014 season, arrival times varied within the



Diamondback moth arrival dates during the 2014 growing season. When the moth arrives in a region is entirely dependent on southern-originating wind currents. Adult moth populations were extremely low and larvae were only rarely observed in canola crops in 2015- no larvae were recovered in 2014.

Peace by up to a month (see figure at right), however in 2015 they arrived much earlier and more uniformly; by May 19th 2015, DBM were detected at all sites except Montney where they arrived the following week. Despite higher counts, adult populations still never reached levels where heavy infestations were likely, and only small densities of larvae were observed in Farmington (see below).



2015 Diamondback moth pheromone trap counts throughout the season. Larvae were only detected in Farmington where moth counts were highest, but still in very low levels.

If the climate shifts to allow colonization and overwintering of this pest, we could see drastic shifts in the frequency of problem years as it's capable of multiple generations in short periods of time so this pest must be watched carefully; globally, it's estimated to cost anywhere between 1 and $5 billion US in management costs and yield loss, and in regions where it's well established, sometimes pesticide control is applied weekly.

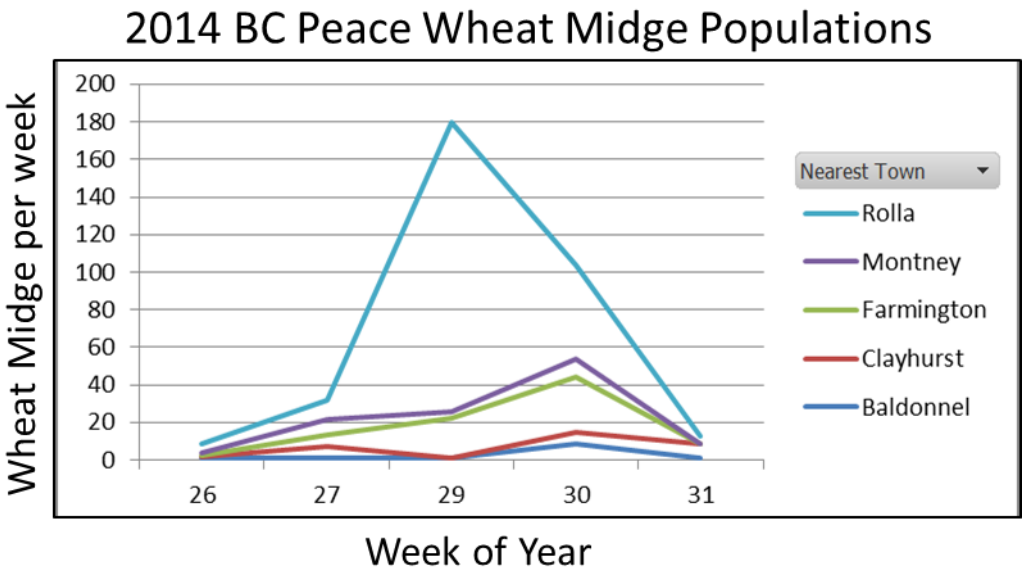
Swede Midge

Swede Midge pheromone monitoring confirmed that this pest is likely still not present in the BC Peace. The traps were situated inside the field using flexible materials to avoid breakage or damage to farmers' equipment; they are placed low within the canopy as midge are very poor fliers. It's a highly destructive pest in some areas of Ontario where Brassica crops, including canola, simply aren't viable anymore. This is because the midge is extremely difficult to control, and once in a region, long crop rotations are the only available means of managing it. It has established populations in areas of the prairies and modelling efforts indicate

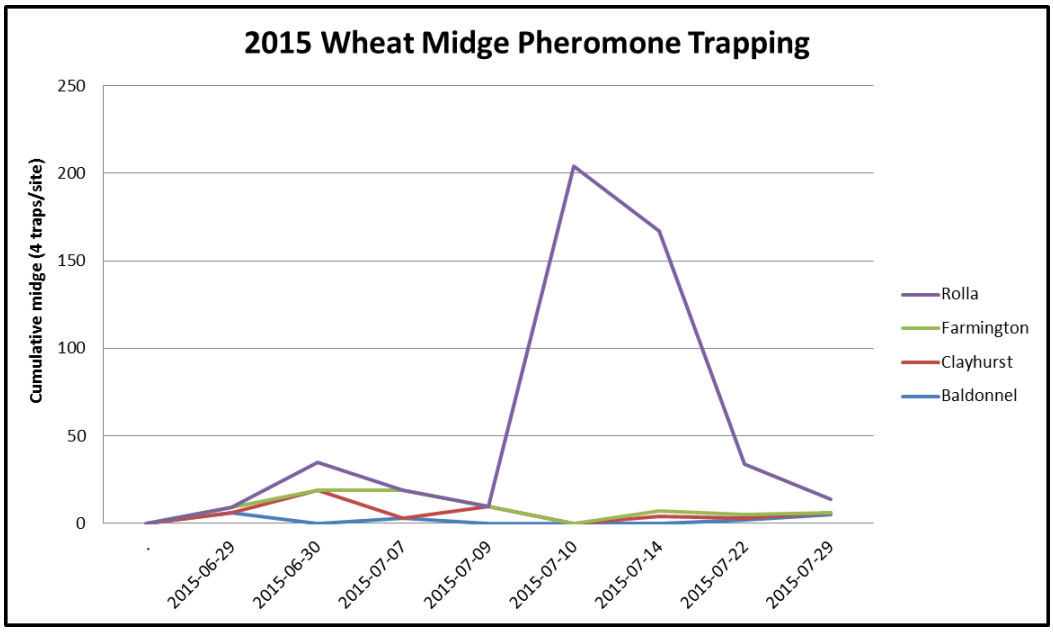
that if it were introduced in the BC Peace, it would likely survive and reproduce, so proactive monitoring for this pest is crucial.

Wheat Midge

Wheat Midge pheromone traps were set out at wheat sites between the end of June and the end of July, and adult midge were detected at all sites within the first week as in both years (Figures below). They were most abundant in the south-eastern portion of the BC Peace, in Rolla, though in terms of risk levels populations were still relatively low across the region.



2014 Wheat midge pheromone trapping results. Week of year values are based on collection dates and run from the first week of July (26th WoY) to the first week of August (31st WoY). Wheat midge counts were weekly and represent the sum of 4 traps per site, 50m apart.



2015 Wheat midge pheromone trapping results. The scale is almost identical to 2014, covering the same span of time and using the same protocol. Notice populations were a bit higher in Rolla in 2015, but quite stable overall. Keep in mind that the cumulative counts are from 4 pheromone traps per site, and threshold values cannot be inferred from pheromone data, though anecdotally, problem areas for midge elsewhere in the Prairies would see much higher counts.

Wheat Midge will be a growing problem in the coming years, as reports show populations still seem to be on an upward trend in nearby Alberta regions as well as the BC Peace, but we still don't understand well how this pest's biology will play out in the Peace. The window of crop susceptibility to this pest is very short- only

after the wheat heads emerge, but before they flower, so climate data (especially temperature) will be increasingly valuable for tracking this pest's crucial synchrony with its host, and tracking its populations will allow the region to make the necessary shifts towards tolerant varieties as needed. Sweep samples from 2014 Canola crops did recover an important natural enemy of the Wheat Midge- a parasitic wasp, (*Macroglenes penetrans*), so this will be an important consideration in future management regimes. It is hypothesized that the parasitoid uses the nectar from Canola as a food source and the canopy for resting in between searching host Wheat midge eggs; this means following economic thresholds in all crops is key for maintaining healthy pest-predator dynamics across rotations. So far, midge population levels have remained far below threshold values (which currently can only be assessed by rather tediously counting in-flight adults in the crop at dusk), but this could change in the future.

Bertha Armyworm

These pheromone traps were set along canola fields to attract adult moths in flight and capture them for counting later; though pheromone traps can't be used for economic thresholds, they can give an idea of the likelihood of an infestation occurring. For reference, Saskatchewan Agriculture uses the following scale where moths are totalled throughout the season, and once the cumulative amount reaches certain points, a risk level is given:

- 0 to 300 = low risk; control measures unlikely in most cases.
- 300 to 900 = uncertain, most variability for this level; periodic monitoring of fields to verify actual numbers of larvae (especially bolting fields) is required.
- 900 to 1,200 = moderate risk; check for larvae and evidence of damage.
- 1,200 to 1,500 = high risk; monitor fields more frequently.

A Bertha armyworm unitrap containing a pheromone that attracts the moth- this is the same system used for Red clover casebearer moths. Note: this trap was victim to a bear that mistook the smell of decaying moths in the trap for a snack

No site in the BC Peace reached moth counts anywhere near where an outbreak would be expected- the highest cumulative counts were around 150 moths, which is at least half as much as indicates checking the field for larvae is warranted at all . As always, scouting is the only way to be sure if you have a problem however, so getting farmers into the habit of employing simple sampling regimes for themselves should be a priority. Larva scouting means you want to shake the plants to dislodge any larvae in a set area (which can vary depending on the species you're sampling for, but usually a meter squared is sufficient) and count them.

You can check for Diamondback moth larvae at the same time, and apply any respective control thresholds. Provincial agricultural websites can be searched for up to date thresholds.

Grasshoppers

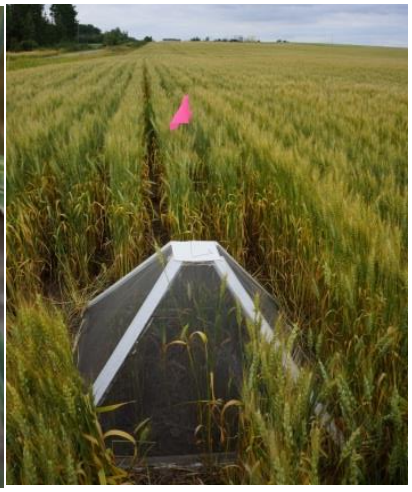
Grasshopper nymphs collected early in the season. Control is much more effective on these immature stages, so identification while they when they are young is a useful skill for farmers to have. The patterning on these nymphs shows they are Migratory grasshoppers- for more information, see the key produced by the BCPPM project.

Grasshoppers caused major damage, mainly in Northern areas of the Peace, during the 2014 growing season, but ideal weather conditions in the Fall and 2015 Spring did not lead to high population densities in the 2015 growing season as predicted. The crash was likely due to a build-up of parasites and natural enemies associated with the booming grasshopper populations. Interestingly, Alberta saw a large grasshopper boom this year, which seemed to consist of the same main species from the 2014 BC problems (predominantly Two-striped (*Melanoplus bivittatus*) and Migratory (*Melanoplus sanguinipes*). This suggests that perhaps the BC and AB Peace share similar pest dynamics, but the local "boom-bust" cycles do not match, therefore the two areas constitute distinctly different management regions with unique requirements. Pests like grasshoppers usually follow these population cycles, and understanding their local biology will be key in developing future forecasting models to better predict when farmers need to be ready for a problem year. There were plans to expand grasshopper monitoring efforts during the 2015 season to start building more accurate/useful long-term population data that would include periodic sweep samples across multiple sites, as well as late season egg counts, however, the massive crash in populations meant priorities were shifted to other efforts. Meaningful egg densities were not recovered, and adults were almost entirely absent throughout 2015, so some of the emerging issues discussed below were focused on instead.

Grasshopper eggs recovered in Clayhurst in spring 2015 after the heavy populations in 2014.

Emergent issues and other insect monitoring efforts

Extra investigations into Cereal leaf beetle damage in Farmington was undertaken, and with the help of emergence cages, it was determined that the beetle is still absent from the Peace. Currently, it's known distribution is limited to southern BC (mainly the Creston valley) and Alberta, but it's been known to establish detached populations in other parts of the prairies, so as a precaution 10 of the traps (at right) were set up mid-season and checked bi-weekly for adults emerging to search for overwintering areas. No beetles were discovered, and it was determined that the characteristic damage in strips along the veins was caused by slugs.



Left:"Cereal Leaf Beetle" damage in Farmington, BC. Slugs can also cause this characteristic feeding damage. Right: Emergence cages used to verify cereal leaf beetle was not present.

A very localized outbreak of red turnip beetle was observed at a field in Rolla in 2014. Though commonly present in fields, it doesn't often cause meaningful damage, so thresholds aren't well studied for this intermittent pest. Issues like this need to be documented so that over time we can make sure the frequency, breadth, and severity of outbreaks does not change; if they do change, understanding why is key for adapting to new pests by developing management strategies before they become a serious issue.

Cutworms were another pest that's seen serious outbreak years in the Peace in the past, but during the course of the pilot project populations remained very low. Periodic checks were undertaken for the subterranean larvae (some remain underground for most of their lives, even to feed, making them difficult and tedious to scout for at low levels), but in most cases none or very few were recovered.

A cutworm can be seen inside the hollowed out portion of a canola stem in Clayhurst. The plant had root rot-like symptoms and was uprooted for inspection.

A pest that causes similar damage in Canola is the root maggot, or *Delia* fly larva. Like cutworms, the immature stages feed on the roots, however *Delia* feeding is far more commonly associated with root rot-like symptoms, and in fact is known to provide an entry for the pathogens and thus increase its prevalence in a field. Despite very dry conditions, root rot was observed in many fields across the BC Peace, albeit at very low incidences, but there were almost always *Delia* associated with it. Root rot will be revisited in the next section as it was the only consistently recovered disease.

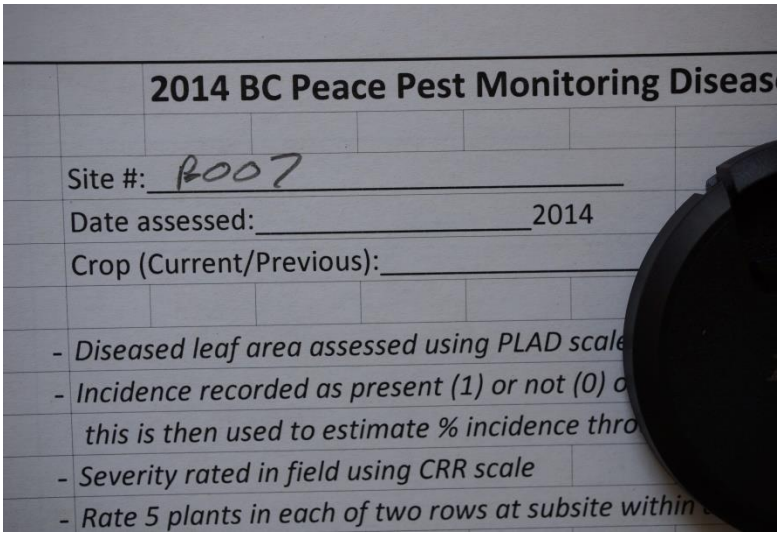
A root maggot feeding on a smaller plant causing the end of the root to stop growing, limiting the nutrient/water uptake, this then causes the plant to wither. On top of this feeding damage, the brown tissue around the larva is infected with root rot, which will continue to hinder the plant even if it survives the maggot's lifecycle.

Insects were by far responsible for most pest problems during the pilot project years, but pathology and weed sampling was also carried out to try and get an idea of their distribution in the BC Peace. Weather conditions were very dry and warm for most of the growing seasons, which ensured that most disease issues were fairly minor.

A stinkbug nymph aggregation in Rolla, BC early in the 2014 season at the edge of a canola field. Not known to be a serious pest of note in the region, because densities stay low enough that it doesn't reach pest status.

Pathology and Weed Monitoring

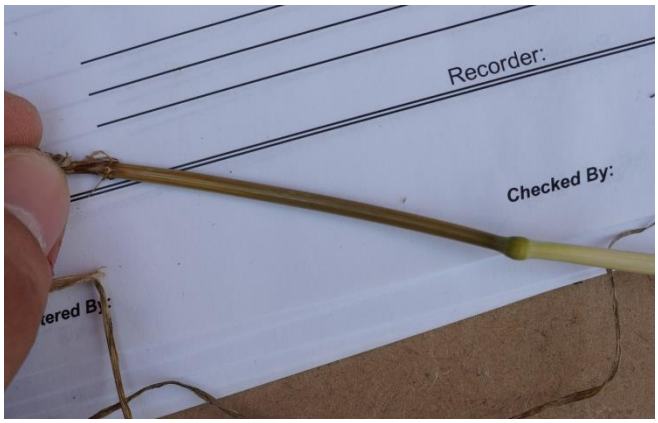
In the 2014 Season, pathology and weed monitoring was carried out in the form of late season surveys, and notes taken throughout field monitoring at and around cooperator insect monitoring sites. Efforts suffered from a lack of organized, established protocols which are so well characterized for insects. However, using advice from AAFC scientists, important crops and pathogens were identified as focus systems for our area, and survey protocols were designed based off these. All of the collection and data sheets were built from scratch. Weed surveys followed a similar path, and were adapted from a 2009-2010 protocol followed in Alberta by the provincial and federal governments. These still yielded few results so the approach was adjusted for 2015.



An example of the 2014 disease monitoring protocol/data sheet developed for end of season surveys in the BC Peace. Due to the hot, dry conditions, the survey met with little success, so 2015 the approach was adjusted to respond to observed/reported issues as they arose.

Pathology

In 2014, the pathology surveys were performed in barley and canola, but disease was almost completely absent from every field. There were trace levels of smut in barley, and trace levels of root rot in both canola and barley. Soil samples sent to the BC plant health lab were tested with PCR methods and found no clubroot across the region, so it seems this important disease is still restricted to parts of the prairies, the nearest being around Edmonton, Alberta. The predominantly hot, dry conditions usually make for low disease years, and high insect years, as was the case this season.



Common root rot symptoms on a barley plant recovered in 2014 BC Peace surveys- the stem turns brown at the base and the root hairs are reduced.

The barley survey was carried out in early August and consisted of 9 fields across the region. At each site, 10 plants were pulled from each of 5 sub-sites for a total of 50 plants per field. These plants were processed in the lab for diseases flagged as important by AAFC and included: Net Blotch, Stripe Rust, Scald, Smut, Take-all, and Common Root Rot. Stripe rust was found in Beaverlodge, Alberta in a few fields, but was not recovered in the BC Peace.

Trace disease symptoms in Barley samples from 2014 surveys. Scald on the left, and smut on the right.

Canola disease surveys were carried out later, in mid-August, and plants were collected from the 5 insect monitoring sites. Five plants were collected from each of 5 sub-sites at a field, for a total of 25 plants per field. These were returned to the lab and assessed for similarly determined "important" canola diseases including: Blackleg, *Sclerotinia, Alternaria*, Fusarium Wilt, Aster Yellows, Foot Rot and Brown Girdling Root Rot. A challenge with assessing disease when it isn't present in a field, is that many pathogens, like *Sclerotinia* and *Alternaria*, are ubiquitous in the environment, so culturing plant samples in the lab usually recovers them, but it's hard to assess risk levels based off this; risk level really comes from the weather conditions during key growth periods. As such, the more relevant information regarding pathogens is whether or not they caused meaningful disease at a site, so the next season's approach was adjusted accordingly.

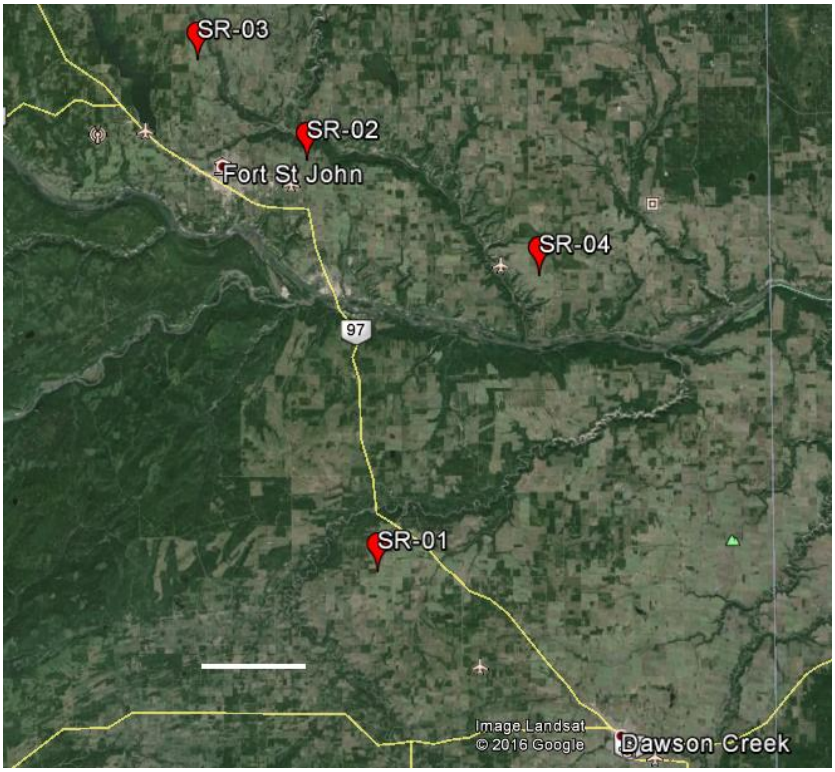
Canola samples from 2014 pathology survey exhibiting root rot symptoms of varying degrees. Left- samples taken to the lab at AAFC for processing facilities. The brown discolouration is root rot, and the mechanical damage (grooves and splits in the root tissue) is from *Delia* feeding. Together they alter the root growth. This is seen on the right- samples collected in the field. The left plant is healthy, and you can see the taproot stop abruptly on the other two from *Delia* and rootrot.

In 2015, the pathology in crops was monitored on a case by case basis with a focus on canola and barley as directed by local pathologists. When an issue was observed or brought to my attention, I would investigate and

A field in Farmington observed in 2015. Samples were taken to the pathologist at AAFC Beaverlodge, where they were plated and grown for identification. The discolouration and stunting seen here was likely caused by *Septoria*.

collect samples if necessary to get proper identification from a trained pathologist (usually at AAFC). I responded to a couple calls, one of which turned out to be a false alarm, and the other which turned out to be webworms in a hay crop near Tomslake.

There were some minor stripe rust outbreaks across the region in 2015, which like Diamondback moths, almost exclusively arises from windblown spores of a southern United States origin as they require a living host plant to overwinter in and fairly mild conditions with heavy snow cover. The outbreaks I observed only covered small patches at the edges of fields, but these should be taken care of with fungicides as soon as possible when necessary because they spread very rapidly.



Striperust outbreaks observed in 2015. In all cases the outbreak was localized to the edges of the field (within 10m) and usually no more than ~20m in length. SR-03 was south of Montney, SR-02 near the Fort St. John Airport, SR-04 in the Golata Creek area, and SR-01 in Farmington which was the worst infection. I also received reports of striperust closer to Dawson Creek as well.

Weeds

Weed surveys were carried out with assistance from Talon Gauthier with the Peace Region Forage Seed Association (PRFSA) in the second season. This joint effort was crucial in lining up more forage-seed cooperators and establishing working relationships with them, and helped solve the 2014 difficulties of contacting cooperators with the desired fescue crops which resulted in only 3 out of 5 fields visited being assessed at a single point late that season. In 2015 by contrast, there were 11 sites sampled twice each, once in late spring, and then once in mid-summer in an attempt to gauge the change in weed populations over time. In 2015 the protocol still consisted of all weeds observed being identified and quantified along a roughly 50 pace arc through the field. Weeds were recorded as being found either on the field edge or inside the field. A list of frequently encountered weeds of concern was compiled from this data, including Rough Cinquefoil, Foxtail barley (a weed especially important in forage seed production, which was often present throughout the fields sampled), and Canada thistle (which was usually present in ditches or along field edges when observed). The 2015 data is far more useful than the 2014 season's data, and as such has been provided to the PRFSA for continued use.

Weather

In total, 10 weekly monitoring sites were established with cooperators- 5 Canola, 4 Wheat, and 1 extra weather station site with remote data-download capabilities (near Clayhurst, BC) allowing regular transfers to AAFC modellers. Three additional manually shuttled weather stations were again maintained in Rolla, Montney, and Farmington to fill in data gaps for longer term purposes. Collectively, these data will prove extremely valuable for forecasting, modelling, and looking at changes to pest populations over time in this unique region.

Left- Manual shuttle weather station; data collected ~twice a year for long term use. Right- Internet accessible data transferred automatically via cell network; annual subscription fee, but reliable and can be used weekly for forecasting.

Regional Extension/Outreach Work

Research support

One other useful opportunity this position provided throughout the season was a person on the ground to support other valuable monitoring and data collection efforts in the region which crucially gives us access to a wider array of forecasting materials, and pest information. One project, a late season *Verticillium* wilt survey was performed in conjunction with the CFIA as an early test for the disease in Canola. This was in response to the first documented case in Canola in Manitoba. This type of proactive monitoring is important for establishing when a new pest is inevitably introduced to our region. An additional project was in coordination with researchers in AAFC in Summerland, BC who are coordinating a national effort to develop a crop pathogen forecasting and modelling system called "Phytoshield". The ultimate goal is to develop PCR protocols for monitoring various agriculturally important pathogens to then predict when and where outbreaks will arise. Currently there are monitoring efforts localized in Western Canada, mostly down in Southern BC, but I was able to run a monitoring station in the BC Peace which the BCGPA has agreed to carry on with for the duration of that project. This will give the researchers, and us, access to a map of what pathogens are frequently encountered in the area, and help them develop tools for predicting their movement and manifestation as disease in crops in the region.

Phytoshield AAFC project. A spore sampler draws in air continuously which is filtered into a collection vial. All of the contents are collected weekly then sent to the researchers; they have started using the data to build PCR diagnostics (tools for using DNA to identify organisms) for cereal pathogens across western Canada. This site is maintained in Fort St. John BC and stewardship has been transferred to the BC Grain Producers association.

Industry support

In addition to research-oriented support and extension work, I was able to provide identification material, advice, and expertise to industry groups, such as Bayer and Crop Production Services. I gave a presentation at one of their grower meetings and provided materials for another, which was an opportunity to arm the growers with tools for their operations, but also the industry representatives as well. Building expertise throughout these groups means the whole region is better informed and at the very least knows where to find information they need to make well-informed decisions. I also responded to calls from these groups regularly to assist with pest identification and if I was unable to directly answer a question, I had the crucial support of AAFC scientists for advice.

Grower groups (the BCGPA and PRFSA) gave me the opportunity to present at meetings during the winters but also during the field seasons, and this was easily one of the most useful ways of communicating with growers. This was a time efficient way of directly sharing identification keys, action thresholds, and informational pamphlets with growers and other industry representatives. These were often collaborations with organizations like the Canola Council who provided personnel to cover knowledge gaps within my areas of expertise by contributing to my presentations. This made for a greater focus and a more useful breadth of information provided on timely issues in the season- such as a talk myself and a Canola council member held on *Lygus* at the BCGPA field day being held just before the crucial stage for that pest was occurring in crops at the time.

Education support

Educating growers on pest issues relevant to them is important- this goes without saying. Educating young people before they've given much thought to agriculture is perhaps a less obvious but equally important task. In 2015 I was invited to give a presentation at a local high-school's biology field trip. The topic was insects in the context of agriculture. I was able to impart some basic anatomical, ecological, and biological knowledge upon the students in an outdoor setting which kept them interested, but more importantly, I got to introduce them to the concept of integrated pest management. IPM is a concept many farmers have yet to fully embrace, and not only does teaching young students about it give the next generation of farmers and early start on another, more sustainable way of doing agriculture, but it can sometimes be a conduit to imparting some of those concepts on parents. It's one more way of reaching growers and one more chance they'll take the wisdom to heart.

Other outreach

I have produced summaries throughout the season when an issue was identified that growers might need information about. These information bulletins would tell growers what pests/disease to watch out for at a given crop stage/time of year, and how they can identify and deal with it. They also included links to AAFC pest monitoring updates from the prairies, and links to agricultural websites with further information. These were shared by email with AAFC researchers, BCGPA/PRFSA members, growers, and agronomists from various industry groups. PRFSA also posted them on their website.

I gave a radio interview with CBC, and an interview with the Alaska Highway newspaper to relay information about the grasshopper outbreak in 2014 to the local area and province.

A twitter account was created for the project which has 39 followers from the region and across the prairies and follows 44 other users. The aim with this was to give quick updates on current undertakings, or brief updates regarding information in the summaries I produced and emailed. It allowed me to track issues other pest monitoring professionals are noticing in nearby areas, and to give more exposure to the project.

Difficulties and Successes

Successes:

- Valuable, high quality insect data produced and entered into a persistent, well maintained database with AAFC where there is a knowledgebase capable of effectively using said data.
- Knowledge shared with growers and industry representatives that helped them in their operations during the course of the project- to be more efficient, more environmentally responsible, and more economically sound.
- Not always enough time during the season for a single person to reliably produce meaningful updates every week, however periodic bulletins during key threshold stages (ie Lygus populations around Canola bolting, or flea beetle populations just prior/during seedling emergence) were probably the most effective use of time. Being periodic makes them able to be more meaningful- direct growers to different control options, cultural practices, info on natural enemies etc. and provide a fuller picture of the issue at hand, when they need it.
- Some of the material produced will have value for long periods of time- such as the identification keys and voucher collections (vouchers allow tracking species shifts over time).
- Laid the groundwork for which pest issues need to be prioritized for the BC Peace region specifically.
- Established and passed on potentially long-lasting collaborations- such as the AAFC phytoshield project which will continue to be maintained in the area for 3 more years at least, creating a lasting adaptation tool for growers

Difficulties:

- Finding the balance between an areawide data collector, and an in-field decision maker for individual growers. Not only are their time constraints, but there are conflicts with private sector groups which offer those services.
- The vast, highly variable area is difficult to cover for a single person, especially when taking into account the wide range of issues that need be attended to.
- A lack of easily employed protocols for some of the weed and disease issues in the region- monitoring these issues is done by a dedicated group of scientists and techs, with specialized lab capabilities in other parts of the country.
- A lack of local experts means a reliance on Alberta-based professionals who are already stretched too thin most times- building lasting local expertise remains difficult in this environment.
- Stable, long-term funding- the more this type of project is fragmented into portions of years at a time, the less valuable the data produced will be. Continuous, good quality data is needed to provide input into forecasting maps, modelling efforts, and up to date pest experience- not to mention a real picture of how climate shifts are affecting the organisms in the area. This is essential not only to agriculture's ability to adapt, but to human's in general. On a related note- to attract the desired level of expertise in a candidate, there should be some level of assurance the position won't disappear without notice- this takes a real commitment from a stable governing body, not ephemeral streams of project money.

This project has collected undeniably valuable data, which is present and will persist in AAFC databases. That means it can be used to adjust or create forecasting maps- though the value of this is reduced if accurate collection does not continue. It's demonstrated the absence of major pests (cabbage seedpod weevil, swede midge, cereal leaf beetle, clubroot) which gives confidence and reassurance to growers. As a pilot project, it was useful in gauging locals' reception to the idea of a locally based pest monitoring expert. Growers have claimed overwhelming support for such a service, and recognize its value. The difficulty is ensuring the pest monitoring expert does not overlap with private sector services for detailed monitoring/assessment and control decisions- this should not be the role of the public expert, as it is not with government extension workers.

Participation in nationwide surveys and research allows our region to be proactive in detecting and responding to new and emerging threats and means we'll be better equipped and able to adapt to any new pest issues that arise and develop here. Having as much time as possible to shift practices or develop mitigation techniques/products will help our growers sustain a lucrative agricultural practice no matter what the future brings.

Future work in this area should continue, and refine this legacy, using the difficulties listed above as a guide- our region has a gap in its ability to respond to pest issues without this position, and as the climate shifts, pest pressures will change, evolve, and increase- growers need the tools to meet these challenges head on if they are to maintain a competitive agricultural economy.

BC Peace Pest Monitoring