Insect Biodiversity - Field Lab

Standard Operating Procedures for APBI 260 Agroecology I field work at the UBC Farm - September to December 2014

Instructor:

Description

Students will work in teams to pilot a baseline study of the UBC Farm's pollinator populations that will continue next spring. They will also conduct a survey of both pest and beneficial insects present across the variety of land use types on the UBC Farm. The primary objective of the laboratory is to develop a set of basic data for each land use type that will enable a better understanding of the pest, beneficial and pollinator insect populations present across the UBC farm and to identify potential biological control and pollination enhancement options for other similar farms.

Learning Objectives

At the end of the lab students will be able to:

- ~~Estimate percent cover of flowering plant species~~*
- ~~Identify potential nesting sites for native bee species~~*
- Effectively capture flying insect species using an aerial net
- Set and collect terrestrial insect species from pitfall traps
- Identify the pest, beneficial and pollinator insect species found on the farm
- Enter data effectively
- Do basic statistics and graphical illustrations of data

*These components have been removed from the APBI 260 Insect Biodiversity lab component, since they will be covered in another lab group in the class. They should be conducted by future bee interns next summer during the Bee Biodiversity Inventory.

Equipment List

- ❑ 2 x iPad for data entry, identification and navigation
- ❑ 1 x walkie-talkie
- ❑ 1 x Field bag
- ❑ 1 x insect net
- ❑ 3 x sheets of insect labels
- ❑ 2 x mason jars
- ❑ 8 x pre-cut pieces of paper towel
- ❑ 1 x bottle of ethyl acetate
- ❑ 1 x bag of small and large ziploc bags to store insect and plant specimens
- ❑ 1 x container to protect insect specimens *label with group # and date*
- ❑ 1 x insect observation container
- ❑ 1 x Meter tape
- ❑ 4 x flags
- ❑ 1 x insect field identification guide (Evans)
- ❑ 1 x plant identification guide (Pojar & Mackinnon)
- ❑ 1 x 1 meter quadrat

Procedures

Students will navigate to four habitats on each lab day throughout the semester to sample insect specimens and assess pollinator habitat resources. Students will work in teams of 6 and decide how best to allocate their resources. Each team will decide on a lab team leader for the day. The lab team leader will be responsible for communications and insuring the effective, safe collection of data. When present, the instructor will demonstrate how a team leader operates.

> Selecting habitat types has been a continual discussion between Dr. Smukler and I throughout the semester, and with Veronik Campbell during my final presentation. Dr. Smukler has requested that we keep the number of habitat types down to four, as he would like to complete all plots in one day to work cohesively with other labs and to produce a larger data set. Three habitat types we were decided upon were the annual production field, forest, hedgerow and wetland. The reasoning for selecting these was that they are unique and diverse ecosystems, and are commonly found in many farms in our region. Two other options that were excluded were the perennial production field and the woodlot. The perennial production field was excluded (rather than the wetland) because it is somewhat similar in its agroecological properties to the hedgerow and annual production field. The woodlot was left out since it has similar properties but lower diversity to the forest habitat, and it is not commonly found on the average farm system.

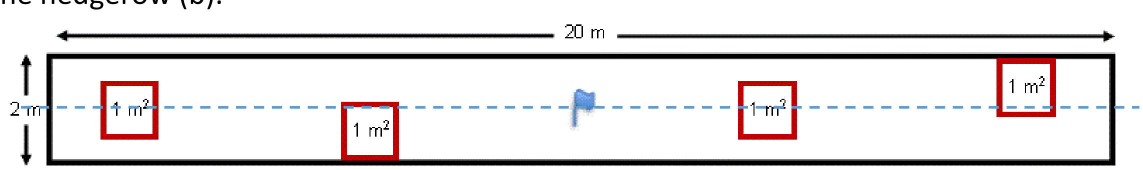
The team's tasks are to:

- Navigate to plot
- Delineate the plot (40 m^2)
- Complete a 15 min transect walk, capturing insects using the net and manual collection from plants
- Collect specimens from pitfall traps
- Identify all insect specimens or catalogue for identification in lab
- Survey % coverage of **flowering** plant species within each quadrat
- Survey % coverage of nesting substrates within each quadrat

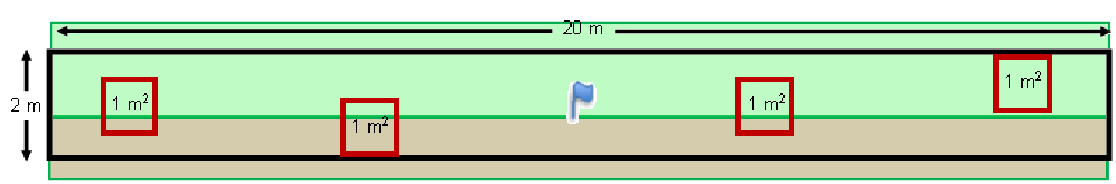
Plot Navigation and Delineation

1. Open the iPad app Trimble Outdoors
2. Select "Map"
3. Select "Goto" and find one of your assigned plots for the day
4. Follow the orange line to your selected plot
5. Repeat for the next plot
6. Delineate a 20m x 2 m plot taking into the following special case scenarios. For hedgerow plots, place the centre margin of the transect along the central margin of the hedgerow (a). For annual production field plots, align the transect parallel to the bed row & arrange so that 40% (0.8m) of the transect covers the path and 60% (1.2m) covers the hedgerow (b).

(a)



(b)



The $40m^2$ plot area was decided upon by Dr. Smukler and I in order to ensure that a wide enough range of diversity that is representative of the entire habitat is captured. While discussing the orientation of the transects to most effectively produce this outcome, we came across the unique case scenario of the annual (and perennial- but later excluded) production fields. Since the fields are composed of sequence of beds an dirt pathways, we concluded that I would need to take bed and path width measurements in the field and from those calculate the average relative percentage of bed width versus path width for the annual production field. I measured the path and bed widths from several rows in 3 different annual production fields, then converted them to relative percentages of 100. The average of these was ~60% bed width and ~40% path width. Since the hedgerows are rectangular in shape, we decided the transects should lie down their central margin. For the forest transects, their location and directionality will be randomized. For the wetland, taking a lack of accessibility to some areas into account, specific sites will be selected to ensure that the diversity of the entire wetland habitat is captures.

~~Habitat Survey~~ - To be conducted in another APBI 260 lab group, but should be conducted by future bee interns

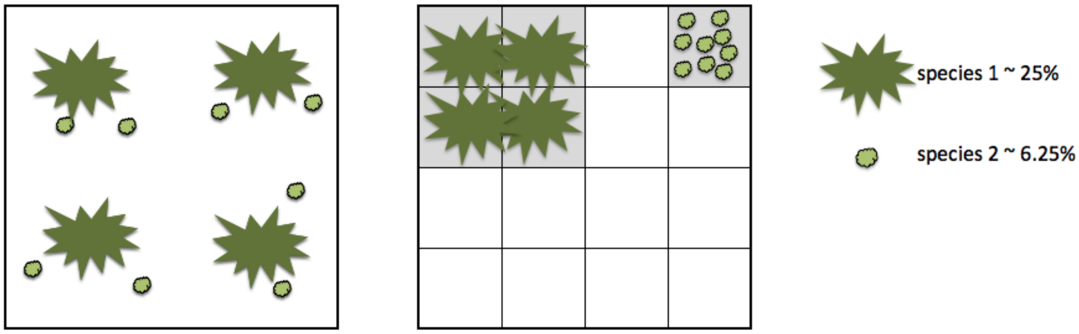
1. Designate one team member to record data and the other to conduct the survey assessments.
2. Enter your plot location, type and weather conditions into the iPad.
3. Set up quadrat in accordance with the above diagram below & enter # on iPad.

    Dr. Smukler designed the layout of the quadrats within the transect during one of our meetings in order to effectively sample the range of situational conditions (ie. Edges, centre, sides etc.) within the transect.

4. Take notes about the conditions of the site.
5. Identify each species of plant. Indicate if flowers are present and note what stage of floral development the species is at. Try as best as possible using Pojar & Mackinnon or Audobon app. If you cannot identify the specimen, take notes along with samples of flowers & leaves, and label the sample with date, plot # and "Unknown Plant #_"

    By noting which stage of development flowers are at, we can relate the species of insects present on each plot to the availability of floral and fruiting resources present. Studies that used transects to assess floral resources pollinators solely distinguished the percentage of "flowering" (Frund et al., 2010; Tommasi et al., 2004). Since the nature of this research has been extended to cover all insect species rather than only pollinators, this assessment must be broadened, as certain insects feed on flower buds, while others utilize fruit as an energy source.

6. Estimate percent cover for each species. Imagine aggregating into "zones" of the quadrat:



7. Record the percentage of flowering species on iPad.

8. Next estimate percent cover of bee nesting substrate using iPad menu descriptions

   The idea to include a nesting substrate estimate was inspired by Teresa Porter's Bee Management Plan (2013). The list of the types of nesting substrates was derived from Mader et al. (2011) and will be listed in the iPad app.

   - Hollow stems - Tunnel Nesting Bees
   - Abandoned insect tunnels - Tunnel Nesting Bees
   - Bare soil (untilled/unmulched) - Ground Nesting Bees
   - Abandoned rodent burrow - Cavity Nesting Bees
   - Brush or grass pile - Cavity Nesting Bees

9. Record the percentage of bee nesting substrate on iPad.
10. Repeat for all 4 quadrats within the plot

Beneficial, Pest and Pollinator Insect Biodiversity

1. Designate one team member to conduct the transect walk & capture, a second to be responsible for "processing" (ie. transferring, labelling and bagging specimens) and the third student who will record data and assist the processing team member.
2. Enter your plot location, type and weather conditions into the iPad.
3. To prepare the kill jar, absorb several dabs of ethyl acetate onto a paper towel piece, immediately place it inside the mason jar and seal it. More ethyl acetate will need to be re-added after about 5 uses of the jar, as the fumes will escape and lose their effectiveness (ie. the insects will die more slowly!)

   The procedure for preparing the kill jar was derived from Kearns & Inoyue (1993), and from personal instruction I experienced during a lab session during BIOL 327 (Intro to Entomology). The argument for killing insects is well-supported in Pohl's article (2009). He describes how capturing insects in small numbers for research has little effect on overall populations, and highlights that many species are nearly impossible to accurately identify without a microscope.

4. Set timer on iPad for 15 min.

   A 15 minute transect walk was derived from a study done by Tomassi et al. (2004), who was similarly working with a number of diverse habitats within the Vancouver region. Though their plots were smaller (25 m^2) we work within the time constraints of the lab period, while still utilizing our designated plot size as discussed in the "Plot Navigation and Delineation" section description.

5. Searching on plants and in the air, locate an insect and capture it if possible. If the insect can be identified using NWF ID book or Audobon Insect app without capturing it (ie. On a plant or in flight), record insect species, where found (plant species & flower colour & stage of development if applicable), on iPad.
   * Note that an insect is an arthropod with 6 legs, 3 body segments, and often 1-2 pairs of
   wings- spiders, centipedes, and isopods (wood lice) are *not* insects

   Designating where on the plant the insect is found can give us ecological evidence such as what part of the plant a pest targets, or what plant resource beneficial insects are utilizing for food or energy sources. Noting the flower colour that an insect is found on will give us information on what species of pollinating insects prefer which colours, and will be useful information for the ongoing bee management plan and future bee interns.

6. To catch an insect on a plant using the net, slowly lower it from above, as most will react by flying upwards. To capture an insect in flight, sweep the net fast enough to force the insect to the bottom, then rotate the handle so the bag is folded over the rim, or (if a safe distance from stinging insects)grasp the bag near the top in order to prevent the insect from escaping. Pass the net with the enclosed insect to the processing team

member and grab another net to continue capturing or, if there is only one net available, pause the timer during transfer time.

Aerial nets are a great tool for the active capture of flying insects. A proper in-lab demonstration of this technique will be a critical supplement to this description to help students fully grasp this procedure. The procedure description for capturing insects with a net was derived from Kearns & Inoyue (1993).

7. If the captured insect cannot be easily identified, transfer it to the kill jar by carefully placing the area of the net where the insect is trapped inside the jar. After 30 seconds- a minute, the insect will become paralyzed. At this point, remove the net from within the jar so the insect falls inside. Keep the insect within the jar for several minutes to ensure it has deceased, then transfer it into the labelled specimen bag. Multiple insects can be placed in the kill jar if necessary.

   As with the above capturing procedure, the in-lab demonstration of the kill-jar usage will be essential to ensure students wholly understand how to use them. As mentioned above, the procedure for using the kill jar was derived from Kearns & Inoyue (1993).

8. On an insect label, write the following: date, plot #, and "Unknown Insect #_" (starting from # 1 at each new plot visited) and place it on the specimen bag. Carefully transfer the specimen bag into your group's specimen container.

   Dr. Smukler and I came up with this labelling system in order to ensure that every specimen caught is labelled uniquely.
9. Repeat above procedure for entire timed capture.
10. If no insects can be found, look for evidence of insects such as holes in leaves from chewing, discoloration from sucking or holes from tunneling. Take a picture of the evidence, and note the location, type and severity of damage on iPad.

Terrestrial Insect Biodiversity

Dr. Smukler and I decided to include pitfall traps in the survey upon deciding to expand our study to include beneficial and pest insect species. Pitfall traps are both cost-effective and low maintenance, and a commonly used trapping technique. They consist of an open container sunk into the ground that passively samples surface-level terrestrial insect biodiversity (Work, 2002). For APBI 260, our pitfall traps consist of two 475 mL plastic cups, each with a square incision in the bottom. One will be placed within the other, and the one on top will contain a mesh square to cover the opening and allow any moisture to flow through without the insects escaping. This specific setup was derived from a Volunteer Resource Manual produced by the User Network for Insect Biology in the Urban Garden (Wahl et al., 2014).

1. Enter your plot location and type into the iPad.
2. Carefully lift off protection plate and remove inner cup of pitfall trap from outer cup
3. Individually transfer insect specimens into observation container and identify using NWF ID book or Audobon App.

   * Though not insects**, millipedes** (2 sets of legs per body segment, legs only slightly visible from above vs. centipedes which are predatory and have 1 pair legs per body segment and are completely visible from above) **and isopods** (pillbugs & sowbugs) **will be included** due to their essential role as decomposers and indicators of ecosystem health. Exclude all other organisms collected in the traps (spiders, centipedes etc.).

   Since one of our main objectives for this lab methodology are the "keep things interesting" (Dr. Smukler) for the students, and our forest pitfall trap turned up a number of millipedes and isopods, I decided to look into if it would be appropriate to include a few other arthropods in our terrestrial biodiversity survey. According to Snyder and Hendrix (2008), both terrestrial isopods and millipedes play a significant role as bioindicators of the health of an ecosystem, since they play a large role in decomposition (breaking down leaf litter into soil). Paoletti et al. (2007) determined that terrestrial isopods are sensitive to disturbance and mosisture levels. They also note that millipedes play a significant role of litter decomposition (25%) in the absence of earthworms. As their roles as decomposers should not be excluded from a terrestrial biodiversity survey, both millipedes and isopods several common species from these groups have been included in the data entry list on the iPad app.

4. Record insect & arthropod species in iPad.
5. If species cannot be identified, repeat steps 7 and 8 above.

References

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