Project Plan

1. Project Title: Determining drivers of soil invertebrate communities: disentangling abiotic and biotic factors.

a. Group Members:

Alex, BIOL570L Students

2. Topic Background Statement:

An ecosystem is structured both by abiotic and biotic factors which govern the ecological landscape in which communities of organisms interact. A major determinant of ecosystem structure can be the presence of certain foundational species. These organisms can structure other communities by providing physical structure, alternations in habitat, and other non-trophic interactions influencing ecosystem processes (Ellison 2019). In forest ecosystems, certain species of trees can be foundational species. The removal of such taxa can result in a wide range of ecosystem-wide consequences (Ellison et al. 2005). They provide habitat for a wide range of organisms both above and below ground. However, trees themselves can be restricted to certain abiotic environments. Thus, the composition of foundational species in a forest might change over relatively short distances.

One major way in which trees influence the ecosystem is through altering soil properties through their leaf litter. This leaf litter is then decomposed by a diverse assemblage of invertebrates. However, it is unclear what determines the structure of the littler invertebrate community. Some studies noted that litter communities did not vary with habitat type (Vasconcelos & Laurence 2005) or altitude (Olson 1994). However, they did not investigate the influence of distinct tree species on the litter community. Here, we propose studying both the tree-specific effects on litter community and the soil moisture affects.

3. Main Question(s):

How does the dominant tree species vary as the soil characteristics change?

Does the leaf-litter invertebrate community have tree-specific associations? Or is the community more-so determined by abiotic characteristics like soil moisture?

4. Hypothesis(es):

(H1): Along a strong, but short, moisture gradient the dominant tree species will vary in distinct regions.

(H2.A): Trees alter the soil composition at a hyper-local scale, so that their leaf-litter supports distinct communities of invertebrates.

(H2.B): Alternative to H2.A, it could simply be that the abiotic factors are the primary factor determining soil community structure, and the community will vary based on the soil characteristics rather than tree-species.

5. Proposed Methodology:

This proposed research has a number of distinct hypotheses to investigate. First, to test H1, trees will be characterized along a transect. They will be identified to the best possible taxonomic resolution. Trees

will be sampled along a hill with a strong moisture gradient in the Gordon Belser Arboretum. This is a protected region in an urban environment with several old trees.

Tree will be sampled using a 2-m wide band transect approach. Approximately 4 transects will be ran up the hill. The starting position of the transect will be randomly assigned along a 25-meter base line. The top of the transect will be approximately 75 meters away. To collect data to test H1, all trees within 1m of either side of the transect will be identified. Each tree will also be measured using a DBH tape (diameter at breast height ~1.5m above ground level). This will facilitate the calculation of tree size and their relative importance along the transect.

Next, to test H2, we'll need to characterize invertebrate litter communities. Little samples will be collected along two distinct regions along the transects. The regions will be representative of the upper soil community and the lower soil community. To distinguish the effects of tree- to the soil moisture effect, we will sample haphazardly trees in the subregions which are representative of the area. Then we will sample open areas which are far away from any tree but still affected by the soil moisture community. While the exact sample size will vary based on available trees and space, the aim will be to collect 3 soil samples per subregion per transect.

Each litter-community sample will be a 10cmx10cm plot. In that plot, the whole little will be extracted as well as the top 3-cm of soil. These samples will be placed into a Ziploc bag and transported to campus. Invertebrates will then be extracted using Burlese funnels which will run for a minimum of 24 hours.

a. List of Needed Equipment:

In-field:
- Transect tape
- DBH tape to calculate tree diameter
- Soil-sampling shovels
- Soil-storage containers w/ sharpies.
- Tree identification guides

In-lab
- Burlese funnels
- Ethanol

b. List of Collected Variables:
- Tree species (categorial)
- Tree diameter (continuous)
- Transect position (continuous)
- Invertebrate species (categorical)
- Invertebrate abundance, biodiversity, composition (continuous)
- Relative importance of trees (derived variable, continuous)

c. Proposed Analysis Method:

To test H1, we will need to calculate which tree is the dominant species throughout the transect. To do this, we can calculate the relative importance index of each tree species in discretized regions along the transect. Then, for each major tree species, we can conduct a linear regression of its relative importance along each subsect of the transect. Note that this analysis assumes that there will be enough trees to calculate many discrete subsects of the transect. If there are too few trees, larger subsects will be constructed which may result in the need for a different test, like an ANOVA.

Then to test H2, soil invertebrate communities will be collected at two regions of the transect, a wet-soil region and a dry soil region. From these samples, we will calculate the abundance of each invertebrate community. Then those abundance metrics will be compared within each region between the dominant tree species and the non-tree impacted site using a t-test. Comparisons between tree taxa can also be conducted between regions using a factorial ANOVA.

Finally, bulk comparisons of community structure can be done with a non-metric multidimensional scaling ordination plot (NMDS).

6. Group Member Responsibilities:

Alex: Provide supplies, process invertebrate samples in lab.

BIOL570L Students: Collect field samples, process invertebrate samples if interested.

7. References:

Ellison AM. Bank MS. Clinton BD. Colburn EA. et al. 2005. Loss of foundation species: consequences for the structure and dynamics of forested ecosystems. *Front. Ecol. Eviron.* 3(9): 479-486.

Ellison AM. 2019. Foundation species, non-trophic interactions, and the value of being common. *iScience.* 13: 254-268.

Olson DM. 1994. The distribution of leaf litter invertebrates along a Neotropical altitudinal gradient. *J. Tropical Ecology* 10: 129-150.

Vasconcelos HL. Laurance WF. 2005. Influence of habitat, litter type, and soil invertebrates on leaf-litter decomposition in a fragmented Amazonian landscape. *Ecosystem Ecology* 144: 456-462.