# Relationship between floral and faunal communities: Vegetation and Insect Surveys at the Wildlands Conservancy

Introduction

Ecological communities consist of groups of coexisting and interacting species. These species, of course, include animals, plants, fungi, protists and bacteria. As we learned in the previous study, **we define a community by its dominant plants**. But what determines which plant species are found in a community? Certainly, interactions with other species will affect what species occur in a community. You will learn later in the semester that **interspecific competition** (i.e., competition among individuals of different species) can be important in determining community structure (i.e., species composition). On a more basic level, **abiotic factors** (i.e., non-living) can have a significant effect on species composition. This is because species vary in their **tolerances** for specific abiotic factors. For example, some species can tolerate higher temperatures or lower pH or require more moderate humidity than other species. This relates to the concept of the **ecological niche**, which is a full range of conditions and resources under which individuals of a species can live, grow, and reproduce. Later in the semester, we'll discuss the concept of **biomes**, which are distinct terrestrial plant communities that occur at the regional or subcontinental scale. Tropical rainforest is a type of biome, as is eastern deciduous forest. Of course, biomes are defined by dominant vegetation. And, the amount of usable moisture and average temperature determines the type of vegetation, dominant or otherwise, that occurs in a biome (Fig. 1).
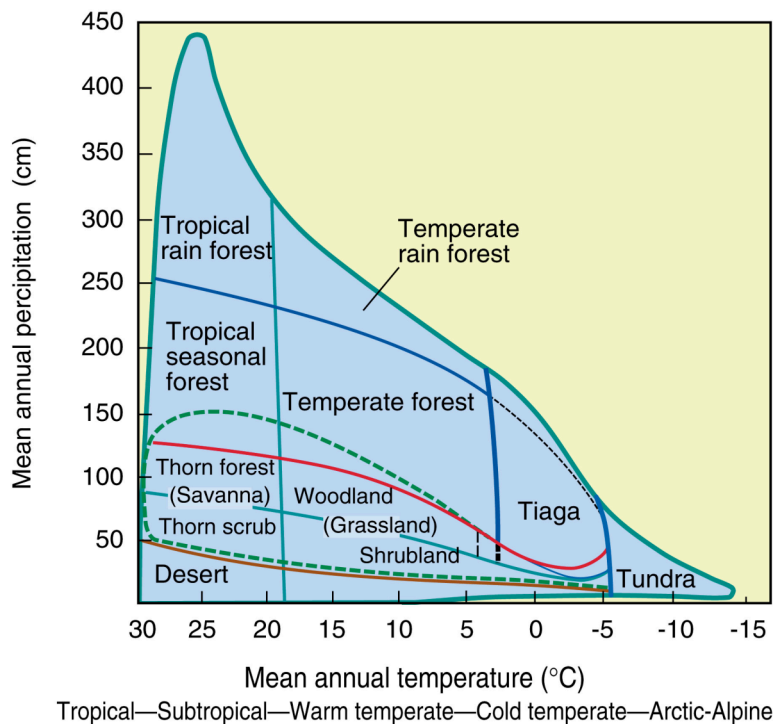
Figure 1. This graph shows how the interaction between temperature and usable moisture determines the biome type of a region.

So, what about animals? Animals also respond to abiotic factors such as temperature and moisture. pH can also be important, especially for aquatic animals. But, fauna is also determined by flora. This is because herbivores tend to be specific in their diets. Thus, a biome is not only distinguished by its dominant vegetation, but also by its animal communities (Fig. 2). Think about how a tropical rainforest differs from an eastern deciduous forest in both the plants and animals that inhabit each.
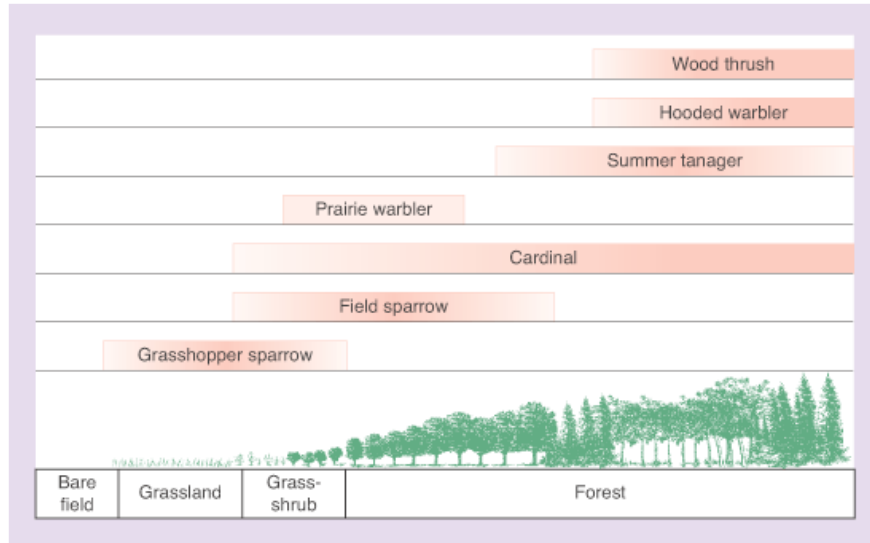

Figure 2. Graphic showing the relationship between biome type and bird community structure. The intensity of shading indicates relative abundance of each bird in that biome (from Townsend et al. 2003)

The type of project that we will conduct is known as an **Ecological Survey**. The objective of this study is to collect basic ecological data to test the hypothesis that plant and animal community structure are correlated. We predict this because of what I discussed above. To make the study more tractable, we will focus our animal surveys on insects and spiders. The study will be conducted at the Wildlands Conservancy and we will survey the field and forest fragment that we looked at during our first trip out there. Thus, we predict that the structure of the insect community will differ between forest and field. To test this prediction we will determine the (1) community type of each fragment (forest and field) and (2) structure of the insect community in each fragment. We will compare the results from the vegetation survey to a guide developed by the Ohio Department of Natural Resources to define the field and to Fike (1999) to define the forest. Insect and spider data will be analyzed using the Shannon-Weiner diversity index to determine whether insect diversity is similar between forest and field and the Jaccard Coefficient of Community Similarity to quantify the level of similarity between insect communities in the forest and field.

Methods

General Methods

Insects & Spiders

There are quite a few ways to sample insects and spiders. Some methods work best with certain types of insects and spiders or in certain types of habitats. In the field, we will use a **sweep net** to sample insects and spiders. This is a robust "butterfly net" that is swept through the vegetation to capture insects and spiders. We will use a **beating sheet** to sample insects and spiders in the forest. This is a square piece of fabric that is held open with wooden dowels. To capture insects and spiders, you hold the sheet under a branch and "beat" the branch (firmly but not too vigorously) with a stick to knock insects and spiders from the branch and onto the sheet. The insects and spiders are then captured using an **aspirator**. In the forest we will also systematically sample along the transect by collecting leaf litter. These will be sifted and sorted so that insects and spiders can be more readily removed using an aspirator.

Vegetation

There are two commonly used methods to sample vegetation, the plot (or quadrat) method and the plotless method. We will be using both methods.

A **quadrat** is a defined area in which to sample. Quadrats can be of any shape but circular, square or rectangular are the most commonly used shapes. The size of the quadrats can vary also from $0.25m^2$ to $100m^2$ and is dependent on what type of vegetation is being sampled. For example:
- For trees (woody stems $\geq$ 9 cm dbh): $100m^2$
- For shrubs and woody stems 2.5 to 9 cm dbh: $10m^2$
- For grasses, herbaceous plants and woody stems (seedlings & sprouts) < 2.5 cm dbh: $1m^2$

dbh=diameter at breast height (1.5 m), the standard height at which the circumference of a plant is measured.

We will use quadrats to sample the field. And according to the above list, we will be using $1 \ m^2$ quadrats.

We will use a plotless method to sample woody stems, shrubs, and trees in the forest fragment. There are several different plotless methods that we can use but we will use the **line-intercept** method. To survey using the line-intercept method, we will place 30m transects through the fragment and identify any plant with a circumference (at breast height) $\geq$ 1.0 cm that touches the transect or extends over the transect.

Overall Procedure

We will conduct the study in the following steps:
1. In each habitat, a 30m baseline transect will placed along a path parallel to the fragment. Choose a random number and extend from this meter mark another 30m transect perpendicular to the baseline transect into the fragment.

2. **INSECTS & SPIDERS:** *Conduct the insect surveys before you do the vegetation surveys.*

   In the **forest**, walk along the transect and beat all the vegetation that touches or overlays the transect. Walk slowly and beat as many branches and shrubs as you can. Be sure to aspirate the insects and spiders from the sheet before moving onto the next plant or you will lose the more mobile species. When you are done, remove the vial from the aspirator, quickly place a label in the vial indicating habitat, collectors, date, and time (you will need to make this up before starting sampling), cap it, and place the vial in the cooler to cool down and immobilize the insects and spiders.

   Next, chose <u>TWO</u> random numbers and mark the corresponding meter marks along this transect. Place one of the corners of the 0.0625 m^2 (0.25 m X 0.25 m) quadrat at the point, making sure that the edge of the quadrat is placed right against the transect line. Be sure to place the same corner (lower or upper) at each point. Before placing the first quadrat, decide to sample either from the left or right side of the transect first then sample from alternate side for the next sampling point. Collect the leaf litter found within the quadrat down to the soil layer. Place the leaf litter in the tin pans and collect the insects and spiders using the aspirator. Place the label inside the vial, cap the vial and place it in the cooler.

   For the **meadow**, walk *slowly* along the transect and sweep the sweep net along both sides of the transect. Be sure to sample as much vegetation as possible. Remove the insects and spiders using the aspirator Place the label inside the vial, cap the vial and place it in the cooler.

   Once the insect and spider sampling has be completed, identify each individual to **Order**. Be sure to record the number of individuals found in each Order. **You will be given a list of commonly found insect orders so it would be very helpful to make a data sheet that lists these orders *before* you begin to identify the insects and spiders.** Then you would only need to maintain a tally. Once you have identified the insects and spiders to the order level, please release them into the appropriate habitat. Do not release specimens that you cannot identify. We will take them back to the lab and you will have the opportunity to identify them in the lab.

   Remember, spiders are *not* insects. Insects are animals of the Class Insecta (Phylum Arthropoda). Spiders are arthropods, as well, but they are from Class Arachnida.

3. **VEGETATION:** In the **forest**, you will be using the **line-intercept method** to sample vegetation. You will identify to species all individual plants that are ≥ 1.0cm circumference at breast height (bh), which is 1.5m. **You will need to record the circumference of each individual you identify**. For multi-stemmed shrubs or trees, calculate the circumference at the point of greatest diameter.

   For the **meadows**, chose five random numbers and mark the corresponding meter marks along the transect. Place a 1m^2 quadrat at each of the randomly chosen sampling points. Place one of the corners of the quadrat at the point and make sure that the edge of the

quadrat is placed right against the transect line. Be sure to place the same corner (lower or upper) at each point and start on the opposite side of the transect that you began the leaf litter sampling. Be sure to sample alternate sides and start on the side opposite from the side you started the leaf litter collection. **For each quadrat, identify each plant to species (< 1.0cm circumference at bh) and estimate the % coverage for each species by estimating the total area of the quadrat the "canopy' of a species occupies. Be sure to keep the data organized by quadrat**. You will have to make a judgment on whether to include an individual if it is not completely inside the quadrat. Usually, if it is more than half in, it is included.

Recording Data and Data Analysis

Each member of the research team must keep his/her own notebook. <u>But, do not split up data between notebooks</u>.

So, what are the hypotheses (H_A and H_0) we are testing? What are the predictions? If you are unsure, please speak to your lab instructor. However, knowing the type of data we are collecting and the analyses we will conduct might help you figure this out. Remember, hypotheses are the tentative answers to your causal question and predictions are the results you expect if your hypothesis is correct.

Data Calculations & Analysis

WE WILL COMBINE THE CLASS DATA INTO A SINGLE DATA SET. YOU WILL ANALYZE THIS DATA SET FOR YOUR PAPER. A SPREADSHEET WILL BE PLACED ON THE MAC IN SC 106 FOR DATA TAULATION. EACH GROUP WILL BE RESPONSIBLE FOR PUTTING THEIR DATA IN THE SPREADSHEET BY THE DATE INDICATED BY YOUR INSTRUCTOR.

Insects and spiders: To determine how similar the insect communities are between field and forest, you will calculate two indices: the **Jaccard Coefficient of Community Similarity** (CC_J) and **Shannon-Weiner Index** (S-W).

The CC_J provides a measure of the similarity of two communities based on presence and absence of species. The index ranges from 0 (when no species are held in common) and 1 (when all species are found in both habitats). The index is calculated as:

$$CC_J = c/(s_1 + s_2 - c)$$

where s_1 and s_2 are the number of species in community 1 and 2, respectively, and c is the number of species common to both communities. Multiply the answer by 100 to give you the measure as percent similarity. ***NOTE***: ***We will be using Orders instead of species but the formula still holds***. Just replace species with Order.

The S-W Index provides a measure of ***species diversity***. So, in addition to determining whether the two habitats are similar in species composition, you will determine if they are similar in species diversity. *Species diversity is commonly confused with **species richness**, which is the*

number of different species that occur in a community. Species diversity considers not only the number of species that occur but also the **evenness** of occurrence of individuals of each species (i.e., the proportion of the total number of individuals that occurs in each species). For example, a community that has **100 individuals, maximum diversity occurs when all of the individuals are equally divided among 10 species and minimum diversity occurs if 99 individuals were of one species and only 1 individual in each of the other 9 species. The species richness is the same between the two examples (s=10) but the distribution of individuals is more even in the first example.**

The S-W index is calculated as:

$$H = -\sum_{i=1}^{s} (p_i)\,(\ln p_i),$$

where H is the diversity index, s is the number of number of species, ln is the natural, and p_i is the proportion of individuals of the total sample belonging to the ith species.

Another way to think about this is that the higher the value of H, the greater the probability that the next individual chosen at random from all the individuals in the community will be a different species from the one previously chosen. The lower the H, the greater the probability that the next randomly chosen individual will be the same species as the one chosen previously.

Again, we will substitute species with Order. So, instead of species diversity, we will measure Order diversity.

Vegetation: You will use coverage to determine dominance. Once coverage is determined, you will rank species by calculating relative coverage. Once this is done, use Ohio Department of Natural Resources guide and Fike (1999) to define habitat types. <u>We recommend that that you use the five most dominant (=highest relative cover) to define the habitat.</u>

Forest: To determine coverage, measure the circumferences of plants at a height of 1.5 m, or chest level. You will then use a chart to determine the basal area from the circumference (chart will be located in SC106 next to the Mac). A direct measure of foliage coverage is difficult in trees but the basal area is proportional to coverage.

Once you have calculated the coverage for all of the sampled plants, (1) add up the area covered by each species and (2) determine total area covered by all species. To determine relative coverage for each species, use the following formula:

$$RC_i = C_i / \sum C$$

Where RC_i = relative coverage of the ith species, C_i = total coverage of the ith species , and $\sum C$ = the area covered by all the sampled species.

Field: Estimate the % coverage of each species each quadrat. Because we will be using $1m^2$ quadrats, the % coverage equals area covered. For example, if a particular species covers 40% of a quadrat, the coverage (i.e., area covered) is 0.40m.

Relative coverage is calculated as described above except that coverage is determined directly from the area covered by each species.

BECAUSE WE WILL RECORD DATA BY TRANSECT, WE WILL COMBINE DATA INTO A SINGLE DATA SET AND CALCULATE AVERAGE RELATIVE COVER FOR EACH SPECIES, AVERAGE H FOR EACH HABITAT, AND AVERAGE CC$_J$. YOU MIGHT ALSO WANT TO CALCULATE STANDARD ERRORS IF YOU PLAN ON USING GRAPHS TO REPORT RESULTS.

Assignment

You will report your findings in a scientific paper in the format of the journal *Ecology.* You will be required to include title, authors (with you being first author), affiliation, results, discussion, and literature cited section. Do you remember what were the objectives/hypotheses of the study? **Be sure to refer to the grading checklist provided with syllabus, the handout on writing a scientific paper in the format of *Ecology*, and speak to your instructor while writing the paper.** And remember, you were part of a large research team that worked on a *single* research project. This was not a collection of several mini-projects. So, your writing must reflect this. Report and discuss the <u>entire</u> data set.

Random Number Table

8	0	13	14	27	13	24	2	20	1	25	15	0	5
24	25	1	12	10	13	0	22	24	26	17	27	25	14
14	24	8	22	28	6	23	24	18	3	25	2	6	26
13	12	3	0	29	28	5	2	14	12	18	16	20	28
1	7	10	18	24	25	22	4	20	2	12	1	9	22
6	18	21	15	7	25	10	2	16	13	8	5	3	23
23	29	11	20	4	27	27	17	17	6	19	28	16	25
25	0	24	17	13	5	0	21	17	4	11	20	26	20
1	28	25	17	17	28	16	28	11	27	18	8	17	27
0	1	28	29	0	11	20	13	18	12	1	11	12	16
17	24	19	11	25	22	22	1	22	1	2	11	29	6
29	0	23	22	19	4	14	14	13	26	15	18	11	3
8	19	6	15	28	5	19	10	28	5	29	27	8	0
24	25	0	4	0	6	14	9	23	12	28	17	24	2
5	19	0	23	13	6	13	20	27	26	14	28	14	22
14	24	8	13	25	22	3	16	10	22	5	15	5	11
26	12	27	20	23	21	3	6	11	7	0	23	22	7
15	29	22	5	20	18	25	29	1	23	17	6	19	1
12	16	10	16	16	18	11	7	3	2	2	5	1	25
23	25	22	27	6	17	22	8	19	25	15	1	22	21
26	14	8	5	3	11	15	14	28	14	29	20	14	17
18	7	21	17	4	25	16	15	16	3	8	20	0	2
22	4	22	25	17	27	8	13	22	24	14	1	13	22
17	6	1	24	16	13	4	2	4	18	18	23	18	27
7	17	24	22	15	15	21	16	12	16	29	4	15	29
3	5	16	1	2	9	23	14	1	23	13	26	4	14
12	29	18	21	13	0	1	18	1	22	6	19	1	1
8	27	12	29	11	2	7	18	13	29	18	23	24	21
1	4	8	29	1	0	0	4	19	22	24	3	20	19
28	26	22	17	1	0	25	20	2	17	24	17	11	24
20	25	18	9	18	10	26	25	26	15	18	8	22	23
19	15	8	7	2	18	17	4	11	8	27	15	22	20
24	22	21	2	11	4	2	20	1	27	17	16	3	12
9	18	18	13	2	11	17	29	12	11	28	17	7	5
29	10	19	24	12	28	21	25	10	6	25	21	19	4
29	23	22	13	10	3	15	15	25	8	14	3	28	16
20	21	27	14	11	17	3	25	23	10	28	6	17	9
3	12	23	15	20	6	4	26	6	10	18	9	0	0
23	26	15	28	3	16	7	13	20	4	2	26	19	18