

Plant community structure

In this lab, we will investigate the effects of exotic plant invasions on native plant community structure. Scotch broom (*Cytisus scoparius*) is a woody shrub that is native to France and England. Over a hundred years ago, the British introduced scotch broom into the grasslands of India as an ornamental. It has been noticed that this shrub is steadily taking over the grasslands, and little has been done to curb its rampant spread. A group of amateur conservationists in India want to conserve the grasslands and they hope to influence ecologists to study the effects of scotch broom invasion on native plant communities, and investigate removal methods. But before this can be proposed to the Forest Service, they need some preliminary data to convince the authorities that the scotch broom is indeed a problem. The amateur conservationists had little time and money, and they were able to collect plant community data from only 10 plots in the grassland. Of this, 6 plots were invaded by scotch broom, and 4 were uninvaded patches. They laid 5mx5m plots, and within these plots listed all the native plant species, and estimated the cover percentage of each species. They have compiled their data as a list of species and the cover percentage of each species in each plot. They have now requested us to analyze their data and see if this data is enough to show that the scotch broom is negatively affecting the grassland plant community.

The data is in an Excel file **Scotchbroom lab.xls**

The file should have 4 work sheets:

Scotch broom plots **grassland plots** **species richness** **community composition**

We will analyze 4 parameters of community structure in the scotch broom plots and the uninvaded grassland plots separately:

1. Species richness – number of species per plot
2. Species composition – make-up of species in invaded plots and uninvaded plots
3. Species diversity – Shannon Weiner index of diversity
4. Species evenness – Simpsons's index

Q1. Predict for each of these parameters if they will be greater in scotch broom invaded plots or uninvaded grassland plots.

Species richness

The species richness is simply the number of unique species found in each plot. To calculate this:

1. Open the file **Scotchbroom lab.xls**
2. Click on the worksheet tab **scotch broom plots**
3. In the cell **B27** type `=COUNTIF(B3:B22,">0")` Hit **Enter**
4. Now right click in cell **B27** and click on **copy**. Select cells **C27 to G27**; right click and click on **paste**. The formula should get copied into all these cells. Now you have the species richness for each plot
5. Now do the same in the worksheet tab **grassland plots**. *Remember that the cell numbers may be different, so be sure to change formulas accordingly.*

Graphing species richness

1. In worksheet **scotch broom plots**, select cells **B27 to G27**. Right click and select **copy**.
2. Go to worksheet **species richness**. Right click on cell **B3** and select **paste special**. In the dialog box that pops up, select **values** and **transpose**.
3. Similarly copy species richness values from worksheet **grassland plots** to the worksheet **species richness**. *Change formulas appropriately.*
4. In the worksheet **grassland plots**, click on **Insert... Chart**
5. Select **Line**, and the chart with the markers joined by lines. Click **Next**
6. Click on the tab **Series**. Click on **Add**.
7. Against **Name**, type "scotch broom invaded plots"; hit **tab**.
8. The box against **Values** should get selected black. *Do not click anywhere on it.* Select cells **B3 to B8**. Hit **tab**
9. Click **Add**.
10. Against **Name**, type "uninvaded grassland plots"; hit **tab**.
11. The box against **Values** should get selected black. *Do not click anywhere on it.* Select cells **C3 to C6**. Click **Next**.
12. Against **Category (X) axis**, type "plot number"; against **Value (Y) axis** type "species richness".
13. Click **Finish**.

Species composition

Species composition is basically a list of species present in each group of plots.

Calculating average of each species cover:

1. Click on the worksheet tab **scotch broom plots**
2. In cell **H3**, type `=average(B3:G3)` Hit **Enter**
3. Right click on cell **H3**, and select **copy**
4. Select cells **H4 to H22**, right click and select **paste**. The formula should get copied to all these cells.
5. Now do the same in the worksheet tab **grassland plots**

Listing the species that are represented in each group of plots

1. In worksheet **scotch broom plots** select cells **H3 to H22**. Right click and select **copy**.
2. In worksheet **community composition**, right click in cell **B2** and select **paste special**; select **values** in the dialog box that pops up.

3. Similarly copy the values of **average % cover** from the worksheet **grassland plots** to the worksheet **community composition** in column “% cover_g”.
4. Now **copy** the species names from worksheet **scotch broom plots** and **paste** in worksheet **community composition** in column “scotch broom invaded plots”.
5. **Copy** the species names from worksheet **grassland plots** and **paste** in worksheet **community composition** in column “uninvaded grassland plots”.
6. Now in each average % cover column look for any 0s. If there are any, select the cell as well as the name of the species it is against (in column to the left of the number), right click and select **delete**. Click on **shift cells up** in the dialog box that pops up.
7. Now you have a list of species for each group of plots – scotch broom invaded plots and uninvaded grassland plots.

Species diversity

The Shannon-Weiner index of diversity is the most common diversity index used. This index takes into consideration the number of species as well the abundance of each species in each plot and calculates an index H' that varies from 0 to 4. Higher the value of H' , the more diverse the site is.

$$H' = -\sum p_i * \ln(p_i)$$

where p_i = the proportional abundance of the i^{th} species, calculated by n_i/N

n_i = number of individuals (or % cover in our case) of the i^{th} species

N = total number of individuals (or total % cover in our case)

We will calculate these values using the % cover averaged over all plots.

Now let's calculate the Shannon-Weiner index for scotch broom invaded plots and uninvaded grassland plots.

1. go to the worksheet **scotch broom plots**
2. In cell **H23**, type **=SUM(H3:H22)** Hit **Enter**
3. In cell **I3**, type **=H3/H\$23** Hit **Enter**
4. Right click on cell **I3**, select **copy**.
5. Select cells **I4 to I22**, right click select **paste**. The formula should get copied into each of the cells. *Now you have the average proportion of cover for each species, p_i .*
6. In cell **J3**, type **=LN(I3)** Hit **Enter**
7. Copy this formula in cells **J4 to J22**. Ignore anything that says #NUM!
8. In cell **K3**, type **=I3*J3** Hit **Enter**
9. Copy this formula in cells **K4 to K22**.
10. In column K, click on each cell that says #NUM! and hit the delete button. *The cell should become empty.* Leave it so.
11. In cell **K23**, type **=SUM(K3:K22)** Hit **Enter**. You should get a negative number. This is almost the Shannon-Weiner index, but not quite yet. *Can you tell why?*
12. In cell **K24**, type **=K23*-1** Hit **Enter**. *Now you have the Shannon-Weiner index.*
13. Now follow the same steps for the worksheet grassland plots. *The cells are not exactly the same, so be careful to change the cell numbers in the formulas appropriately.*

Species evenness

The Simpson's index D gives us a measure of evenness, or how even a community is with respect to the species present there. In other words, it is the probability that any 2 random individuals picked from a community will belong to the same species. The higher this probability, the higher the evenness of the community. It may also be regarded as an index of dominance, since if a species is dominating in a community, most individuals in the community will belong to that species, and it is probably going to be an "even" community. Hence it is intuitive that a more even community is less diverse. Also a more even community has a strongly dominant species, while a less even community may not have a clearly dominant species. D ranges from 0 to 1.

Simpson's index of evenness is given by

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where n_i = total number (or total % cover) of individuals of the i^{th} species

N = total number (or total % cover) of individuals in the community.

Simpson's diversity is given by $1-D$.

1. Go to the worksheet **scotch broom plots**
2. In cell **B23**, type **=sum(B3:B22)** Hit Enter
3. Copy this formula and paste in cells **C23 to G23**.
4. In cell **G24**, type **=sum(B23:G23)** Hit Enter
5. In cell **G25**, type **=G24-1** Hit Enter
6. In cell **G26**, type **=G24*G25** Hit Enter
7. In cell **L3**, type **=sum(B3:G3)** Hit Enter
8. Copy this formula to cells **L4 through L22**
9. In cell **M3**, type **=L3-1** Hit Enter
10. Copy this formula to cells **M4 through M22**
11. In cell **N3**, type **=L3*M3** Hit Enter
12. Copy this formula to cells **N4 through N22**
13. In cell **N23**, type **=sum(N3:N22)** Hit Enter
14. In cell **N24**, type **=N23/G26** Hit Enter. This is the Simpson's index of evenness.
15. Similarly calculate the Simpson's index in worksheet **grassland plots**. Take care to change cell names in formulas appropriately.

Now that the data has been analyzed, answer the following questions.

Q2. Fill in the values in the following table:

	Scotch broom invaded plots	Uninvaded grassland plots
Species richness		
Shannon-weiner diversity H'		
Simpson's index D		

Q3a. Plot the graph of species richness in each plot below. The graph should be properly labeled.

Q3b. From the graph above, are scotch broom invaded plots similar to each other in species richness?

Are uninvaded grassland plots similar to each other in species richness?

Q3c. Which group of plots has the higher species richness?

Q4. From the community composition list of species in each group of plots, how many species are unique in each group and common to both groups? List their names also.

Exclusive to scotch broom invaded plots:

Exclusive to uninvaded grassland plots:

Common species:

Q5. Which group of plots has a higher Shannon-Weiner index? What does this mean?

Q6a. Which group of plots has a higher Simpson's index? What does this mean?

Q6b. In which group of plots is there a possibility of a dominant species?

Q7. Do you think that the scotch broom has affected the native species composition? Explain.