Comparing Ecological Communities
Part One: Classification

Reading Assignment: Ch. 15, GSF

Review Community Ecology Lecture, Sept. 17

And GSF, Chapter 9

What are three basic ways vegetation can be quantified?

- Make sure to review these concepts before Exam 2.

Univariate vs. multivariate techniques

- If each community is represented by a single variable, such as biomass per unit area, univariate techniques such as ANalysis Of Variance (ANOVA) can be used
- If each community is represented by multiple parameters, such as a species list, multivariate techniques must be used
- Math techniques reduce multiple variables into one or more dimensions, by comparing differences in values for the entire data set at the same time

Multivariate techniques

- Multivariate techniques allow us to:
  - Quantify differences in community composition and structure
  - Evaluate how species are distributed among communities
  - Determine relationships between community composition and environmental variations

Why classify vegetation?

- Quantitative methods of classification are needed for establishing objective and repeatable categories

Advantages:

- Vegetation is a strong, if complex, indicator of the ecological functioning of natural systems
- Vegetation is readily measured for inventory and monitoring purposes at multiple scales
- Change over time is more easily monitored in communities than individual species

Why classify vegetation?

Disadvantages:

- Vegetation is dynamic temporally and highly variable spatially
- Many categories may be needed
- There will always be gray zones between categories

How are groups defined?

- A non-numerical approach is to create an ordered (differentiated) table from a raw data matrix
  - First, a species list is made for each study site
  - Then, grouping of species that are found together, and sites that share the most species, is done
- More quantitative techniques for deciding how to create groups, or communities, reduce the subjectivity

TABLE 15.1 The use of presence/absence data to analyze relationships among sites *(Part 1)*

(A) Typical presence/absence data[a]

Species	Sites A	B	C	D	E
1	1	1	0	0	1
2	1	1	1	0	0
3	0	0	1	1	1
4	0	0	1	1	0
5	1	0	1	1	0
6	0	1	0	0	1
7	0	0	1	1	1
8	1	1	0	0	0
9	1	1	1	0	0
10	0	1	1	0	0

[a] The presence of a species in a site is indicated by a 1.

TABLE 15.1 The use of presence/absence data to analyze relationships among sites *(Part 2)*

(B) Reordered matrix[b]

Species	Sites A	B	E	D	C
8	1	1	0	0	0
1	1	1	1	0	0
9	1	1	0	0	1
2	1	1	0	0	1
6	0	1	1	0	0
10	0	1	0	0	1
5	1	0	0	1	1
3	0	0	1	1	1
7	0	0	1	1	1
4	0	0	0	1	1

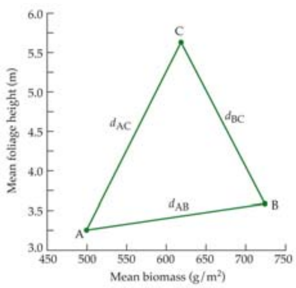
[b] A reordered matrix attempts to group sites that share species and species that share sites.

Similarity indices

- A.k.a. "community coefficients"
- Quantitative basis for deciding how to create groups (communities)
  - reduce the subjectivity
- One step in reducing the number of variables we have to deal with
- Often the basis for more complex multivariate methods (e.g., cluster analysis and ordination).
- Also known as distance measures, because they quantify how "far apart" two sites are in ecological space.

Euclidean distance

- Pythagoras gave us a useful tool:
  $x^2 + y^2 = z^2$
- Distances can be thought of as vectors
- Easy to visualize in 2 dimensions
- Multiple dimensions need to be reduced mathematically



Jaccard Index

$$Sj = a/(a + b + c)$$

The proportion of species contained in two sites that are shared by those sites, where:

a = number of species present in both sites
b = number found in second site only
c = number found in first site only

"Site" could be a quadrat or a whole community
This index consistently works well in a wide variety of situations

Sørenson's Index

$S_s = 2a/(2a + b + c)$

- As can easily be seen from the equation, Sorenson's index gives more weighting to species that are common in both sites, rather than to those occurring in either site
- Both Jaccard and Sørenson's indices can be combined with cover data by multiplying by the proportional cover or density
- Other similarity indices are available (Table 15.2)

Apply Jaccard Index to Table 1

- Make a matrix comparing each site to all other sites (A through E)
- Determine

  a = # species in both sites

  b = # species in second site only

  c =#species in first site only

  $S_j = a/(a+b+c)$

Similarity index (community coefficient) values are placed into a new matrix for use in cluster analysis

TABLE 15.1 The use of presence/absence data to analyze relationships among sites *(Part 3)*

(C) Matrix of Jaccard similarity values for the data in (A) or (B)

	Sites				
Site	A	B	C	D	E
A	1.00	0.57	0.33	0.13	0.13
B	0.57	1.00	0.30	0.00	0.25
C	0.33	0.30	1.00	0.57	0.22
D	0.13	0.00	0.57	1.00	0.33
E	0.13	0.25	0.22	0.33	1.00

Classification methods

Divisive classification takes the full data set (all sites) and divides it sequentially into pairs of groups

Agglomerative classification works in the opposite direction, starting with the two sites that are most similar

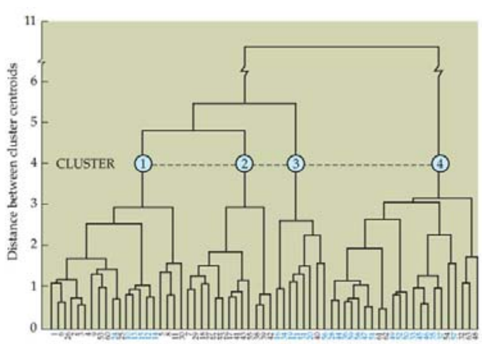
Monothetic approach is based on only one species

Polythetic approach is based on multiple species

Cluster analysis

- is agglomerative and polythetic
- a dendrogram, or tree diagram, is a graphical representation of the results
- The investigator must decide at what level to group the data

Dendrogram for lodgepole pine in Canada



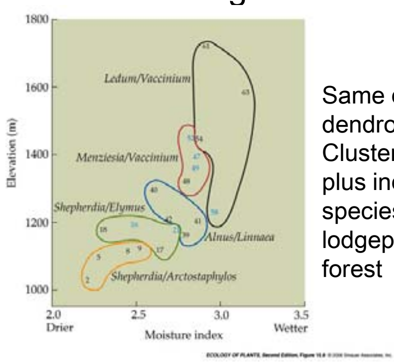
Pinus contorta forests of Banff and Jasper
Polythetic-agglomerative cluster analysis

ECOLOGY OF PLANTS, Second Edition, Figure 15.7

Indicator species

- Can be very useful for defining communities, if one species is found in all communities of a given type, and not in any other type.
  - A classification based only on one indicator species is monothetic
  - Various methods have evolved for picking indicator species
  - Try it in PC-Ord

Combining methods



Same data as in dendrogram Cluster analysis plus indicator species for a lodgepole pine forest

National Vegetation Classification System

- Combines physiognomy and indicator species to classify all of the vegetation in North America
- See “Ecological Classification” on Veg Ecology home page

National Vegetation Classification System

TABLE 15.3 An example of the classification of a North American plant community

Physiognomic categories	
Class	Woodlands
Subclass	Mainly evergreen woodlands
Group	Evergreen needle-leaved woodlands
Subgroup	Natural/seminatural
Formation	Evergreen coniferous woodlands with rounded crowns
Floristic categories	
Alliance	*Juniperus occidentalis*
Association	*Juniperus occidentalis/Artemisia tridentata*

Note: This classification follows the National Vegetation Classification system proposed by the Ecological Society of America. The classification uses a dual system in which higher categories are based on physiognomic criteria and finer-level categories are based on floristic criteria.