Debre Tabor University

Faculty of Natural and computational Sciences

Department of Biology

Course: Advanced Plant Ecology (Biol. 613)

3 Cr. Hrs. (7 ECTS)

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What is Plant Ecology?

- Plant ecology is the interactions between plants and their environments.
- Plant ecology is both a subset of the discipline of ecology and a mirror for the entire field.

Vegetation ecology

- is the study of the plant cover and its relationships with the environment.

Plant Vs. Vegetation???

- Vegetation is the central object of study in vegetation ecology, can be loosely defined as:
    - ✓ a system of largely spontaneously growing plants.
- Not all growing plants form vegetation; for instance, a sown corn field or a flowerbed in a garden do not.
- But the weeds surrounding such plants do form vegetation.
- A pine plantation will become vegetation after some years of spontaneous growth of the pine trees and the subsequent development.

Unit one: Ecological data (Ecological variables and data; data collection, analysis and interpretation)

Ecological variables

- In ecological studies, there are at least three major types of variables based on their relationships to each other:
    - ✓ independent variables
    - ✓ dependent variables
    - ✓ interdependent variables

Ecological Data… types of variables

Independent versus Dependent

In most cases, we are interested in relating one or more independent variables to one or more dependent variables

- *Independent variable*… typically the variable being manipulated or changed; controlled or selected by the experimenter to determine its relationship to an observed phenomenon (i.e., the dependent variable); also known as "X ", "predictor," "regressor," "controlled," "manipulated," "explanatory," "exposure," and/or "input" variable
- *Dependent variable*… the observed result of the independent variable being manipulated; usually cannot be directly controlled; also known as "Y", "response," "regressand," "measured," "observed," "responding," "explained," "outcome," "experimental," and/or "output" variable

Ecological Data... types of variables

Interdependent

In some cases we are interested in a *single set* of interdependent variables, without distinction between independent and dependent

- *Interdependent variables*... a set of related variables that are presumed to covary in a meaningful way

Example:

Sites	Species			
	A	B	C	D
1	1	9	12	1
2	1	8	11	1
3	1	6	10	10
4	10	0	9	10
5	10	2	8	10
6	10	0	7	2

Sites-by-species
2-way data matrix

Ecological data

- In ecological studies, there are several major types of data:
    - ✓ continuous data
    - ✓ Counts
    - ✓ Proportion
    - ✓ binary data
    - ✓ time at death
    - ✓ time series
    - ✓ circular data

Ecological Data… types of data

Continuous Data

- Data in which the observations can be measured on a *continuum* or scale; can have almost any numeric value; can be meaningfully subdivided into finer and finer increments, depending upon the precision of the measurement system.

Examples:

- Temperature
- Mass
- Distance
- Etc.

Some methods:

- Regression
- Analysis of variance

Ecological Data... types of data

Count Data

- Data in which the observations can take only the *non-negative integer values* {0, 1, 2, ...}, and where these integers arise from counting rather than ranking.

1) Simple counts

Plot	#Infected
1	2
2	11
3	7
...	...

2) Categorical data

	Town	
Status	A	B
Infected	4	9
Not infected	21	43

Examples:

- #territories
- #detections in each habitat type
- Etc.

Some methods:

- Log-linear models
- Contingency tables

Ecological Data... types of data

Proportion Data

- Data in which we know how many of the observations are in one category (i.e., an event occurred) and we also know how many are in each other category (i.e., how many times the event did *not* occur).

Trial size	#Infected	#Not infected
10	8	2
15	11	4
12	9	3
...	...	...

Examples:

- Percent mortality
- Percent infected
- Sex ratio
- Etc.

Some methods:

- Logistic regression

Ecological Data... types of data

Binary Data

- Data in which the observations can take only one of two values; useful when you have unique values of one or more explanatory variables for each and every observational unit.

Individual	Infected
1	0
2	1
3	1
...	...

Examples:

- Present or absent
- Dead or alive
- Male or female
- Etc.

Some methods:

- Logistic regression

Ecological Data... types of data

Time at Death

- Data that take the form of measurements of the *time to death*, or the *time to failure* of a component; each individual is followed until it dies (or fails), then the time of death is recorded.

Individual	Time to death
1	7
2	10
3	1
...	...

Examples:

- Animal/plant longevity
- Snag fall
- Etc.

Some methods:

- Survival analysis

Ecological Data... types of data

Time Series

- Sequence (vector) of data points, measured typically at successive times (or locations), spaced at (often uniform) time (or space) intervals.

Time	Measurement
1	0.07
2	1.20
3	0.61
...	...

Examples:

- Population size
- Annual temperature
- Etc.

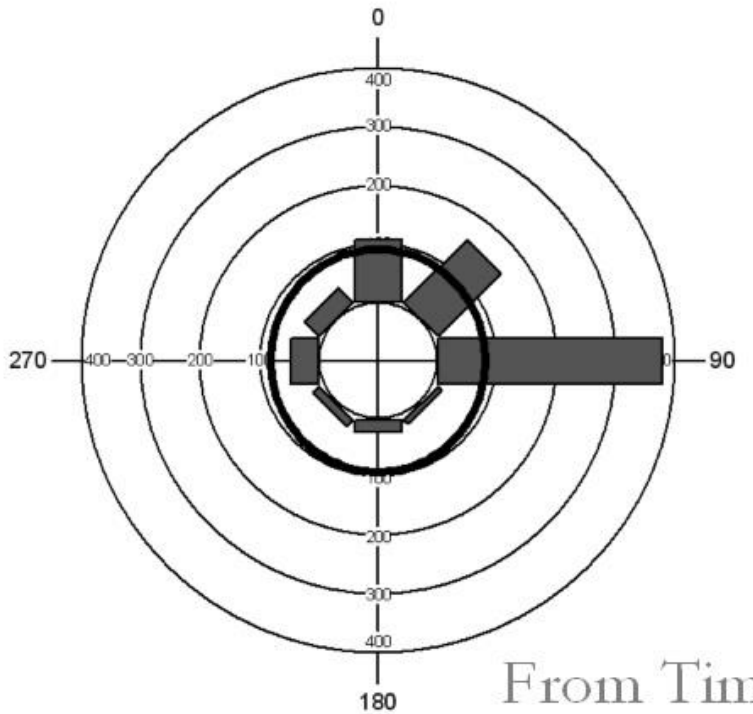
Some methods:

- Autocorrelation
- Spectral analysis
- Wavelet analysis

Ecological Data... types of data

Circular Data

- Data in which the observations are circular in nature; where the beginning and end of the sequence is the same.



From Timm et al (2007)

Examples:

- Aspect
- Day of year
- Etc.

Some methods:

- Circular stats

Commonly used ecological data and their analysis in vegetation ecology studies

Abundance and frequency

- **Abundance** is the number of individual plants of a given species per unit area.
  - ✓ It can be used to show spatial distribution and ranges over time.
- **Frequency** is the proportion of plots in which a species occurs.
  - ✓ It is a measure of the occurrence of a given species in a given area.
  - ✓ It indicates how the species are dispersed and is an ecologically meaningful parameter.
  - ✓ In other words, it gives an approximate indication of the homogeneity of the stand under consideration (Kent and Coker, 1992).
- **Cover-abundance scale of plant species in a unit area of land**

Species diversity

- Example: Shannon-Wiener Diversity Index (H’)

$$H' = -\sum_{i=1}^{s} pi(\ln(pi)) \text{ Whereby,}$$

- H'= Shannon diversity index
- Σ= Summation symbol;
- S = the number of species;
- Pi= the proportion of individuals or the abundance of the i^{th} species expressed as a proportion of the total cover in the sample;
- ln = natural logarithm to base n ($\log_n$)

Species evenness

- Example: Shannon's evenness (J) or equitability
- $J = \frac{H'}{H'max}$ Whereby,
- J = the species evenness
- H' = Shannon-Wiener Diversity Index
- H'max = Maximum Diversity Index of species in the sample (Kent and Coker, 1992).

Similarity coefficient:

Example: Sørensen's similarity coefficient

$$Ss = \frac{2a}{(2a + b + c)} \text{ where,}$$

- Ss = Sørensen's similarity coefficient
- a = Number of species common to both communities
- b = Number of species in community 1 only;
- c = Number of species in community 2 only.

Species importance value index (SIV) and dominance

- SIV permits a comparison of species in a given location and reflects the dominance,
- occurrence and abundance of a given species in relation to other associated species in an area.
- Therefore, for setting conservation priority, it is a good index for summarizing vegetation characteristics and ranking species for management and conservation practices.

IVI = Relative density + Relative dominance + Relative frequency

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- Relative density = $\left[\frac{\text{The number of individuals of the species}}{\text{The total numbers of all individuals}}\right] *100$

Density is a derivate variable, being the abundance per unit area.

- Relative frequency
- $\left[\frac{\text{The number of individuals of plots where the species found}}{\text{The total plots of the study}}\right]*100$
- Relative dominance = $\left[\frac{\text{The basal area of the individual species}}{\text{The total basal area of all species}}\right]*100$
- Basal Area (BA) = $\pi d^2/4$, where, $\pi = 3.14$; d = DBH (cm)
- Basal area is the area outline of a plant near the surface, is of particular interest for trees and can be used for tree volume estimations.