

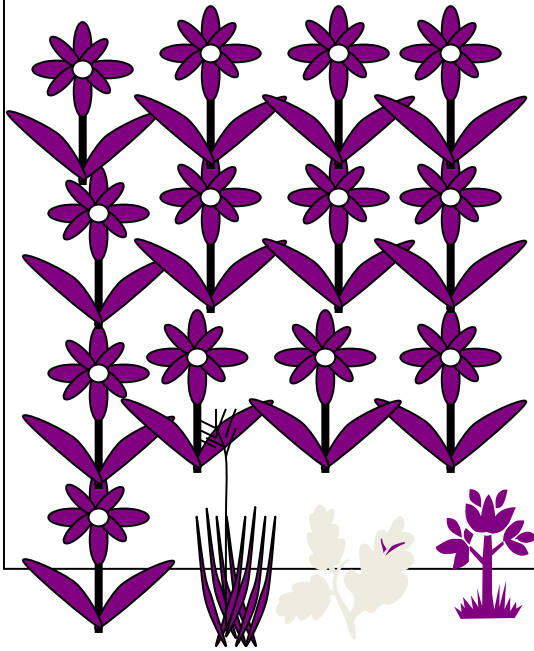
Chapter three:- Biodiversity

Assessment

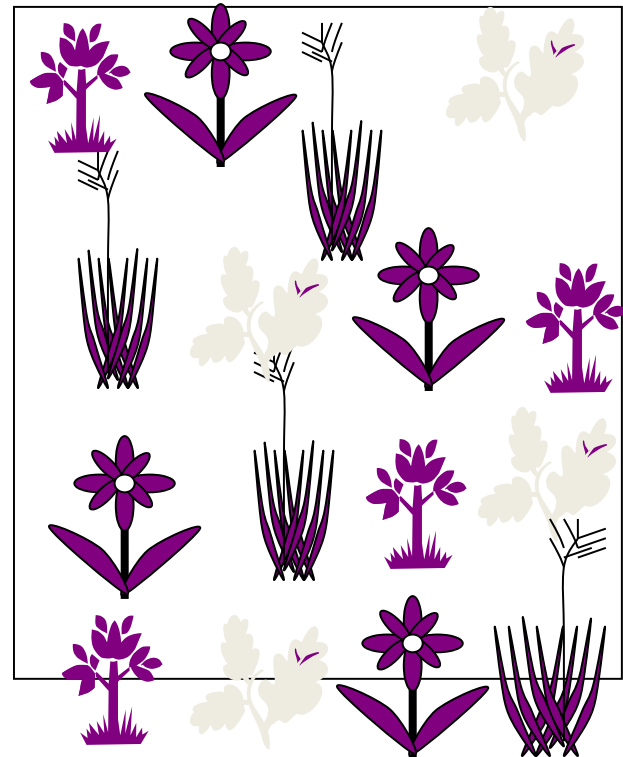
- important because they provide information on the condition of ecosystems and the changes that are taking place within them
- To estimate or measure biodiversity one must first sample an area(s)
- Sampling is measuring a small part of an entity assuming that this small part is representative of the larger entity

➤ Species richness and Evenness

Habitat 1 (low diversity)



Habitat 2 (high diversity)



PROCEDURES IN BIODIVERSITY DATA COLLECTIONS

Four Methods:: (1) sampling methods

(2) collecting specimens

(3) gather and organize
data

(4) run statistical tests

✓ *Always be precise and accurate!*

(1) sampling methods

specify a, research to find which organisms are classified as threatened or endangered

1. Canopy fogging

- ✓ is an effective way of collecting information about the biodiversity of insects
- ✓ A low dose of insecticide is sprayed up into the
top of a tree
- ✓ When the insects fall, they are collected on a large screen, shaped like a funnel

In Action



2. Quadrat sampling

- A quadrat is a known square area that is marked using a pre-made square of plastic, or stakes and string
- Quadrats can range in size from 1 m² to 2 m² depending on the type of habitat surveyed
- Different species and their numbers within the quadrat are counted
- Counting is repeated many times in different places throughout the habitat to get an accurate representation of biodiversity



3. Transect sampling

- ✓ Transect sampling is done using a transect line
- ✓ A transect line is usually a rope or measuring tape that has been marked at set intervals, such as every meter
- ✓ The line is unrolled within the habitat
- ✓ At every interval, the type and number of species along the line are recorded



Netting

- ✓ Fine mesh nets are used to capture birds and bats in terrestrial ecosystems, and fish and other organisms in aquatic ecosystems
- ✓ Once captured, an organism is identified
- ✓ In addition, it may be measured, blood may be taken for genetic analysis, and it may be tagged (labelled)

In many cases, the organism is then released



(2) Collecting specimens

- Educate yourself on local Possession and Collection laws before collecting
- In many jurisdictions(authorized body), collecting or keeping wildlife is restricted or even forbidden. Check laws online or ask a local authority or bureau responsible for wildlife for details
- Collect specimens at consistent and precise time intervals
- Use worldwide definitions of an individual's category, or recognizable taxonomic unit, RTU. (for example, subspecies, species, etc).

- ✓ Factor in what time of year and day to collect specimens
- ✓ Mating, spawning (time of egg lying), and flowering seasons are the best times to collect
- ✓ If they're small, devise ways to extract them
For example, use very fine filters
- ✓ Depending on your collection permit, you may be able to collect the entire sample area In which case, identify each specimen alphabetically, numerically or alphanumerically

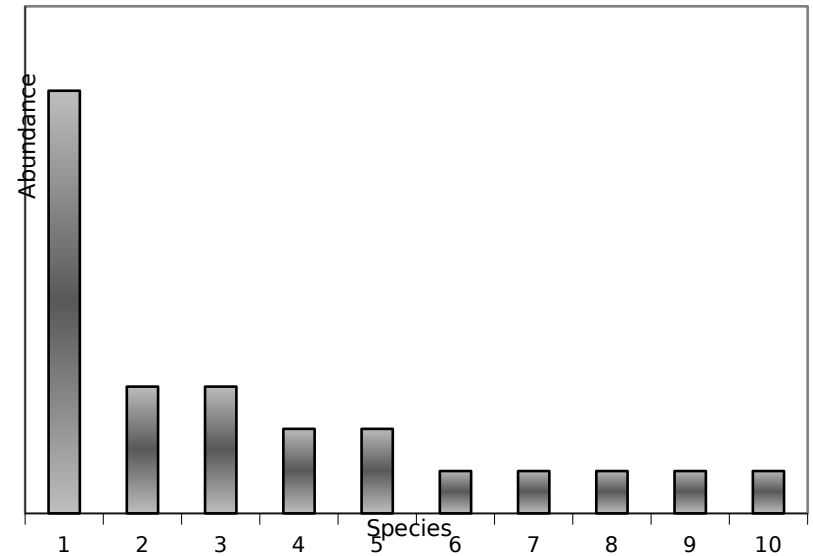
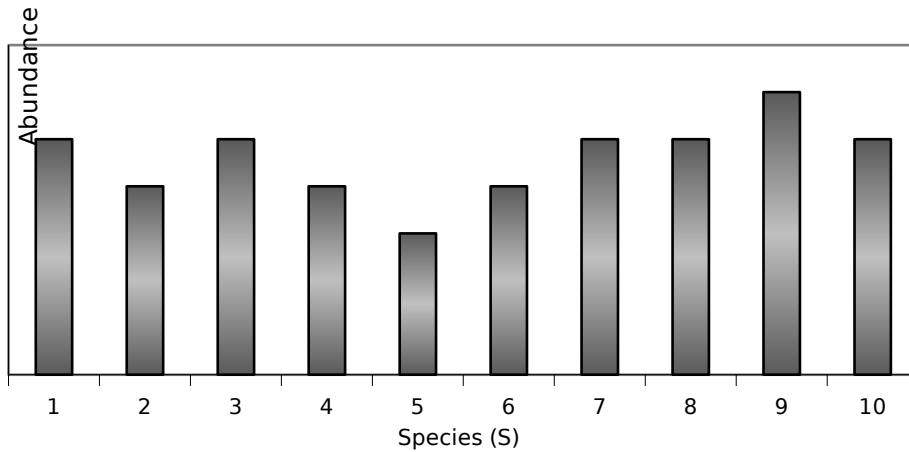
(3) gather and organize data

- Collect as much as possible
- You can *never* have too much data
- Collecting everything from date and time to weather and size of specimen to the mm is fantastic
- **Whether independent or in a group, all data must be:**
 - Precise and accurate
 - Consistent throughout
 - Clear and straightforward

(4) run statistical tests

- Apply measurements
- The most common measures of biodiversity are species richness, Simpson's index, and Shannon's index
- Although it's good to know what each test helps you understand, software programs have been designed to do the math for you
- The most commonly used program for measuring biodiversity is EstimateS
- The count of the species coupled with these tests, summarizes most of the information on biodiversity.

➤ **Species diversity
(heterogeneity), species
abundance, species richness
(numerical) and evenness
(equitability)**



- diversity is considered to have two important components: (1) richness and (2) evenness
- Richness is simply defined as the number of species in a community
- evenness is the degree to which % cover is distributed equally among all of the species present in a plant community
- Eg, If there are 5 species, each with exactly 12% cover, that community is **highly even**
- Alternatively, if four species had 12% cover and the fifth species had 45% cover, the community would be considered **less even** than the first example
- A community that is less even is considered to have **high dominance** (dominance is the inverse of evenness)

Diversity Indices:

- A diversity index is a mathematical measure of species diversity in a given community
- Based on the species richness (the number of species present) and species abundance (the number of individuals per species)
- The more species you have, the more diverse the area
- However, there are two types of indices, dominance indices and information statistic indices
- The equations for the two indices we will study are:

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

- **The Shannon index is an information statistic index, which means it assumes all species are represented in a sample and that they are randomly sampled**
- **In the Shannon index, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), ln is the natural log, Σ is the sum of the calculations, and s is the number of species**
- **If the E value is 1, the species are equally present in the habitat. The formula to find E is: $E = H/\ln(S)$.**

- **The Shannon index (H')** is based on information theory, and measures the average degree of '*uncertainty*' in predicting to what species individuals chosen at random will belong
- The higher the degree of uncertainty (large values of H'), the higher the diversity and the greater the uncertainty in correctly predicting the identity of the next species chosen at random
- Maximum uncertainty ($H_{\max}$) occurs when each species in a sample is equally represented
- If diversity is low, then there is a higher certainty of correctly predicting the species likely to occur in a sample
- In other words, the predictability of the sample is high

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

➤ **The Simpson index is a dominance index because it gives more weight to common or dominant species. In this case, a few rare species with only a few representatives will not affect the diversity**

➤ **In the Simpson index, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), Σ is still the sum of the calculations, and s is the number of species**

Low species diversity suggests:

- relatively few successful species in the habitat
- the environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment
- food webs which are relatively simple
- change in the environment would probably have quite serious effects

High species diversity suggests:

- a greater number of successful species and a more stable ecosystem
- more ecological niches are available and the environment is less likely to be hostile
- complex food webs
- environmental change is less likely to be damaging to the ecosystem as a whole

➤ **Eg. Table 1.** *Species composition of three different communities*

Species	Communit y 1	Community 2	Communit y 3
A	10	72	35
B	9	6	34
C	11	3	31
D	10	3	0
E	8	1	0
F	12	3	0
G	10	4	0
H	11	3	0
I	10	2	0
J	9	3	0
Total	100	100	100

- It may be easier to understand the use of Simpson's index with the following example
- Consider three communities, each made up of a total of 100 organisms, drawn from combinations of ten species, A to J.
- Community 1 has the highest diversity. It has the joint highest species richness (10) and each species has a similar relative abundance
- Community 2 has the same species richness as community 1, but is dominated by one species (A) so that the diversity of this community is lower than in community 1
- Community 3 has a lower diversity than community 1, due to its lower species richness

The formula for calculating Simpson's index is:

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

➤ Where **N** = the total number of all organisms,
 n_i = the numbers of individuals of each
individual species

➤ The lower the value of **D**, the greater is the
species diversity. Take for example community
1 in the table 1 above. The values of **(n-1)** and
 $n_i(n-1)$ in the computation of **D** are shown in
table 2 opposite.

➤ **Table 2** *Data for calculation of Simpson's index for community 1.*

Community 1			
Species	n_i	$n_i - 1$	$n_i(n_i - 1)$
A	10	9	90
B	9	8	72
C	11	10	110
D	10	9	90
E	8	7	56
F	12	11	132
G	10	9	90
H	11	10	110
I	10	9	90
J	9	8	72
Total	N = 100		$\Sigma n_i(n_i - 1) = 912$

So for community 1: $D = \frac{912}{100 * 99} = 0.09 = 0.09 \text{ (high diversity)}$

➤ **By the same method, the Simpson's index, D, for community 2 has been calculated and is shown in table 3 below**
Table 3 *Values for Simpson's index for communities 1, 2 and 3*

Community	D	Level of diversity
1	0.09	Very high
2	0.52	Moderate
3	0.327	Moderate

Calculate the value of D for community 3 and insert these in the table and Show your working in the space below

proposes that diversity is related to the *probability* that two individuals chosen at random from a sample belong to the same species

- Lambda (λ) is usually expressed as a value between 0 and 1
- If the probability (λ) is high (λ approaches 1) that both individuals belong to the same species, then the diversity of the sample is low and *vice versa*
- However, because λ decreases as diversity increases, the index is usually expressed as $1/\lambda$
- When $\lambda = 1$, most individuals in a sample are concentrated in a single species and therefore dominance of species within the sample is high (λ can also help explain evenness in a sample.)

Examples of Shannon Index calculation

Shannon Index Calculation

Sample I		pi	Ln(pi)	pi*Ln(pi)
Species				
A	24	0.44	-0.81	-0.36
B	20	0.37	-0.99	-0.37
C	7	0.13	-2.04	-0.26
D	3	0.06	-2.89	-0.16
Total	54	1	H' = 1.15	

Sample II		pi	lnpi	-pi lnpi
A	48	0.44	-0.81	-0.36
B	40	0.37	-0.99	-0.37
C	14	0.13	-2.04	-0.26
D	6	0.06	-2.89	-0.16
Total	108	1	H' = 1.15	

Sample III		p_i	$\ln p_i$	$-p_i \ln p_i$
A	24	0.41	-0.88	-0.37
B	20	0.34	-1.06	-0.37
C	7	0.12	-2.11	-0.26
D	3	0.05	-2.96	-0.15
E	3	0.05	-2.96	-0.15
F	1	0.02	-4.06	-0.07
Total	58	1	$H' = 1.36$	

- Note that: the index is invariant with respect to sample size, but rare species add to it
- In other words, the higher the “H” value is high diversity

- The samples of 5 species are 60,10,25,1,4. Calculate the Shannon diversity index and Evenness for these sample values
- **Given :-** Sample Values (S) = 60,10,25,1,4
number of species (N) = 5
- **To Find :** shannon diversity index and Evenness

➤ **Solution : Step 1:**

- First, let us calculate the sum of the given values $\text{sum} = (60 + 10 + 25 + 1 + 4) = 100$

No of sample	$\text{pi} = \text{sample} / \text{sum}$	$\ln(\text{pi})$	$\text{pi} * \ln(\text{pi})$
60	0.60	-0.51	-0.31
10	0.10	-2.30	-0.23
25	0.25	-1.39	-0.35
1	0.01	-4.61	-0.05
4	0.04	-3.22	-0.13
sum=100			SUM = -1.07
4	0.04	3.22	0.13

- **Step 3:** $H_{\max} = \ln(N) = \ln(5) = 1.61$
Evenness = $H/H_{\max} = 1.07/1.61 = 0.66$
- **Result :** Shannon diversity index(H)=1.07 Evenness =0.66
- The higher the degree of uncertainty (large values of H'), the higher the diversity and the greater the uncertainty in correctly predicting the identity of the next species chosen at random
- Maximum uncertainty ($H_{\max}$) occurs when each species in a sample is equally represented
- If diversity is low, then there is a higher certainty of correctly predicting the species likely to occur in a sample
In other words, the predictability of the sample is high

Sampling design for vegetation descriptions and analysis

- **A sample** is an independent subset of the population that you are studying
- **Why sample?** in most biological studies, it is logistically impossible to enumerate the entire population of organisms
- individual count, population of mobile animals, time, energy
- sampling plays a very important role in biological studies
- Data can be collected in a variety of ways , among them we use six types of sampling designs in biodiversity data collection

1. Selective (Preferential) sample

- A sample that is deliberately chosen by using a sampling plan that screens out materials with certain characteristics and/or selects only material with other relevant characteristics

2. Random Sampling

- Selected by using chance or random numbers
- Each individual subject has an equal chance of being selected
- the best type of sampling because it is unbiased

3. Systematic Sampling

- Select a random starting point and then select every k^{th} subject in the population
- Simple to use so it is used often



4. Stratified Sampling

- Divide the population into at least two different groups with common characteristic(s)
- then draw SOME subjects from each group (group is called strata or stratum)
- Basically, randomly sample each subgroup



5. Transect Sampling

- is most useful when the area to be sampled is zoned in some way or has some sort of gradients running through it
- Think of the intertidal habitat on a small scale or the vegetation running up the side of a mountain on a larger scale
- A transect is simply a line we stretch over an area we want to study
- then placing quadrants at known intervals along the line

Make a Transect



6. Plotless sampling

- the nearest-neighbor method
- It is particularly useful in areas where carrying large quadrants
- would be difficult to manage such as a dense forest
- It is also most suited to habitats that are relatively *uniform*
- Plotless methods do not use a **defined area** rather, they use distances between a point and an individual, or between two individuals
- they are not useful for determining density
- They are however quite useful for determining the dispersion pattern of the organisms