
Diversity Indices as an Educational Tool

Level

10

Key question

What can a diversity index tell us about an ecosystem?

Key outcome

Understanding of biodiversity. Use qualitative scientific methods to evaluate biodiversity.

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Biodiversity includes all life forms not just a list of species but also the genes and gene combinations they contain as well as the diversity of the ecosystems and habitats to which they belong.

Biodiversity is not just a measure of how many species are present but also the relative abundance of each species (also known as species evenness) and the overall number of individuals (species abundance). These three measures can be combined in mathematical formulae to produce indices of diversity for a certain habitat.

Different ecosystems can then be compared to determine the most valuable from a biodiversity point of view, as well as comparing the same ecosystems over time, to work out if that ecosystem is under stress or actually improving.

The quality of habitat is likely to have a major effect on animal diversity. Two characteristics of vegetation which are likely to affect animal diversity include vegetation structure (or physiognomy) and number of species. An indication of both will be gained using a transect sample.

This field study uses a standard transect to find out about different habitats and the bird species in these. Then, the bird species are used as indicator species to prepare an index of diversity to allow comparisons between different habitats. If time is short, the habitat (or vegetation) can be quickly assessed and two or more contrasting areas used to prepare the list of bird species.

What each group needs

Bird field guide
Binoculars
Tape measure
Calculator with log function
Field sheets
Clipboard, pencil

What each group does

1. Habitat study

- Assemble your group and collect the required equipment.
- Each group works in a different vegetation type, for example, close to a water body, pond, seashore, a swamp, a ridge line or forest, low lying scrub and roadside verge.

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- Identify and mark in the location of the habitat on a map. Name and label each habitat according to the dominant species of plant(s). If no plants exist it might be named after the dominant physical characteristic, such as 'clay pan habitat' or 'stony desert habitat'.
- On the table below, note the main species, approximate area and water levels for each habitat. Use general terms to describe water levels such as 'shallow', 'deep' or 'below ground level'. Note that there could be more than one water level within a habitat.
- Describe the relationship between water depth and main plant species.

Location	Plant Species	Water Levels	Approx. Area

2. Transect Vegetation Survey

- Lay the tape measure out across terrain typical of the terrestrial habitat you have classified above (i.e. the habitat which occurs entirely on dry land). The spot may be indicated to you by your teacher.
- Using Table 1, record the type and height of plants which lie within one metre either side of the tape over a distance of 20 m. This information will be used to construct a profile of the vegetation. Plant type need only be a broad description such as grass, herb, reed, shrub or tree. Include dead trees and fallen logs and branches.
- Record the number of species as you do this (see next section).

Table 1. Results of vegetation transect

Distance Along Tape	Plant Type	Plant Height

- The variety of species in a habitat usually has an effect on the diversity of other organisms. In the box below, tally the number of species in each habitat. For this study we are interested in the number of species, rather than which species they are, so there is no need to identify them.

In the space below tally the number of plant species you find 1 m either side of the tape.

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	Tally
Total	

Transfer your line transect data to a graph to produce the vegetation profile for that habitat. This gives a good indication of the complexity of the structure of that habitat. Your teacher will help you with this.

3. Using indicator species to measure diversity

Because of the difficulty and expense of surveying every species of animal in an ecosystem we often survey just one group of animals which we believe give a good indication of the diversity of a much wider selection of organisms. For this survey birds are used. Birds are a good indicator for other vertebrates (reptiles, mammals, frogs). When using indicator species to compare diversity of different habitats it is best to use only species in the same trophic level (i.e. the same stage in the food chains) because organisms occurring higher up the food chain naturally occur in lower numbers (there must be fewer predators than there are prey, for example). If this level of accuracy is required for this study, research the diet of all the species you observe and use only insectivorous (insect eating) birds in the calculations for diversity.

Diversity is more than the number of species in an ecosystem – although that is part of it. It includes the total variation in the species of that system – in their structural characteristics as well as the variation in the genetic make-up of plants and animals.

Before starting this activity, discuss this. If you find a total of 20 birds, of whom 10 are golden whistlers, six are wrens and four are lorikeets, does the area have a higher diversity than one where you find 20 birds, 12 of which are individual species, three are wrens, three are lorikeets and two are honeyeaters?

One way the diversity of different habitats can be compared is by working out diversity indices. We can use a formula to assign a number to a habitat which gives an indication of the level of diversity in it.

Shannon-Weiner Index = $\sum p_i \log p_i$

where:

i = the species surveyed

p = # each species (n_i) divided by total # of species (N)

= n_i / N

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EXAMPLE

Habitat ____ No. 1

Species	Number (ni)	$pi=ni/N$	$pi \log pi$
Honey Eater	20	0.2	- 0.130794
Noisy Miner	20	0.2	- 0.130794
Silvereye	20	0.2	- 0.130794
Superb Fairy Wren	20	0.2	- 0.130794
Rainbow. Bee-Eater	20	0.2	- 0.130794
Total (N)	100		- 0.69897

Habitat ____ No. 2

Species	Number (ni)	$pi=ni/N$	$pi \log pi$
Honey Eater	92	0.92	- 0.133315
Noisy Miner	2	0.2	- 0.130794
Silvereye	2	0.2	- 0.130794
Superb Fairy Wren	2	0.2	- 0.130794
Rainbow Bee-Eater	2	0.2	- 0.130794
Total (N)	100		- 0.13591

Diversity Index Habitat 1 = -0.69897

Diversity Index Habitat 2 = -0.13591

The mathematicians will notice that this will give a higher value for diversity where the ecosystem is not dominated by any one species – that is, the more even the species are in numbers of individuals, the higher diversity is likely to be. This property is related to the extent of genetic diversity – the variability of all the characteristics in all the populations in an ecosystem.

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Bird Diversity Index _____

(c) From the results above, discuss the relationship between plant species abundance and biodiversity of vertebrates

Discuss how vegetation structure and the extent of variety of structure and environments (e.g. water depth) affects vertebrate diversity

Discuss the relationship between number of plant species and vertebrate diversity

Does the Index confirm the results of your original discussion

From your findings outline a management strategy for this area which will increase diversity and safeguard fragile ecosystems
