Simpson's Reciprocal Diversity Index

O.C.4- Analysis of the biodiversity of two local communities using Simpson's reciprocal index of diversity.

Background:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. In essence it measures the probability that two individuals randomly selected from an area will belong to the same species. The formula for calculating D is presented as:

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

This does not seem intuitive or logical, so some texts use derivations of the index, such as the inverse (1/D) or the difference from 1 (1-D).

The Simpson's reciprocal index quantifies biodiversity by taking into account richness and evenness. The greater the biodiversity in an area, the higher the value of D. The lowest possible defined value of D is 1and would occur if the community contained only one species. The maximum value would occur if there was perfect evenness and would be equal to the number of species. The formula for Simpson's reciprocal index of diversity is:

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

D = Simpson reciprocal diversity index (note: D is the really 1/D for Simpson's Diversity)
N = total number of organisms of all species found
n = number of individuals of a particular species.

Note that this reciprocal equation will always be shown in a question where you are asked to calculate Simpson's index.

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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

Species biodiversity may be used to indicate the 'biological health' of a particular habitat. However, care should be used in interpreting biodiversity measures. Some habitats are stressful and so few organisms are adapted for life there, but, those that do, may well be unique or, indeed, rare. Such habitats are important even if there is little biodiversity. Nevertheless, if a habitat suddenly begins to lose its animal and plant types, ecologists become worried and search for causes (e.g. a pollution incident). Alternatively, an increase in the biodiversity of an area may mean that corrective measures have been effective.

Activity

1. Groups of students studied the species diversity of the beetle fauna found on two upland sites in Europe. The same number of students searched for a similar length of time in each of the two sites. The two sites were of equal area. The number of individuals of the four species found at each site is given in the table below.

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Species	Site A	Site B
Trichius fasciatus	10	20
Aphodius lapponum	5	10
Cicindela campestris	15	8
Stenus geniculatus	10	2

a) Calculate the reciprocal Simpson diversity index (D) for the beetle fauna of the two sites.

b) Suggest a possible conclusion that can be formed.

2. A group of students carried out some fieldwork to investigate the diversity of insects in three habitats:

   - a field of barley
   - a field of wheat
   - the vegetation under a hedge.

   Their results are shown in Table 1.

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Table 1: Number of Insects of various species in 3 habitats

	Number of individuals of each species in each habitat		
Species	Barley field	Wheat field	Under hedge
a	32	4	0
b	78	0	1
c	0	126	2
d	0	5	12
e	0	0	8
f	0	0	9
g	0	25	3
h	0	10	3
i	0	0	2
j	0	0	5
k	86	56	0
l	0	0	7
Species richness	3	6	10
Total number of insects (N)			
Simpson's Reciprocal index (D)			

a) State what is meant by the term *species richness.*

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b) Using the data in Table 1, suggest why the value of Simpson's Reciprocal index (D) for the vegetation under the hedge is much higher than that for the wheat field.

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c) Describe how the students may have determined the numbers of individuals of each species in each habitat.

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d) Studies of biodiversity are an integral part of an environmental impact assessment (EIA). Discuss the role of an EIA as part of a local planning decision.

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e) Suggest why some conservationists might object to these studies.

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