🌲 DP IB Environmental Systems & Societies (ESS): SL

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Your notes

An Introduction to Biodiversity

Contents

What is Biodiversity?

Biodiversity

Why is biodiversity important?

- Biodiversity can be thought of as a study of all the **variation** that exists within and between all forms of life

- Biodiversity looks at the range and variety of **genes**, **species** and **habitats** within a particular region

- It can be assessed at three different levels:

  - The number and range of different ecosystems and habitats

  - The number of species and their relative abundance

  - The genetic variation within each species

- Biodiversity is very important for the resilience of ecosystems, in that it allows them to resist changes in the environment

Habitat diversity

- This is the range of different habitats within a particular ecosystem or biome

- If there is a large number of different habitats within an area, then that area has high biodiversity

  - A good example of this is a coral reef. They are very complex with lots of microhabitats and niches to be exploited

- If there is only one or two different habitats then an area has low biodiversity

  - Large sandy deserts typically have very low biodiversity as the conditions are basically the same throughout the whole area

Photo by Francesco Ungaro on Unsplash

A coral reef is an example of a habitat with high biodiversity

Species diversity

- An ecosystem such as a tropical rainforest that has a very high number of different species would be described as species-rich

  - Species richness is the number of species within an ecosystem

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- Species diversity looks at the number of different species in an ecosystem, and also the evenness of abundance across the different species present

  - The greater the number of species in an ecosystem, and the more evenly distributed the number of organisms are among each species, then the greater the species diversity

  - For example, an ecosystem can have a large number of different species but for some species, there may only be 3 or 4 individuals. As a result, this ecosystem does not necessarily have high species diversity

- Ecosystems with high species diversity are usually more **stable** than those with lower species diversity as they are more resilient to environmental changes

  - For example in the pine forests of Florida, the ecosystem is dominated by one or two tree species. If a pathogen comes along that targets one of the two dominant species of trees, then the whole population could be wiped out and the ecosystem it is a part of could **collapse**

Photo by Worm Funeral on Unsplash

The lack of species diversity in the pine forests of Florida makes them vulnerable to collapse when pathogens enter the ecosystem
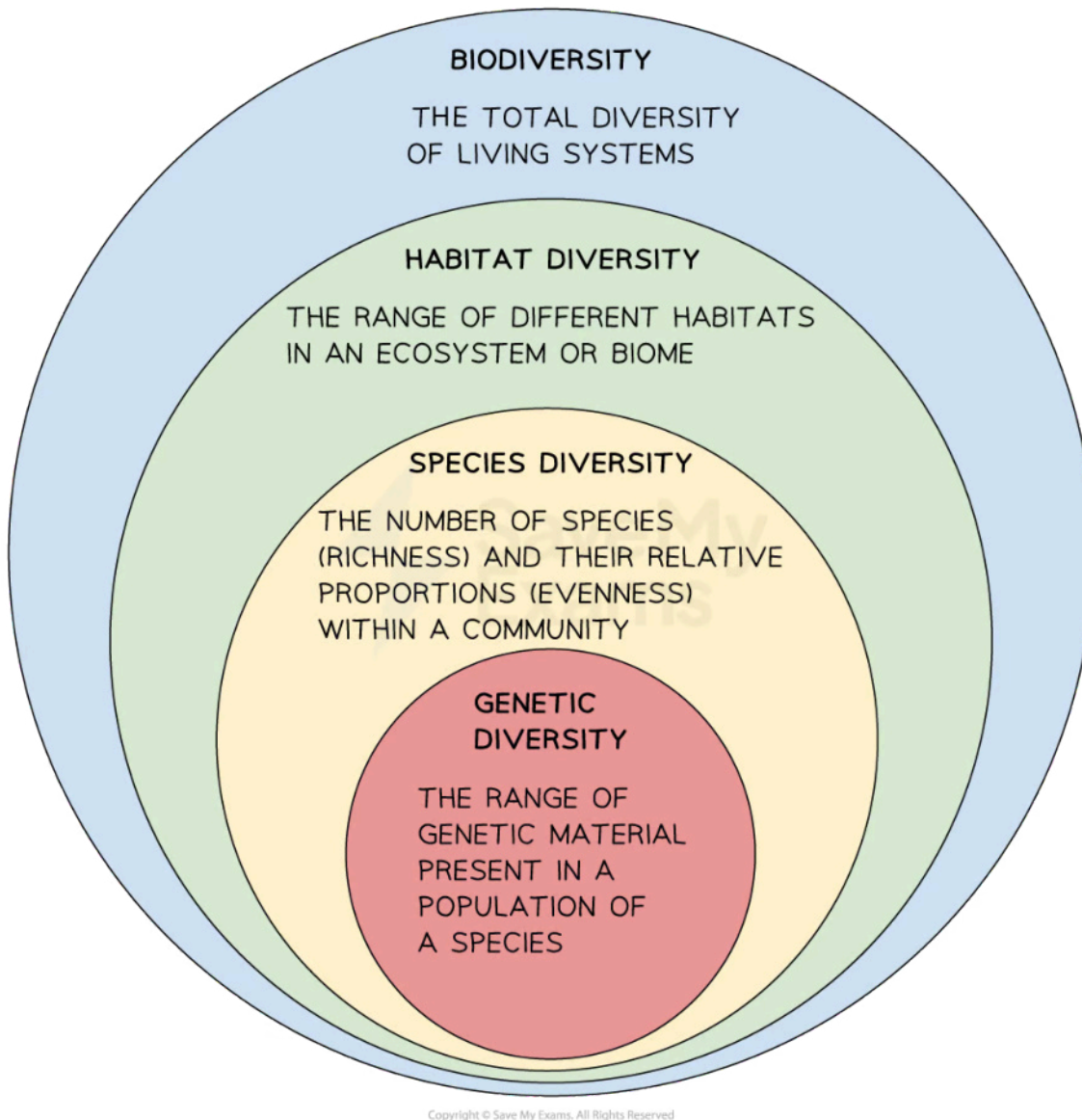
Genetic diversity

- Genetic diversity is the diversity of genes found within different individuals of a species

- Although individuals of the same species will have the same total set of genes, these genes can take a variety of different forms

- This makes it possible for genetic diversity to occur **between populations** of the same species

  - For example, some humans can digest milk even as adults. (this ability is called lactase persistence), while others cannot

  - It depends on a gene called LCT, which has different versions in different populations

  - In European populations, there is a gene variant called C/T-13910 that is linked to lactase persistence – if someone has the CC version of the gene, they are more likely to be able to digest milk as adults, but if they have the TT version, they may have difficulty digesting milk

  - In East Asian populations, like Chinese and Japanese, there is a different gene variant called G/C-13915 – people with the GG version of this gene are more likely to have lactase persistence, while those with the CC version may struggle with digesting milk

  - So, these differences in a single gene can affect whether individuals can digest lactose or not

  - This shows how genetic variations can contribute to the observed differences in lactase persistence among different human populations.

- Genetic diversity **within a single population** also occurs

- This diversity is important as it can help the population **adapt to**, and survive, **changes in the environment**

- The changes could be in biotic factors such as new predators, pathogens and competition with other species

- Or the changes could be through abiotic factors like temperature, humidity and rainfall

Biodiversity is a broad concept encompassing the total diversity of living systems, which includes the diversity of species, habitat diversity and genetic diversity

Diversity Indices

Diversity Indices

- Communities can be described and compared through the use of diversity indices, which are mathematical tools used to quantify the diversity of species within a community

    - These indices provide a measure of the variety of species present, as well as their relative abundances, and can be used to compare different communities or to track changes in diversity over time

- When comparing communities that are similar, low diversity could be **indicative** of several factors, such as **pollution**, **eutrophication** and **recent colonisation** of a site

    - For example, pollution can have a negative impact on the diversity of a community by reducing the number of species that can survive in the area

    - Similarly, eutrophication, which is the process of nutrient enrichment in aquatic ecosystems, can lead to a decrease in diversity as a few dominant species outcompete others

    - Finally, when a site is recently colonised, the diversity of the community is naturally low as it takes time for a diverse range of species to establish themselves

- Some commonly used diversity indices include the Shannon-Wiener index, Simpson's index, and the evenness index

    - The Shannon-Wiener index is a measure of the diversity of a community that takes into account both the number of species present and their relative abundances

    - Simpson's index, on the other hand, is a measure of the dominance of a few species within a community, and is calculated based on the probability that two individuals selected at random from the community belong to the same species

- Overall, diversity indices provide a powerful tool for describing and **comparing communities**

- By quantifying the diversity of species within a community, researchers can gain insight into the ecological processes that drive community structure, as well as track changes in diversity over time

- Additionally, when comparing similar communities, a low diversity index may indicate that one of the communities has undergone some kind of disturbance (usually caused by some kind of damaging and detrimental human activity)

Photo by Dustan Woodhouse on Unsplash
*A low biodiversity index may indicate detrimental human activity in a community*

Case Study Example

- A study conducted by researchers in India compared the diversity of phytoplankton in a lake impacted by industrial pollution and a control lake (a similar lake that was not impacted by pollution

    - The control lake, L1, was located in a rural area and had no known sources of pollution, while the impacted lake, L2, received effluent discharges from an industrial area

- The study was conducted over a period of six months, during which time the researchers collected samples of phytoplankton from each lake and calculated the Simpson Index values for each site

    - The table below shows the Simpson Index values for each lake:

Simpson's Diversity Index Values

Lake	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6

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| L1 | 0.84 | 0.82 | 0.83 | 0.81 | 0.84 | 0.85 |
| L2 | 0.62 | 0.63 | 0.61 | 0.61 | 0.62 | 0.64 |
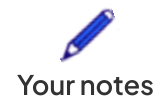
- The results of the study showed that the reference lake, L1, had a higher diversity of phytoplankton compared to the impacted lake, L2

  - The Simpson's Index value for L1 ranged from 0.81 to 0.85, indicating a high level of diversity, while the Simpson Index value for L2 ranged from 0.61 to 0.64, indicating a low level of diversity

- The data also showed that certain taxa of phytoplankton were more abundant in the reference lake, while others were more abundant in the impacted lake

  - For example, the reference lake had a higher abundance of diatoms and green algae, which are considered to be indicators of good water quality

  - In contrast, the impacted lake had a higher abundance of blue-green algae, which are considered to be indicators of poor water quality

- This study provides a clear example of how the Simpson's Index can be used to compare the diversity of the communities in two similar habitats

  - The low Simpson's Index value for the impacted lake indicates a reduced diversity of phytoplankton, which is likely due to the negative impact of pollution on the community

Examiner Tips and Tricks

Although it is important to be aware that there are different types of diversity indices, you only need to be familiar with Simpson's index for your exams.

You will be provided with the formula for Simpson's Index in the exam but you need to know how to use it to calculate Simpson's Diversity Index for example sets of data.

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What are the Methods of Conserving Biodiversity?

Conserving Biodiversity

- The quantification of biodiversity is important to conservation efforts because it helps identify areas of high biodiversity that may be **vulnerable** to human activities, and guide appropriate conservation measures to protect them

Identifying areas of high biodiversity:

- Quantifying biodiversity helps identify areas with high levels of species richness and **endemism**

- These areas may be prioritised for conservation efforts since they are likely to have unique and important ecological roles, and may be particularly vulnerable to human activities such as deforestation, mining, and urbanisation

Exploration and research:

- Once areas of high biodiversity have been identified, further exploration and research can be conducted to better understand the biodiversity of the area

- This can include surveys of flora and fauna, habitat assessments, and studies on ecological interactions

- This information can then be used to develop appropriate conservation strategies

Conservation planning:

- Quantification of biodiversity can help guide the development of conservation plans

- For example, **protected areas** can be established to conserve important habitats and species, and restoration efforts can be focused on areas with high ecological value

- Conservation measures can also be targeted towards specific threats such as habitat fragmentation, invasive species, and over-harvesting

Monitoring and evaluation:

- Biodiversity quantification can also be used to monitor and evaluate the **effectiveness** of conservation efforts

- This can include monitoring changes in species composition, habitat quality, and ecosystem services over time

- By evaluating the success of conservation efforts, strategies can be adjusted and improved to better protect biodiversity

Photo by Hemendra Ahuja on Unsplash

Flora and fauna surveys can help inform conservation strategies

- In summary, quantification of biodiversity is important to conservation efforts as it helps identify areas of high biodiversity, guide appropriate conservation measures, and monitor and evaluate the success of conservation efforts

- Effective conservation strategies are required in order to protect the biodiversity of our planet and ensure that **future generations** can **benefit** from the many ecological, economic, and cultural benefits that it provides