4.6 Biodiversity Within a Community

Recap

We learnt about taxonomy and the hierarchies in the phylogenetic classification system. You now understand that each species has a universally identified binomial, and that two organisms belong to the same species if they are able to produce fertile offspring..

Key Aims

1. *Biodiversity*
2. *Measuring Biodiversity*
3. *Human Impact on Biodiversity and Climate Change*

AQA Specification

Biodiversity can relate to a range of habitats, from a small local habitat to the Earth.

Biodiversity

Biodiversity is a measure of the variety of living organisms within a particular habitat, ecosystem, biome, or all over Earth.

A **habitat** is an area where one or more organisms live. For example, a fish could have a pond as its habitat.

A **community** refers to all of the populations present inside a single habitat. For example, a pond might have populations of birds, toads, fish and insects.

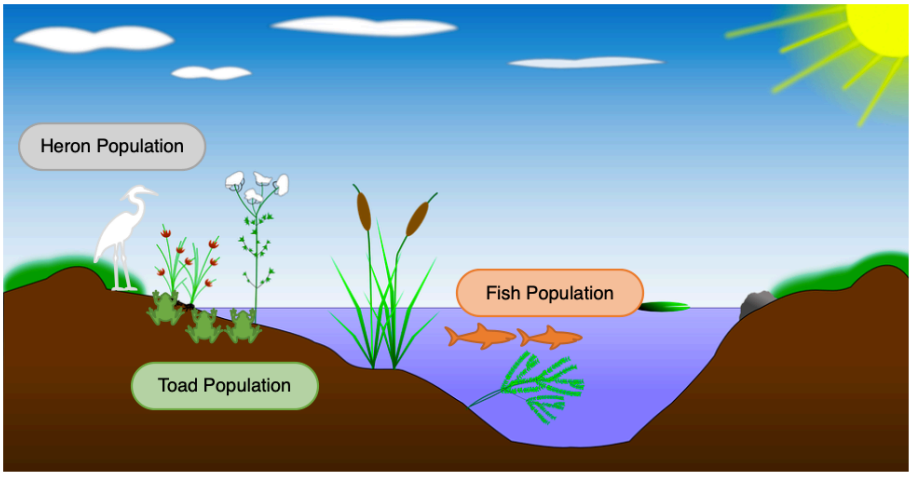


Fig 1. Pond Habitat. The pond is one big habitat, but also has many small habitats within (e.g. the water, the grassland) and many small populations.

Levels of Biodiversity

There are different levels of biodiversity:

- **Species diversity**: the number of different species within an area.
- **Habitat diversity**: the number of different habitats within an area.
- **Intra-specific genetic diversity**: the diversity in genes within a species.

- **Inter-specific genetic diversity**: the diversity in genes between species.

AQA Specification

Species richness is a measure of the number of different species in a community.

Measuring Biodiversity

Biodiversity can be quantified using **species richness** and **evenness**.

Species Richness

Species richness is the number of species within a particular region or habitat.

Species richness only measures the number of different species, but not the number of individuals in each species. Therefore, a species with only 10 individuals is counted equally as a species with 100 individuals.

Knowledge Recall

1. *Define a habitat.*
2. *What is a community?*
3. *What is the difference between species richness and evenness?*

Species Evenness

Species evenness takes into account the number of individuals in each species.

Using **species evenness**, we can develop a distribution of all the species in a region, as well as how equal their populations are:

- If all species have similar numbers of individuals, then species evenness is considered to be high.
- If all the species have varying numbers of individuals, then species evenness is considered to be low.

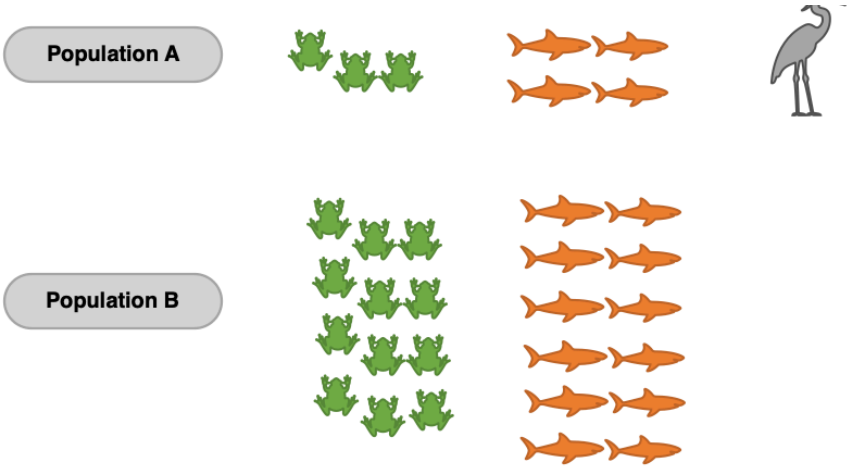


Fig 2. Species Richness and Evenness. Population A has higher species richness (3 species) compared to B (2 species). Population B has higher species even (12, 12) compared to A (3, 4, 1).

AQA Specification

An index of diversity describes the relationship between the number of species in a community and the number of individuals in each species.

Simpson's Diversity Index (D)

Simpson's Diversity Index (D) is a measure of the relationship between the number of different species in a habitat (**species richness**) and the number of individuals within each species (**species evenness**).

Simpson's Diversity Index can be calculated using the following formula:

AQA Specification

Calculation of an index of diversity (d) from the Simpson's Diversity formula.

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

D = Simpson's Diversity Index
Σ = sum of
N = total number of organisms of all species
N = total number of organisms of each species

Skills Development

You could be given data to calculate an index of diversity and interpret the significance of the calculated value of the index so be sure to brush up on this!

A **highly biodiverse** and **stable** environment will have a **high *D* value**. This also indicates that the particular environment has "good biological health".

In contrast, an **unstable** and **non-biodiverse** environment will have a **low *D* value**. This also indicates that the particular environment has "poor

biological health".

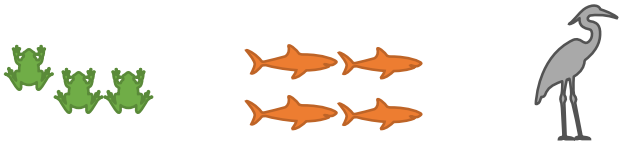
AQA Specification

Students could be given data from which to calculate an index of diversity and interpret the significance of the calculated value of the index.

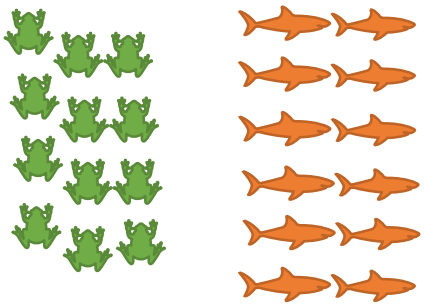
Practice Question

Work out the Simpson's Diversity Index for Population A and B.

Population A



Population B



Population A

There are 8 organisms in total, so N(N-1) is 8(7) = 56

There are 3 toads, so n(n-1) for toads is 3 (2) = 6

There are 4 fish, so n(n-1) for fish is 4 (3) = 12

There is 1 heron, so n(n-1) for herons is 1 (0) = 0.

D = 56 / (6 + 12) = ***3.11***

Population B

There are 24 organisms in total, so N(N-1) is 24(23) = 552

There are 12 toads, so n(n-1) for toads is 12 (11) = 132

There are 12 fish, so n(n-1) for fish is 12 (11) = 132

D = 552 / (132 + 132) = ***2.09***

AQA Specification

Farming techniques reduce biodiversity. The balance between conservation and farming.

Human Impact on Biodiversity

Throughout our history, humans have had a negative impact on overall biodiversity of the Earth. Hunting, poaching, development of agriculture, development of cities, and pollution of the environment have lead to

large scale extinctions of many species resulting in an overall reduction in biodiversity.

Farming, in particular, has led to several problems because farmers use several techniques to maximise food production:

Knowledge Recall

1. *What is the formula for Simpson's Diversity Index?*
2. *What does a low D value indicate?*
3. *What is deforestation? Give examples of its consequences.*

Deforestation

Deforestation is the clearing of forests (or other habitats such as glaciers) to make way for human settlements and farmland. Deforestation for farming has several severe consequences:

- **Deforestation ruins habitats.** The biggest impact is habitat **destruction**. Loss of habitat results in loss of shelter, food, water, and other resources that other organisms need to survive.

- **Loss of habitat causes extinction.** Habitat destruction leads to **extinctions** and **die offs** of different species in the ecosystem. This leads to **loss of biodiversity** which puts the ecosystem in a state of poor biological health.

- **Loss of trees leads to soil erosion**. Tree roots hold soil in place. Without tree roots, rain and wind can remove the soil from the area. This leads to loss of nutritional value of the soil, which impacts the growth of plants, which in turn impacts the entire ecosystem.

Pesticides and Herbicides

- **Pesticides and herbicides kill pests and weeds.** **Pesticides** kill undesired animals (pests), and **herbicides** kill undesired weeds.

- **Pesticides can kill other animals.** Intensive farming often uses pesticides which are **toxic** to other organisms within the ecosystem.These pesticides can get into the ground and can be carried to nearby river systems by rain water, where they can affect fish and other aquatic animals.

- **Herbicides can kill other plants.** Herbicides can kill other plants aside from weeds, which educes biodiversity of plants. It also affects any animals that rely on weeds for food.

Knowledge Recall

1. *Describe the process of eutrophication.*
2. *What is the difference between pesticides and herbicides?*
3. *Why does loss of trees lead to soil erosion?*

Fertilisers and Eutrophication

Use of fertilisers can lead to **eutrophication**.

1) **Fertilisers used by farmers**. **Fertilisers** provide **nutrients** to help farmers promote good crop growth.

2) **Fertilisers are carried by rain water**. These fertilisers can get mixed in with rain water which carries them to nearby bodies of water.

3) **Fertilisers enter lakes and rivers.** When the fertilisers get into lakes, rivers, and streams, they lead to a spike in nitrogen, ammonia, and other nutrients in the water.

4) **Nitrogen spike kills aquatic animals.** This spike in nutrients and nitrogen is **beneficial** to **aquatic plants** which causes them to grow very rapidly and densely. However, nitrogen and ammonia are toxic to other aquatic organisms.

5) **Overgrowth of plants**. The over growth of plants **removes oxygen** from the water.

6) **Large loss of aquatic animals.** Ultimately, eutrophication leads to **large scale die off** of aquatic organisms, and eventually the plants themselves.

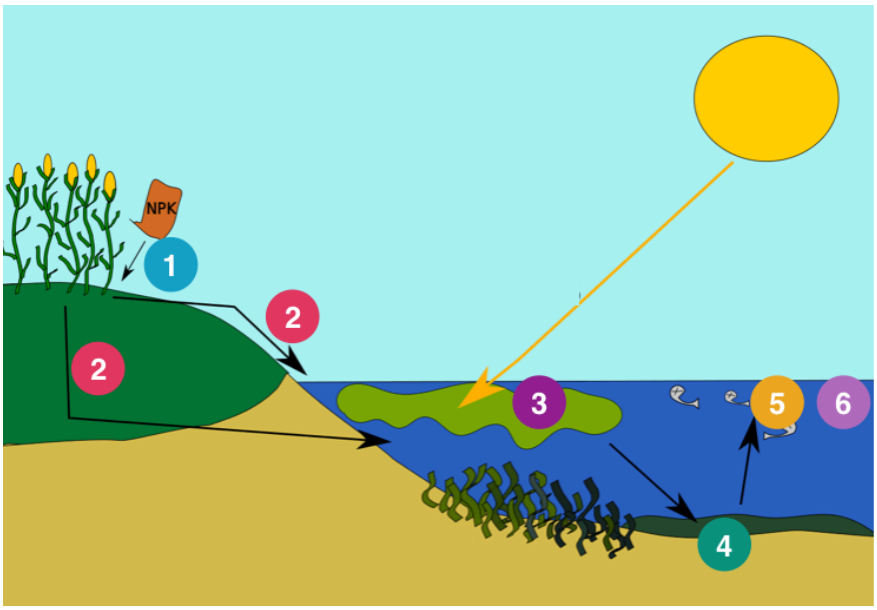


Fig 3. Summary of Eutrophication.

Knowledge Recall

1. *What is selective breeding?*
2. *Explain the main ways in which humans negatively impact on biodiversity?*
3. *What is the meaning of the 'sustainable'?*

Selective Breeding

Selective breeding means choosing plants and animals with the best traits (e.g. most food producing) and breeding them more. However, this leads to a loss in genetic diversity of farm animals, which leads to a loss in biodiversity.

Conservation and Farming

Modern Farming is Unsustainable

It is important to understand that modern farming is **unsustainable**.

- **Loss of genetic diversity increases susceptibility to disease.** Loss of genetic diversity in domesticated plants and animals makes them easily susceptible to diseases that can wipe out large numbers of plants and animals, resulting in severe food shortages.

- **Soil erosion can affect nutritional quality of soil.** Soil erosion due to farming leads to poor nutritional quality of soil, which will eventually lead to a shortage of food once the soil is nutritionally wasted.

Conservation is Needed

Conservation practices need to be implemented into modern farming in order to sustain it. Here are three strategies:

- **Conserving wild species -** Conservation of wild species of domesticated animals (e.g. dogs) allows for a **genetically diverse** population of animals that can be used later on.

- **Preventing deforestation -** Preventing deforestation helps improve soil quality, which promotes better farming. Certain areas are protected as **SSSIs** (**Sites of Special Scientific Interest**).

- **Preserving habitats -** Land and habitat preservation promotes **biological diversity** which ultimately helps domesticated plants and animals as well.

Knowledge Recall

1. *What are some of the negative potential consequences of climate change?*
2. *Why is conservation necessary?*

Climate Change

The use of fossil fuels leads to the **greenhouse gas effect**, which in turn causes **global warming**. Global warming causes the temperatures on Earth to increase drastically.

Changes in climate negatively impact ecosystems:

- **Organisms aren't adapted to the new climate.** Many plants and animals require very **specific** climates in order to survive. Changing the climate results in a loss of suitable habitat which can cause these organisms to become extinct.

- **Certain organisms can outcompete.** Organisms better suited to warmer temperatures can **outcompete** other animals for resources and habitats, which also results in a loss of biodiversity.

- **Increase in diseases.** Climate change can promote the proliferation of many **disease-causing organisms** such as mosquitoes, mould, viruses, bacteria, and other parasites. This can harm not only other plants and animals, but also humans.

Study Mind Tip

Climate change is not mentioned directly in the AQA specification for this section, but it is useful to understand it, and you can definitely add it into your exam answers.