Edexcel (B) Biology A-level

Topic 10: Ecosystems

Notes

An **ecosystem** is a life-supporting environment. It includes all of the organisms living in a particular area known as a **community,** as well as all of the non-living elements of that particular environment. Ecosystems vary in size:

- Biosphere (all life-supporting environments on the earth's surface)
- Biome (major ecosystems e.g. tundra, desert)
- Habitat
- Microhabitat

Energy Transfer Through Ecosystems

An organism's **trophic level** describes its feeding relationships with other organisms - its position in a food chain/web. Trophic Levels:

- Producer
- Primary Consumer
- Secondary Consumer
- Tertiary Consumer
- Decomposer

Ecosystem structure can be represented via a **pyramid of number, biomass, or energy.** There are advantages and disadvantages of measuring in any of these ways:

- Pyramids of **number** are the easiest to measure but can be distorted by large organisms.
- Pyramids of **biomass** are more accurate, but dry mass has to be used and they don't account for the rate of production of biomass.
- Pyramids of **energy** are the most accurate, but also the most difficult to measure and use an outdated definition of energy.

Sampling

Abundance and distribution of organisms can be measured with the use of:

- **Line transect-** where a line is placed down across the habitat and species in contact with the line are recorded.
- **Quadrat –** a square frame of a given size, randomly placed in the area being sampled. The species inside the quadrat are identified. The species can be counted or an estimate of percentage cover can be produced.
- **Belt transect –** a combination of a line transect and quadrat.

Net primary productivity (NPP) – the rate at which energy is transferred into the organic molecules that make up new plant biomass.

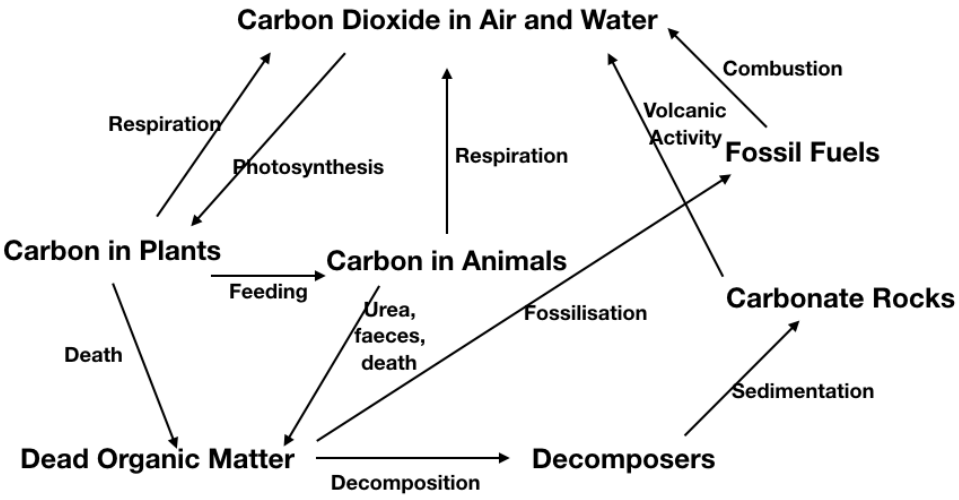
Gross primary productivity (GPP) – the energy transferred to primary consumers.

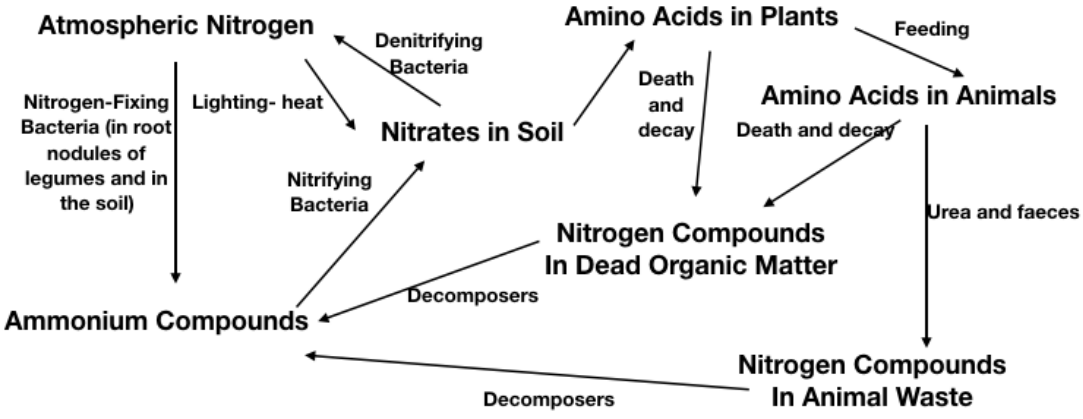
Therefore, **NPP = GPP – R.**

Some energy is lost at each trophic level. This can be due to:

- **Undigested matter** e.g. bones and hair
- **Respiration** (exothermic, transfers thermal energy to the surroundings)
- Metabolic **waste products** like urea

Microorganisms are important in the **recycling of nutrients** within an ecosystem, for example in the nitrogen and carbon cycles:





Spearman's Rank Correlation Coefficient

$$r_s = 1 - \frac{6\sum D^2}{n\left(n^2 - 1\right)}$$

A way of **measuring the correlation** between two variables is to use a **Spearman's Rank correlation coefficient**.

The closer the answer is to 1, the closer to a **linear positive correlation.** The closer the answer to -1, the closer to a **linear negative correlation.**

Student's T-Test

A Student's T-Test can be used to determine if the **means of two sets of data** are significantly different from one another.

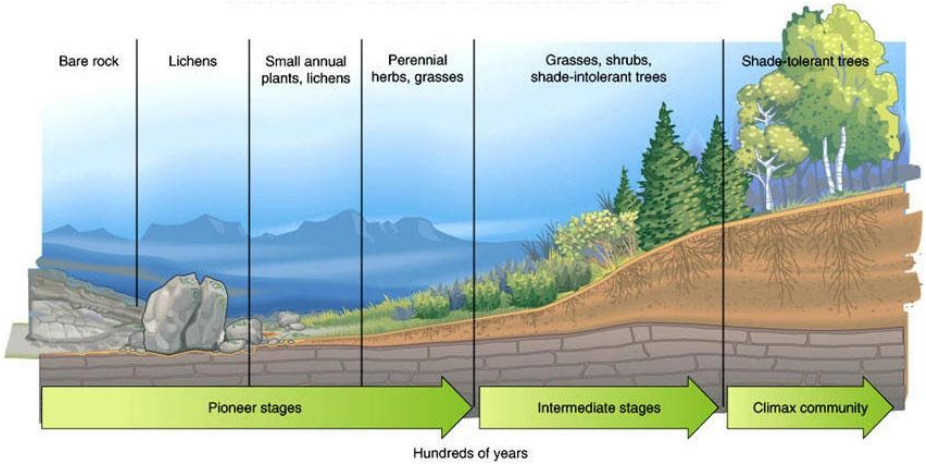
$$t = \frac{\bar{X}_1 - \bar{X}_2}{S_{x_1 x_2} \bullet \sqrt{\frac{1}{\sqrt{n_1}} + \frac{1}{\sqrt{n_2}}}}$$

Changes in Ecosystems

Succession is the colonisation of an area by organisms and the gradual replacement of those organisms by other, more varied and productive species.

Primary succession occurs when an area previously devoid of life is colonised by communities of organisms; for instance, after the **eruption of a volcano** which has led to the formation of a **rock surface.**
Secondary succession occurs with **existing soil that is clear of vegetation.** This may occur after an event such as a forest fire.

The area is first colonised by the **pioneer species,** such as lichens, which are adapted to survive in **harsh conditions.** These species penetrate the rock surface and break it down into grains. As organisms die, they are decomposed by microorganisms, thus adding **humus (the organic component of soil).** This leads to the **formation of soil,** which makes the environment more suitable for more complex organisms.



As more organisms are decomposed over time, the soil becomes richer in **minerals,** thus enabling larger, more varied and more productive plants such as shrubs to survive. Eventually, a **climax community** is established - this is the **most productive, self-sustaining and stable** community of organisms that the environment can support.

If there is **human intervention** such as grazing, the climax community which forms is called a **plagioclimax community.** Initially, it was thought that a given climate could support only one climax community - this theoretical climax community was called a **climatic climax community.** This idea has since been discredited.

The **distribution** and **abundance** of organisms in a **habitat** is controlled by both **biotic** (living) factors and **abiotic** (non-living factors).

Examples of biotic factors:

- **Predation** (predator/prey populations oscillate, although prey populations seem to oscillate even without a predator - may be responding to other changes)
- **Reproductive partners** (lack of species in an area - cannot find a mate to reproduce)
- **Territory** (necessary so breeding pairs have sufficient resources to raise young)
- **Parasitism/Disease** (affect survival/reproductive success)

Examples of abiotic factors:

- **Light intensity** (photosynthesis - influences plant growth unless plants are adapted to low light, affects circadian rhythms, reproductive patterns, availability of food).
- **Temperature** (enzyme activity).
- **Wind and water currents** (wind = water loss and cooling, gales/hurricanes destroy habitats, water = organisms have to flow with the current, attach to surfaces, or be strong swimmers to survive).
- **Water availability** (need water to survive unless adapted to very low water levels).
- **Oxygen availability** (oxygen necessary to survive. May especially be a problem in stagnant or hot water or waterlogged soil where air spaces fill with water).
- **Edaphic factors** (edaphic = relating to the structure of soil. **Sandy soil** = leaches minerals as water passes through quickly, drains quickly. **Clay** = gets waterlogged as difficult to drain, take too long to warm, hard to work. Ideal soil is **loam** which is a mixture of types).

Population size can also be influenced by **density-dependent factors** such as predation, parasitism, food source, space and competition. **Density independent factors** include climate, weather and natural disasters.

There are two types of **competition** between organisms; **interspecific competition between individuals of different species** and **intraspecific competition between individuals of the same species**.

Human Effects on Ecosystems

Global warming is a term used to describe a **gradual increase in the average temperature of the Earth's atmosphere and surface**. It is believed that global warming will lead to a permanent change in the Earth's climate. The evidence for climate change includes:

- **Records of carbon dioxide levels** – increasing levels of carbon dioxide in the atmosphere are believed to contribute towards climate change as carbon dioxide is a greenhouse gas and is involved in the greenhouse effect.
- **Temperature records** which enable analysis of changes in temperature.
- **Pollen in peat bogs** – pollen grains are preserved in peat bogs and analysis of samples of pollen can give us an idea of what kind of plants were present at the time when the peat was being formed.
- **Dendrochronology** is the study of tree rings as the size of tree rings is affected by temperature.

The data can be **extrapolated to make predictions** which can then be used in **models of future climate change**. On the other hand, such models have limitations as they do not include factors such as reduction in emission of greenhouse gases.
The **Greenhouse effect** is the process by which infrared radiation from the Sun is trapped by gases such as **carbon dioxide and methane** thus leading to an increase in the temperature of the Earth's surface and atmosphere.

The **effects of climate change** include changing rainfall patterns and changes in seasonal cycles which in turn would lead to:

- **Changes in distribution of species** – species would move to cooler areas i.e. northwards. This could potentially lead to the extinction of some species due to competition.
- **Changes to development** – sex of many reptiles is determined by temperature, therefore an increase in temperature would affect the sex ratio of certain species thus potentially leading to extinction.
- **Disrupted life cycles**

The **International Union for Conservation of Nature** (made up of 200+ governments and 900+ NGOs) draws up a **Red List of Threatened Species** annually. Threatened can be further broken down into vulnerable, endangered and critically endangered.

To prevent extinction, there are many **international agreements** to support conservation, encourage sustainable use of resources and protect endangered species.

An example of this is the **Convention on International Trade in Endangered Species of Wild Fauna/Flora** (**CITES**). It regulates the trade of living organisms and their products by classifying them into three appendices depending on the level of threat to the organism, guided by the Red List.

CITES has had some success at conserving biodiversity (e.g. ivory trade, sharks, turtle species brought back from the brink of extinction). However, its successes are limited because it **deals exclusively with trade**, many countries **haven't signed up**, there is **no legal obligation** to abide by the rules (only trade sanctions can be used) and **commercial interests often override scientific evidence.**

Conservation serves to **maintain or increase the biodiversity within a particular habitat** by allowing **sustainable use of natural resources,** whereas **preservation serves to maintain** the biodiversity **levels and the habitat intact** by **minimising the effects of human activities** on the particular habitat.

One of the ways of **reducing global warming** is the reduction of carbon dioxide levels in the atmosphere. This can be done through:

- Growing plants to use as a fuel as **biofuels** which are **carbon neutral** – carbon dioxide released by burning the fuel is removed from the atmosphere by the plants it is made from (by **photosynthesis**).
- **Reforestation** to increase the rate at which carbon dioxide is removed.

Similar ideas of sustainability can also be applied to the management of **global fish stocks**. There are many **economic, social and ethical reasons** for conservation. For instance, many species provide a source of **food and medicine** and are important for processes such as **pollination of crops** as well as for maintaining a good **quality of water** as well as attracting **tourism**. Social reasons include conservation for **aesthetic reasons** and **recreation** whereas ethical reasons include the **right to survive.**

To validate evidence related to the climate change debate, studies are **peer-reviewed, published in scientific journals, and debated at scientific conferences.**