12 Interactions within Ecosystems

Biodiversity refers to all the variety of life on Earth. This biodiversity exists within an ecosystem. An ecosystem is made up of many different organisms such as plants, animals and microorganisms living together within an environment and depending on each other, in various ways, for survival. Biodiversity supports everything in nature that we need to survive such as air, food, water and medicine. Due to human activities, the balance within the ecosystem is being disrupted, causing the loss of biodiversity. To help maintain biodiversity, we must look into ways to live more sustainably through our lifestyle. We must also develop technologies that can help us use Earth's resources more sustainably such as using alternative sources of energy, exploring sustainable materials and increasing energy efficiency of our products.

- Ecosystems (12.1)
- Interactions within ecosystems (12.2)
- Environmental conservation (12.3)

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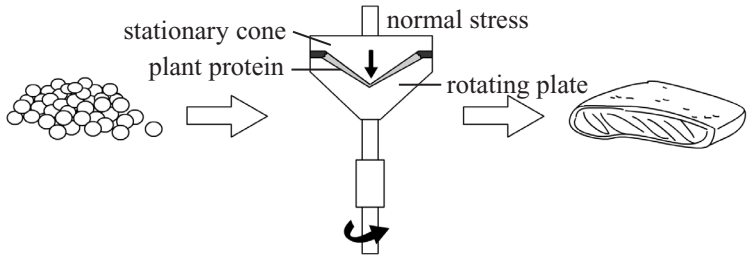
12.1 Ecosystems

There are many ecosystems on Earth – marine, forests and desert are a few examples. In each of these ecosystems, we may find different types of organisms living in it. All these organisms, including humans interact with the environment and are part of a delicate balancing act to maintain a healthy ecosystem. A healthy ecosystem is able to protect biodiversity. With greater biodiversity, our resources such as air, clean water, arable land (land that can be used to grow crops) and food are protected. We can do so by using technology to reduce consumption of our resources, reduce waste generated and increase the efficiency of production.



Sustainability

Fig 12.1 Meat and dairy production and consumption are increasing the rate of deforestation and greenhouse gas emissions. There is an urgent need for dietary change, for example, to plant-based 'meat' as a healthy and sustainable alternative. The technology shown here uses forces to make plant protein into a layered, fibrous structure that mimics the appearance and texture of real meat.

1. A biosphere is made up of all ecosystems on Earth.
2. An ecosystem is the interactions between a community and its physical environment.
3. An ecosystem can be as small as a pond or as large as a forest.
4. A community is made up of different populations living together in a particular habitat (i.e. environment).

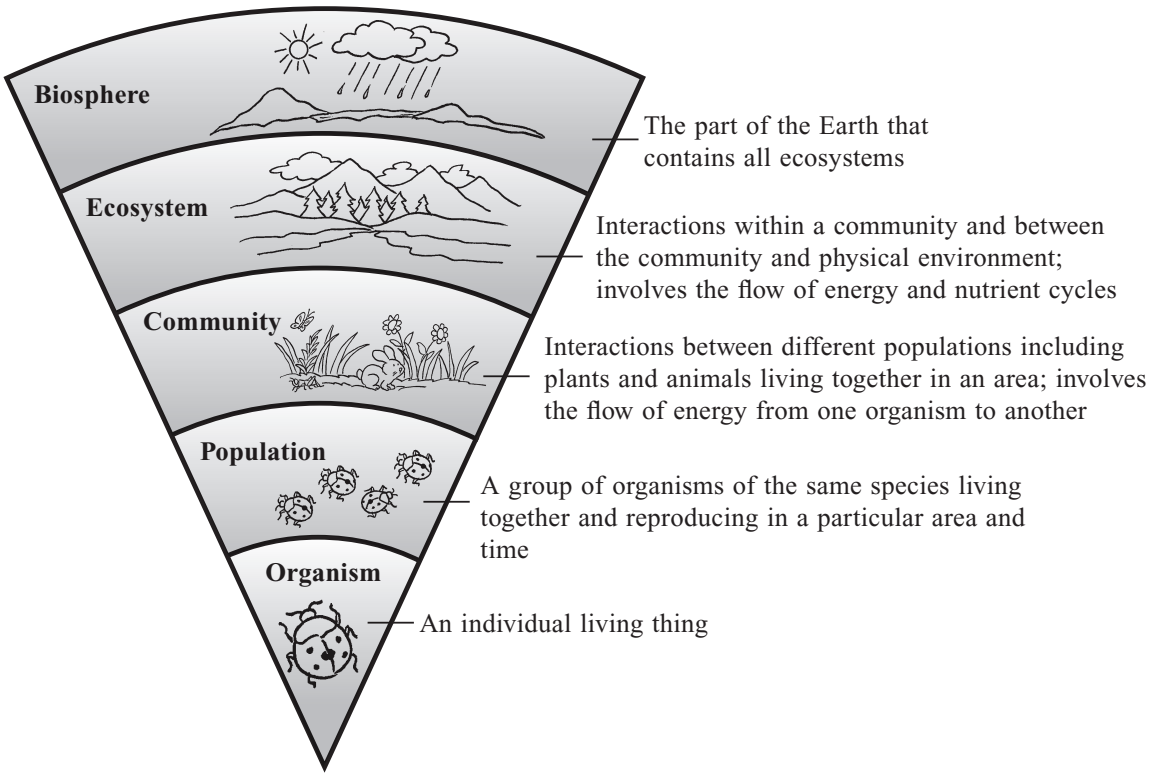


Fig 12.2 From organism to biosphere

5. Ecosystems provide ecological services that are essential to the survival of all organisms.
6. These ecological services include provision of clean water and air, maintaining the soil for plant growth, regulating the climate and recycling nutrients.
7. Ecosystems provide raw materials to make things we need in daily life such as wood, food, medicines and other purposes.
8. Rich biodiversity shows that an ecosystem is healthy and balanced.
9. A wide variety of species will allow the ecosystem to adapt and survive changes in the ecosystems.
10. On the other hand, extinction of a species may cause the destruction of entire ecosystems.
11. Changes in ecosystems can be due to human activities such as pollution and acceleration of climate change.

12.2 Interactions within Ecosystems

Every factor in the ecosystem interacts with other factors. A thriving ecosystem requires a delicate balance among all the factors in the ecosystem. Human activities such as increase in motor vehicles and intensive farming of livestock have led to an increase in greenhouse gases in the atmosphere. Greenhouse gases in the atmosphere trap heat within the Earth, leading to global warming. Global warming accelerates climate change, leading to extreme and unpredicted weather events. Some organisms that are unable to survive or adapt fast enough to the changing environment head towards extinction. The world is currently facing its sixth mass extinction event where 500 land species are expected to go into extinction in the next 20 years. The rate at which this is happening is accelerating due to human overpopulation and human overconsumption.

Fig. 12.3 Seed banks are one way to conserve plant species. In Singapore, a seed bank was started in 2019 to store and conserve tropical plant species. The seed bank also supports research into optimization of seed storage methods. This complements other countries' seed banks that usually focuses on temperate plants.

Physical (Abiotic) Factors that Affect the Survival of Organisms

1. **Air**—contains oxygen needed by most organisms for respiration; also contains carbon dioxide which is an important raw material for photosynthesis.

2. **Water**—all living things need a percentage of water in their body to live healthily; water in living things enables biochemical reactions; some organisms are adapted to live in water.
3. **Temperature**—living things are adapted to survive in a range of temperatures.
4. **Light**—plants need light energy to make food through photosynthesis. The food made by plants is then transferred to animals through food chains and food webs.
5. **Mineral salts**—plants grow healthily in fertile soil which contains nitrogen, phosphorus and potassium. Plants need nitrogen to make proteins.
6. **Acidity /Alkalinity (pH)**—most plants grow healthily in slightly acidic soil.
7. These physical factors can be investigated using instruments such as the data logger and probes.
8. The advantages of using data loggers are that:
   - they are able to take readings over long periods of time,
   - they are able to take multiple readings in a short time, and
   - data can be shown as a graph for easier interpretation of trends.

Biological (Biotic) Factors that Affect the Survival of Organisms

1. Biotic factors are the living things in an ecosystem.
2. These are the producers, consumers and decomposers.
3. Producers are organisms that make their own food via photosynthesis. For example, plants, algae and phytoplankton.
4. Photosynthesis involves the use of light energy obtained from the Sun to convert carbon dioxide in the air into sugar (glucose) and oxygen.
5. Consumers cannot produce their own food but eat other organisms to survive. These organisms can be herbivores, carnivores or omnivores.
6. Decomposers break down dying or dead organisms. For example, fungi and bacteria.
7. The interactions between producers, consumers and decomposers affect the survival of organisms within the ecosystems.

8. For example, in a balanced aquatic ecosystem, a sufficient number of algae and phytoplankton is required to feed a number of zooplankton. They then provide food to small fish who are prey for larger fish and even animals such as bears and humans.

SCIENCE AROUND US

The tropical rainforest in Borneo is one of the world's most biodiverse ecosystem. However, illegal burning of the forest is threatening the wildlife. Farmers are clearing the land by burning it to plant palm trees. The burning causes hazy conditions, blocking out the sunlight in the area. Wildlife such as orangutans are becoming critically endangered due to this.

(a) Describe how the burning changes the physical factors in the area. [2]
(b) Explain why orangutans are becoming critically endangered. [3]

ANSWER

(a) *The burning of forests increases temperature, reduces sunlight, reduces the amount of water, and increases nutrients in the soil.*

(b) *The orangutans lose their habitats, are unable to find shelter and lose their source of food because plants die as they are unable to photosynthesise. Some are burned to death. These decreases the population of orang utan till a critical level.*

Relationships between Organisms

1. Animals that hunt and kill other animals for food are known as predators. The animals that they hunt are known as prey.
2. **Predator-prey relationship** is where one species (predator) feed upon another species (prey).
3. For example, the lynx preys on the hare. Their population depends heavily on each other as shown in this graph. When the population of lynx increases, the population of hare decreases due to over-predation. When the population of hare decreases too much, it can no longer support a large population of lynx. The lynx population thus decreases. This in turn, results in an increase in the population of the hare as there is less predation. The predator-prey relationship is a cyclical one.

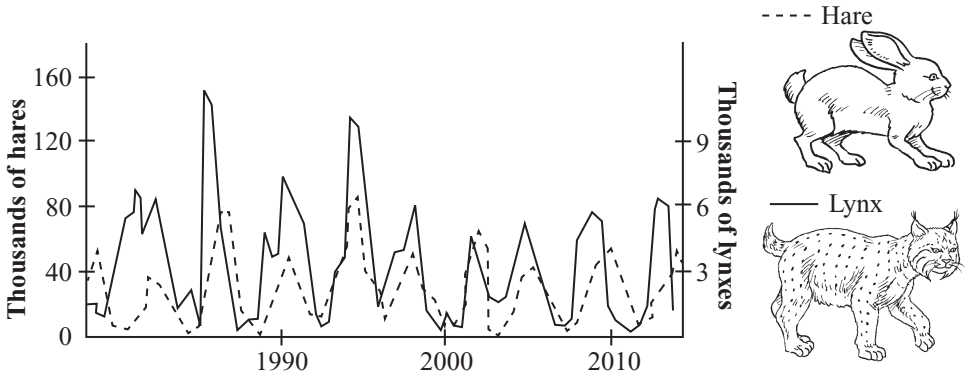


Fig 12.4 Predatory-prey relationship between the lynx and hare

4. **Mutualism** is the relationship between two different species of organisms such that they both benefit from each other.
5. An example is pollination. Insects such as bees and butterflies visit flowers to obtain nectar, a sweet food source that is secreted by the flower. Once a pollinator arrives at the plant, it usually rubs against the flower in order to obtain the nectar. During this process, pollen grains stick on to the body and legs of the pollinator. When the pollinator visits the next plant to obtain nectar, the pollen grains are deposited on another flower. This helps to distribute the pollen from the first plant far away.
6. **Parasitism** is the relationship between two organisms where one is harmed while the other benefits from the relationship.
7. A parasite is an organism that causes harm to another organism, its host, without necessarily killing it.
8. For example, tapeworms can live in intestines of animals such as cows, pigs and humans. They get food by eating the host's partly digested food. This may deprive the host of nutrients.
9. While the parasites may harm the host, it usually does not kill it. This is because the parasite usually depends on the host for survival.
10. When all these interrelationships are maintained, the ecosystems will be balanced.
11. The removal of any organisms or changes in the physical environment may cause imbalance in the ecosystem. This may lead to extinction of certain species.

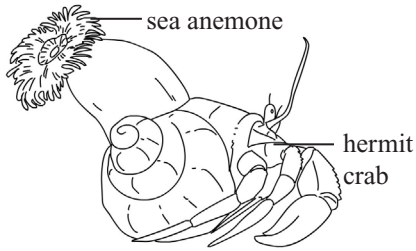


Fig 12.5 The sea anemone obtains scraps of food produced as the hermit crab eats. The hermit crab is protected from predators such as the octopus by the stinging tentacles of the sea anemone. Hence, the hermit crab and the sea anemone have a mutualistic relationship.

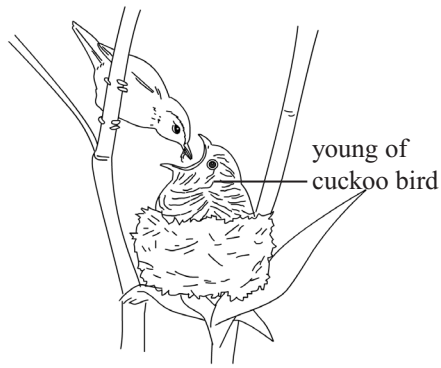


Fig 12.6 The cuckoo bird is a brood parasite as it lays its eggs in the nests of other birds which incubate the eggs and feed the young of the cuckoo birds that hatch out.

Adaptive Traits

1. Adaptations are qualities that enable organisms to be better suited to survive in their environment and reproduce.
2. **Structural adaptations** refer to the physical features of organisms that help them to survive.
3. **Behavioural adaptations** refer to the patterns or actions of organisms that help them to survive in their environment.
4. For example, some plants such as the sunflower move so that their leaves or flowers face the Sun to obtain more light for photosynthesis.
5. The migratory pattern of birds are also a behavioural adaptation. To escape the cold winter seasons, some birds and grazing animals migrate to warmer areas where they can find food.

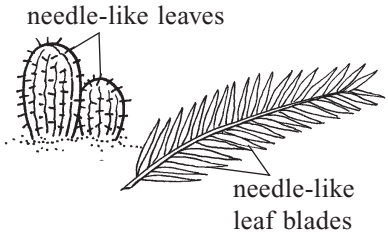


Fig 12.7 To minimise water loss by transpiration, the cacti which live in the dry desert have needle-like leaves. The pine trees in cold temperate areas have needle-like leaf blades to prevent accumulation of snowflakes.

Fig 12.8 Predatory birds such as hawks have sharp claws to catch prey and sharp pointed beaks to tear flesh of prey.

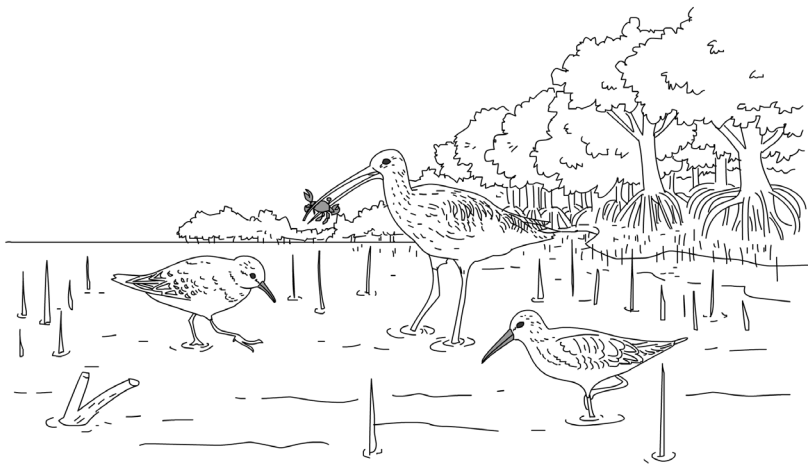


Fig 12.9 Sungei Buloh is one of the transit stops for some migratory birds that travel from Northern countries of Asia to escape the cold winter. Some spend the whole winter here while some feed here for a few days then resume their journey to Australia and New Zealand.

6. Adaptive traits of a species change through natural selection. Natural selection is one of the driving forces of evolution.

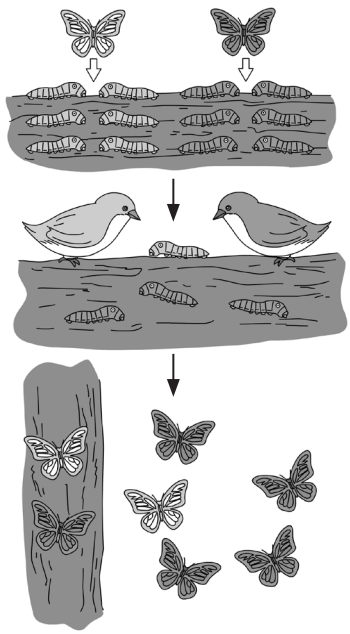


Fig 12.10 How do the beneficial alleles (different forms of a gene) increase in frequency through natural selection? Imagine that in a population of butterflies, there are yellow butterflies and brown butterflies (genetic variation). As the brown caterpillars can better camouflage themselves amongst the brown tree trunks, they are more likely to survive predation, reproduce and pass their alleles (different forms of a gene) to the next generations.

SCIENCE AROUND US

The leopard cat is a critically endangered species of wildcat found in Singapore. It has yellowish-brown fur with black spots on the body and black stripes that run from the head to the back. Leopard cats are typically found in tropical rainforests and feed on rodents such as rats. They are usually more active at night.

(a) Identify the structural adaptation of the leopard cat mentioned in the question. Explain how it helps with its survival. [3]

(b) Suggest one other structural adaptation you would expect to find in a leopard cat. Explain why you would expect to find this structural adaptation. [2]

(c) Identify the behavioural adaptation of the leopard cat mentioned in the question. Explain how it helps with its survival. [2]

ANSWER

(a) *The leopard cat has yellowish-brown fur with black spots and black stripes which allow it to blend/ camouflage into the understorey/ground of the tropical rainforest. Hence, it is able to avoid predators and avoid detection by prey.*

(b) *The leopard cat has sharp teeth/canines, which enable it to hunt/prey easily/kill prey easily/ tear flesh easily.*

It has good night vision, which enables it to hunt at night.

It has strong limbs which enable it to run fast.

(c) *The leopard cat is more active at night. It hunts at night as rodents are usually more active at night.*

Food Chains

1. A food chain shows the feeding relationships and hence a one-way flow of energy from one organism to another.

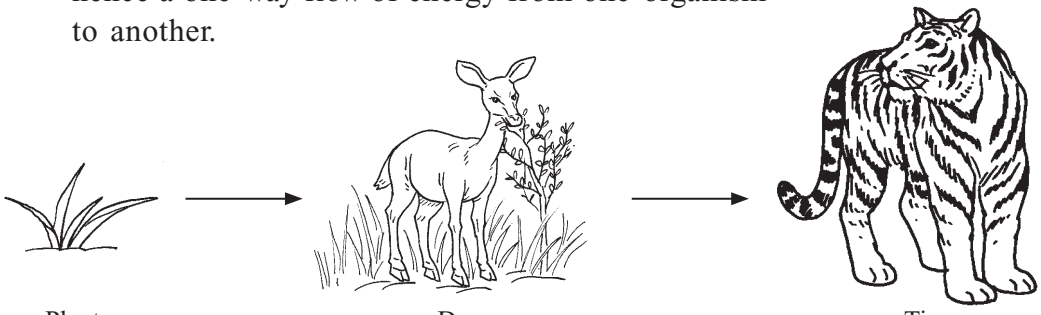


Fig 12.11 A food chain shows the flow of energy from the producers.

2. Each food chain is made up of organisms at different trophic levels. Trophic levels are the feeding positions of organisms in a specific ecosystem.
3. The first trophic level of a food chain is made up of a producer. Producers make their own food.
4. Most producers make their food via photosynthesis as they have chloroplasts in their cells.
5. Photosynthesis is a process where carbon dioxide and water are converted into glucose and oxygen in the presence of light. Energy is released in the process.

$$\underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} \xrightarrow{\text{Light}} \underset{\text{Sugar}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2}$$

6. **Consumers** are animals that eat other organisms in a food chain.
7. The second trophic level of a food chain is made up of primary consumers. These are often **herbivores** (plant-eaters).
8. The third trophic level of a food chain is made up of secondary and tertiary consumers which are usually **omnivores** (plant-and-animal eaters) or **carnivores** (animal-eaters).
9. At each stage of a food chain, **90% of the energy is lost** through wastes and respiration. Only about 10% of the energy in one stage of a food chain is transferred to the next stage.

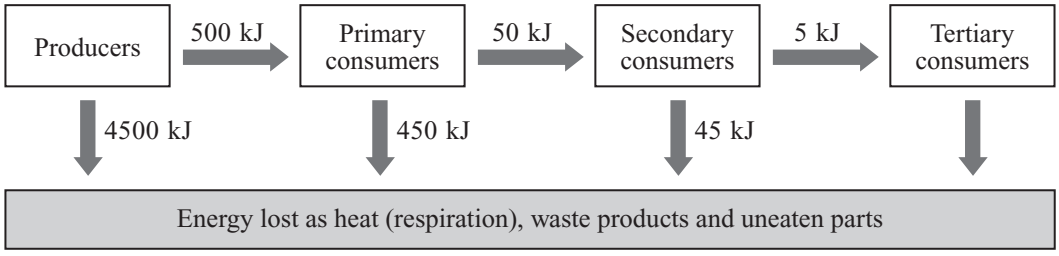


Fig 12.12 The loss of energy along a food chain

10. Energy lost at each stage cannot be recovered. The flow of energy is **non-cyclical**.
11. Therefore, energy must be constantly supplied to an ecosystem.

12. Nutrients trapped inside organisms are recycled in the ecosystem through the action of decomposers on dead organisms. The flow of nutrients is thus **cyclical**.
13. Decomposers break down the complex compounds in dead organisms into
    (a) carbon dioxide,
    (b) mineral salts.
14. Examples of decomposers are bacteria and fungi.
15. Scavengers are not decomposers.
16. The scavengers such as vultures and earthworms help the decomposers by breaking up dead organisms into smaller pieces.

Food Webs

1. In any community, the different food chains can be **interconnected** to form a **food web**.
2. A food web shows a more holistic picture of the feeding relationships within a specific ecosystem.
3. The diagram shows a food web found in the Arctic region.

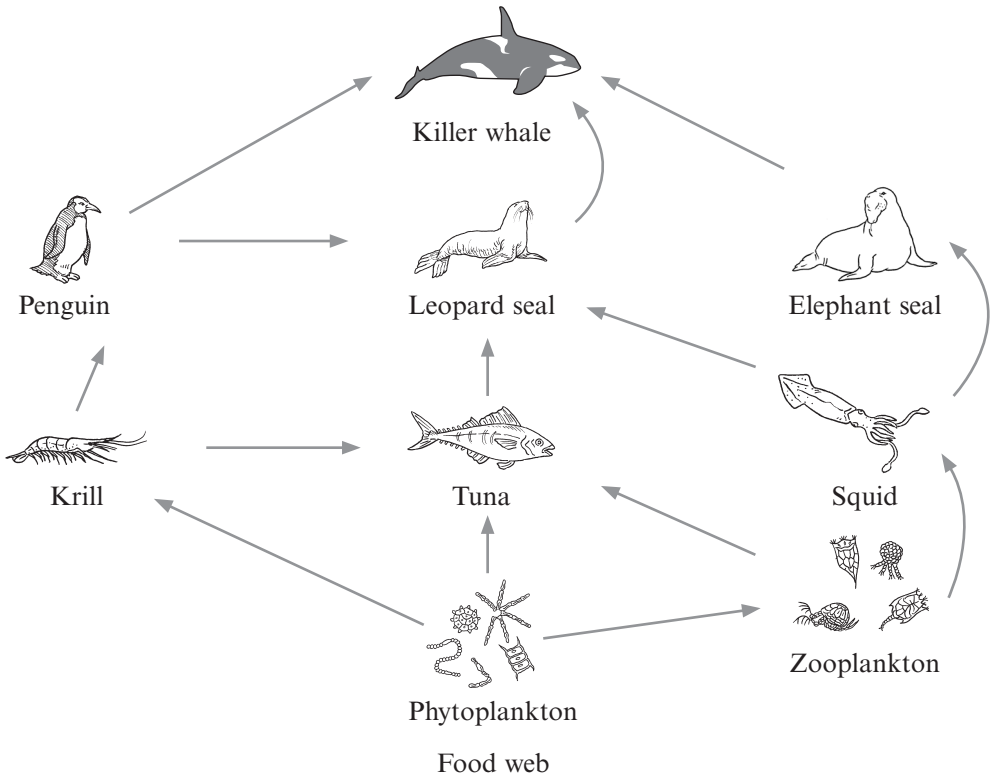


Fig 12.13 A food web in the Arctic

4. Examples of food chains found in this habitat would be:
   phytoplankton → zooplankton → tuna → leopard seal → killer whale
   phytoplankton → krill → penguin → leopard seal → killer whale

Ecological Pyramids

Optional for **N(A)**

1. An **ecological pyramid** shows the energy, biomass or number of organisms available within each stage in a food chain.

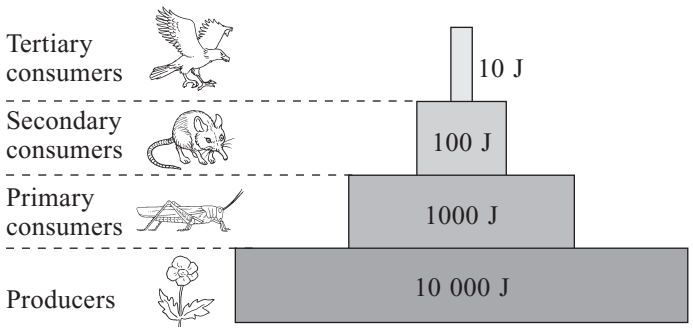
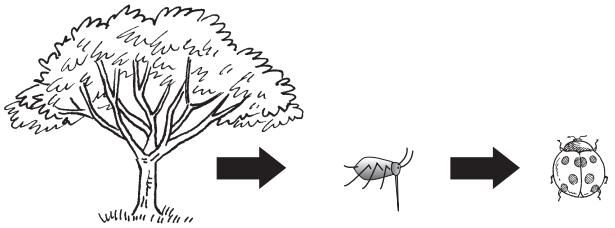


Fig 12.14 The pyramid of energy

2. The base of the ecological pyramid is formed by the first trophic level of organisms (the producers) in the food chain, the second level of the pyramid is formed by the second trophic level of organisms and so on.
3. The **pyramid of energy** usually decreases by a factor of 90% from one trophic level to the next. This is because 90% of energy is lost from one trophic level to the next.
4. Biomass is living or recently dead tissues.
5. The **pyramid of biomass** measures the amount of biomass at each trophic level in a food chain.
6. Generally, the pyramid of biomass also decreases from one trophic level to the next. This is because fewer organisms are supported at higher trophic levels as energy transfer decreases up each trophic level.
7. The **pyramid of numbers** shows the number of organisms at each trophic level.

8. Unlike the pyramid of energy and biomass, the pyramid of numbers does not necessarily follow the decreasing pattern.



Oak tree Aphid Ladybird

Organism	Number	Biomass
Oak tree	1	500 000
Aphids	10 000	1000
Ladybirds	200	50

Pyramid of numbers Pyramid of biomass

Fig 12.15 The pyramid of numbers and the pyramid of biomass

SCIENCE AROUND US

Optional for **N(A)**

This is a typical food chain found in the marine ecosystem.

algae → krill → tuna → shark

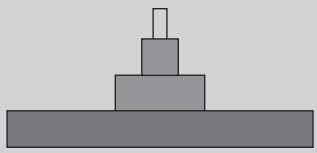
(a) (i) Draw the pyramid of energy for this food chain. [1]

(ii) Explain the shape of the pyramid of energy. [3]

(b) Shark population has been declining over the years. With reference to the food chain above, outline how this may affect the marine ecosystem. [4]

ANSWER

(a) (i)



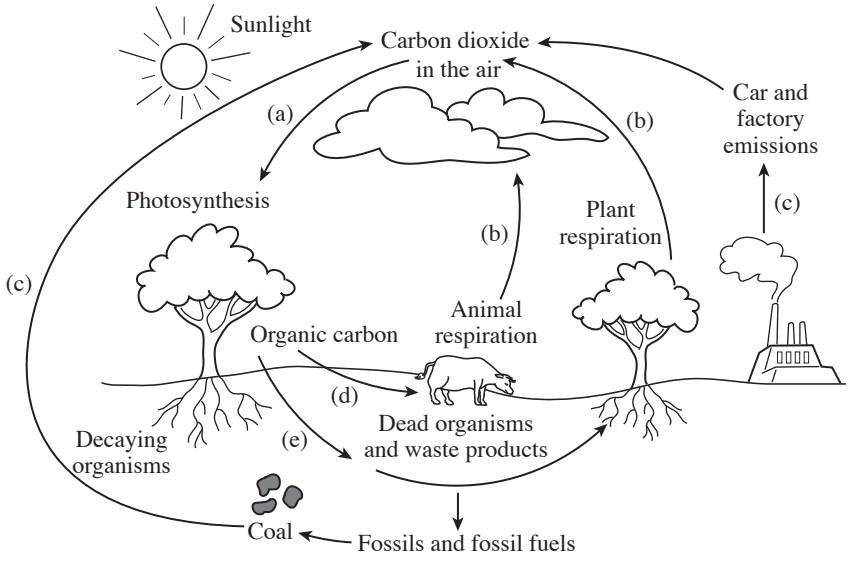
(ii) *Only 10% of energy is passed on from one trophic level to the next. Energy is lost through heat and feces. Energy is also used up by the organism for movement and during processes such as respiration.*

(b) *The food chain will be disrupted. The tuna population will increase due to less predation, krill population will decrease due to increased predation, and the population of algae will increase. The overpopulation of algae may cause algae blooms that are harmful to other marine organisms. The decreased krill population may result in the collapse of other organisms that depend on them for food.*

The Carbon Cycle

Optional for **N(A)**

1. In the ecosystem, the element carbon moves between the atmosphere, living things and ground through different processes such as:
   (a) photosynthesis
   (b) respiration
   (c) combustion
   (d) feeding / nutrition
   (e) death / decay



Carbon cycle

Fig 12.16 The carbon cycle

2. Carbon is mostly stored in rocks and sediments. The rest of the carbon moves through the oceans, atmosphere and living organisms.
3. Carbon is released into the atmosphere through combustion of fossil fuels.
4. Carbon is moved through the food chain when producers take in carbon dioxide via photosynthesis. The process of photosynthesis converts carbon dioxide (CO_2) into glucose ($C_6H_{12}O_6$).
5. Consumers eat and digest their food that contains carbon and use them for processes such as respiration.

6. Decomposers break down dead organisms and waste products. Decomposition usually takes place through anaerobic decomposition. Anaerobic decomposition refers to the processes by which microorganisms break down biodegradable materials in the absence of oxygen.
7. Carbon is stored in reservoirs known as 'sinks'. Rocks, fossil fuels, oceans and forests act as carbon sinks.
8. The forests take in carbon from the atmosphere through photosynthesis and stores it in their biomass.
9. Oceans are able to dissolve carbon in the atmosphere. Carbon dioxide dissolves to form carbonic acid.

Note

Carbon sequestration is the long-term removal of CO_2 from the atmosphere and storing the carbon in stable solid forms (biomass, biochar, rocks) or liquid forms (oil). Figure 12.17 shows an example of carbon sequestration that occurs in nature while figure 12.18 shows an example of artificial carbon sequestration.

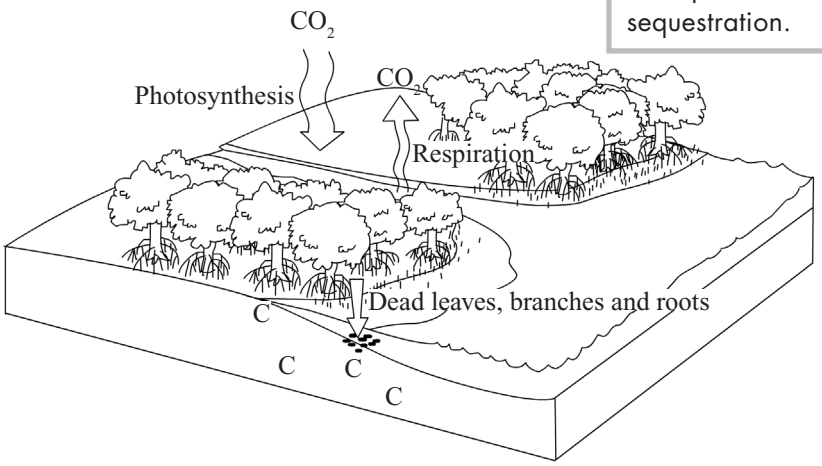
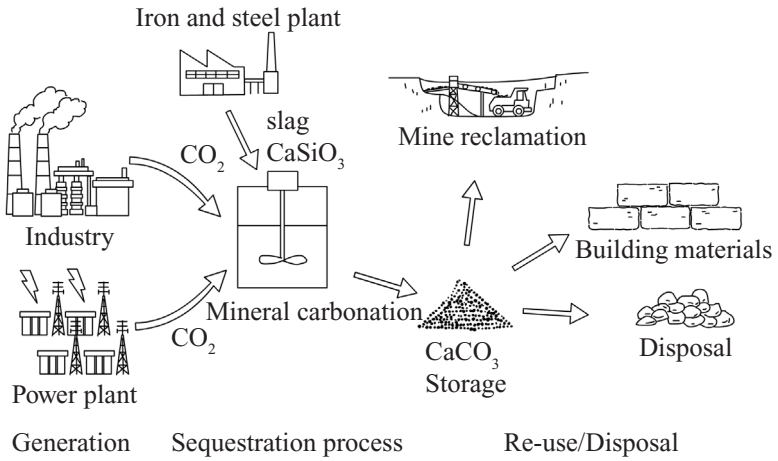


Fig 12.17 Mangrove forests are effective carbon 'sinks'. Carbon in the atmosphere is taken in by mangrove plants through photosynthesis. Some carbon is lost as CO_2 during respiration. Dead leaves, branches and roots which contain carbon are buried in the clayey soil. As decomposition of the plant matter is slow in the oxygen-poor soil, carbon can be stored in mangrove forests for a long time.



Emerging technology

Fig 12.18 In the mineral carbonation technology (MCT), CO_2 is reacted with minerals such as CaO, MgO and slag $CaSiO_3$ (from iron and steel plants) to form carbonates such as $MgCO_3$ and $CaCO_3$.

12.3 Environmental Conservation

There is an urgent need for humans to change our lifestyle and actively protect the environment. We need to reduce the stress on our natural resources by reducing our consumption and switching to more sustainable sources of food and products. We need to harness technology to create a circular economy where waste is reduced and resources can be reused continuously. A smartphone application in the United Kingdom helps people to identify types of materials used in packaging and determines the nearest recycling facility for the material. To slow down climate change and protect the biodiversity on our planet, we need to rethink our lifestyle, reduce our consumption, refuse unsustainable products and practices, reuse and repair products, and recycle materials.

	Questions for designers, manufacturers and consumers		Questions for designers, manufacturers and consumers
 Reduce	Can the amount of materials used be reduced? Can the energy used in manufacturing the product be reduced?	 Repair	Can the product be repaired easily or cheaply? Can parts of the product be replaced?
 Reuse	Can the product be repurposed? Can parts of the product be reused?	 Recycle	Can the materials used be recycled?
 Refuse	Does the product use plastics in its packaging? Will consumers buy the product if it is not sustainable?	 Rethink	Can I redesign the product to make it more sustainable? Do I really need the product?

Sustainability

Table 12.19 These six R's help designers, manufacturers and consumers to be self-aware of the effects of the things or decisions we make on the environment.

Impacts of Human Activities

1. Human activities such as agriculture, burning of fossil fuels and over-fishing affect the environment.
2. Intensive agriculture to feed the growing population is causing soil to become infertile faster. This results in the use of fertilisers to support crop yields. If handled improperly, these fertilizers can be washed

3. Burning of fossil fuels releases carbon dioxide into the atmosphere. Carbon dioxide is a greenhouse gas that contributes to global warming, accelerating climate change.
4. Over-fishing disrupts the ocean ecosystem as certain populations diminish. Removal of top predators such as sharks will result in an increase in organisms that are usually consumed by the sharks. In turn, there will be a decrease in the smaller organisms. This changes the balance in the ecosystem.

Improper Sewage Disposal

Optional for **N(A)**

1. Human activities such as improper disposal of sewage can affect the environment adversely:
   (a) Sewage that is discharged into rivers and seas without treatment causes rapid growth of bacteria, depleting the amount of oxygen in the water.
   (b) Industrial wastes may contain poisonous metals such as mercury, arsenic and cadmium. These metals, when discharged into rivers, lakes and seas, will accumulate in the aquatic organisms causing harm or death to humans when consumed.
   (c) Insecticides that are washed into rivers and lakes accumulate and are amplified in organisms up the food chain. This is known as bioaccumulation and bioamplification. Organisms at the top of the food chain then suffer from the toxic effects of the high concentration of insecticides.
   (d) Fertilisers that are washed into rivers and lakes cause algal bloom. This excessive plant or algal growth (usually caused by nitrates and phosphates) is called eutrophication. When these algae die, bacteria grow and deplete the oxygen in water, causing aquatic organisms to die.

2. Wastewater treatment: In environmental biotechnology, microorganisms (algae, aquatic plants, marsh plants, aerobic bacteria, anaerobic bacteria, small invertebrates) are used to treat sewage (break down organic matter and nutrients such as nitrates NO_3^- and phosphates PO_4^{3-}) before they are discharged into rivers and seas.
   - Sedimentation is the separation technique in which sand or dirt in water settles to the bottom.
   - Anaerobic digester: In sealed tanks, anaerobic bacteria, which do not require oxygen (aeration), reduce the volume of sludge and produce methane gas (biogas), an alternative energy source.
   - Anoxic digester: In an anoxic condition, molecular oxygen O_2 is not present (similar to condition for anaerobic respiration) but nitrates NO_3^- which contain oxygen are present. Bacteria break down nitrates, thereby removing nitrogen from the wastewater.
   - Aeration is the mixing of air with water. The disadvantage of aeration is that it increases energy consumption.
   - Aerobic digester: Microorganisms and aerobic bacteria, in the presence of oxygen, digest solids (food, cardboard), reducing the volume of sludge.
   - Clarifiers are settling tanks that have the mechanical means to remove solids (sludge) that have settled to the bottom.
   - Disinfection is the killing of harmful microorganisms. Chlorine and/or UV may be used.

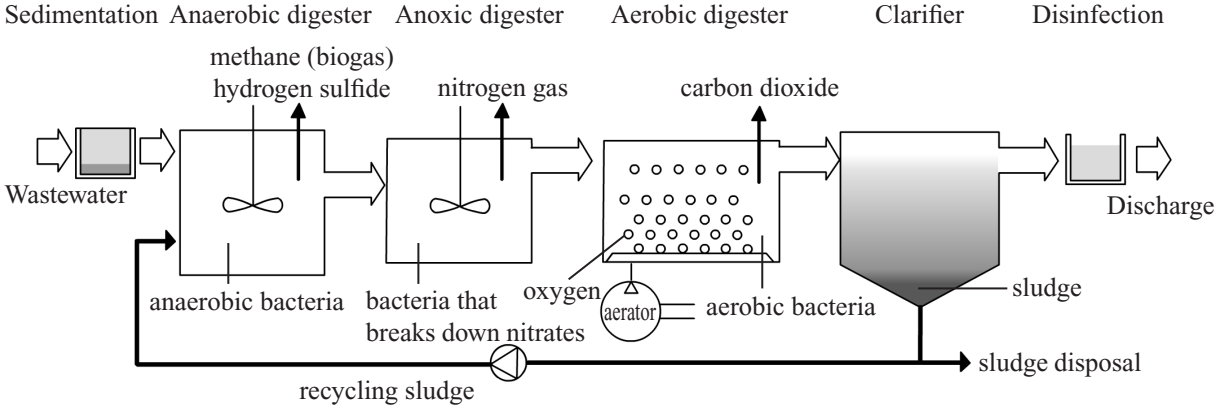


Fig 12.20 Sewage from homes and factories is pumped into sedimentation tanks and will be subjected to a few levels of treatments by different types of bacteria before being discharged into rivers or seas.

3. If the treated wastewater is discharged into an area that is near to an ecosystem such as a coral reef, chlorine used for disinfection would kill the corals. One alternative technique of removing harmful bacteria is by slow sand filtration which uses a layer of Schmutzdecke (a biofilm) that consists of a community of microorganisms (small invertebrates) to feed on the bacteria. Another technique is to construct artificial wetlands.

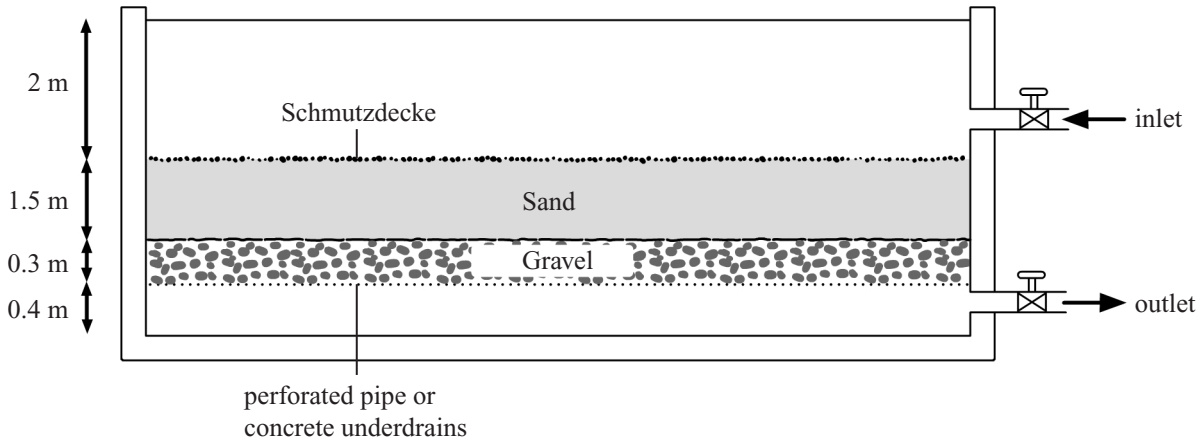


Fig 12.21 The slow sand filtration has a biological layer, called Schmutzdecke, that removes bacteria.

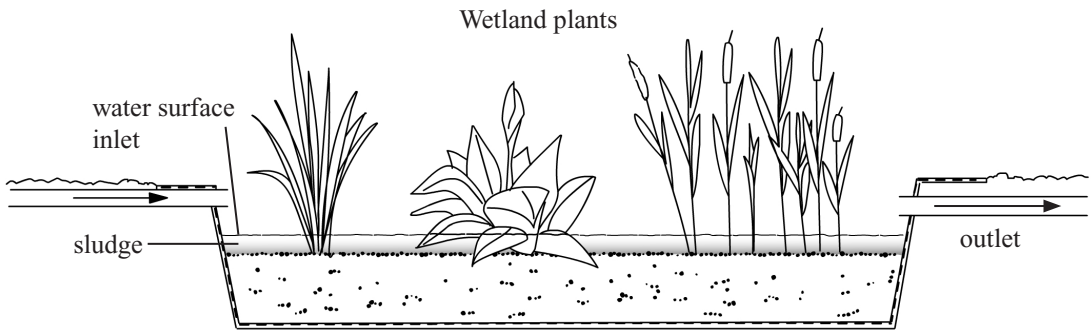
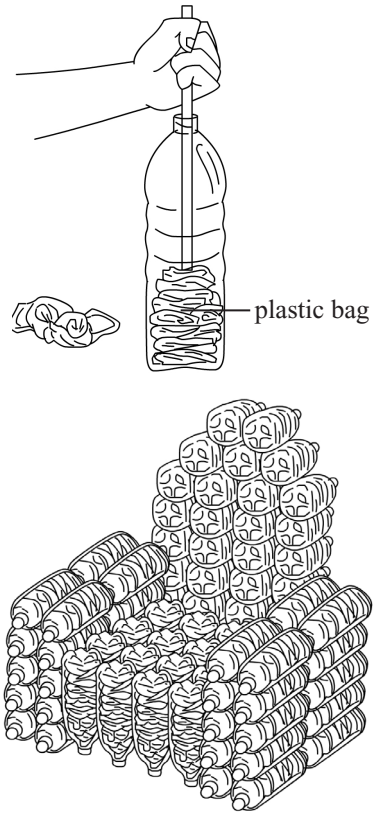


Fig 12.22 Artificial wetlands remove insoluble solids, organic matter and nutrients (nitrates and phosphates).

Sustainable Living

1. **Sustainability** refers to the ability of Earth to substitute the used resources so as to maintain the resources forever.
2. By living sustainably, we live within the means of our natural environment and ensure that our lifestyle does not cause harm to the environment and other people.

3. To live sustainably, we need to be informed about the sources of food, clothes, energy and whether ethical practices in producing goods are ensured.
4. Examples:
   (a) When we purchase a packet of coffee powder, we should check whether it is certified with fair trade which includes paying farmers fairly.
   (b) Haze could be a result of deforestation by open burning which may be done to clear forest lands for palm oil plantations. Palm oil is used in foods, cosmetics, toothpastes and shampoos. Governments need to work together to find ways to prevent forest fires.
   (c) Power stations and motor vehicles release carbon dioxide into the air. The rise in the level of greenhouse gases in the atmosphere leads to global warming which in turn leads to floods in low-lying areas and climate change worldwide. We need to change our lifestyle to reduce carbon dioxide emission. Using fans instead of air conditioners, and taking public transportation instead of driving are just two of the many ways to reduce emission of greenhouse gas.



Sustainability

Fig 12.23 Rivers and seas in some countries can be heavily polluted with plastics. Some companies use the blockchain technology to reward people for collecting plastic wastes for recycling. However, plastic wastes might not be easily recycled. One company uses the blockchain technology to award tokens for 'ecobricks' made by compressing clean and dry used plastic bags in plastic bottles. These 'ecobricks' can be used to make furniture.

Fisheries Management

Optional for **N(A)**

1. The high demand for fish has led to overfishing in many waters. This results in loss of biodiversity as the marine ecosystem is disrupted.
2. For example, tuna fishing disrupts biodiversity in many ways:
   (a) Many other marine organisms are caught during tuna fishing. These include sharks, marine turtles and dolphins. They are known as bycatch.
   (b) Due to increasing demand for tuna, there is overfishing of tuna fish, which can upset the delicate marine ecosystem.
   (c) Illegal, unreported and unregulated fishing worsens the problem of overfishing, as authorities are unable to monitor and control fisheries.

3. To help maintain biodiversity, there are regulations in place to prevent overfishing. Some examples are:
   (a) For each type of species of fish, fisheries need to determine how vulnerable they are. Fisheries need to ensure that the amount they catch will allow the species to recover its population.
   (b) Fisheries should use fishing equipment that reduces bycatch.
   (c) Fisheries should use new and innovative monitoring, control and surveillance tools to ensure they comply with existing regulations.
4. When purchasing fish products, we should ensure that they are sourced from sustainable practices.

Timber Management

Optional for **N(A)**

1. Wood is an important resource. The high demand for wood products has led to extensive deforestation in some countries.
2. Forests supports a large biodiversity. There are over three million species living in the Amazon rainforest. Deforestation threatens the survival of these species.
3. To help maintain biodiversity, timber management practices are put in place. Some examples are:
   (a) Designating parts of the forests as protected areas.
   (b) Mandatory labelling of wood products to indicate if they are harvested from sustainable sources. This allows consumers to make an informed choice. Singapore uses Forest Management certification from Forest Stewardship Council (FSC).
   (c) Requiring companies to replace the trees that have been cut.
4. When buying wood products, we should ensure that the companies are accredited for sustainable practices.