Life on Earth

Biodiversity and the distribution of life

| Unit 3 | Life on Earth |

Sub-topic 3 – Biodiversity and the distribution of life	

a	Measuring abiotic factors

b	Biomes

c	What is an ecosystem

d	Role of a species in an ecosystem

e	Factors affecting biodiversity in an ecosystem

Measuring abiotic factors

Learning Outcomes:

1.To measure abiotic factors including light intensity, temperature, pH and soil moisture using appropriate techniques and suggest possible sources of error.

2. To analyse the effect of abiotic factors on the distribution of organisms.

Abiotic factors are non living factors that affect organisms.

Abiotic factors include temperature, rainfall, light intensity and pH. An organism is only able to survive in a habitat if combinations of abiotic factors are present which suit its needs.

Task

Copy the table below.

Your teacher will demonstrate the use of moisture, light and pH meters.

Use the light meter to take at least two readings from different locations.
Record your results in the table.
Repeat for moisture, pH and temperature.

Remember to wipe the probe between readings!

Location	Light meter reading	Moisture meter reading	pH	Temperature (°C)

Think!

What could be done to make your results more reliable? What are possible sources of error when using a light meter and a moisture meter?

Notes

1. **Write brief notes (2 or 3 sentences) on how to use a light meter, possible sources of error and how they can be minimised.**
2. **Repeat for the moisture meter.**

Effects of abiotic factors on the distribution of organisms.

Task – Complete the following questions in your jotter

1. An investigation was carried out into the effect of light intensity on the distribution of a plant species. At eight different measurement points in the garden, the average light intensity was measured and the percentage ground cover of the plant recorded.

The results are shown below.
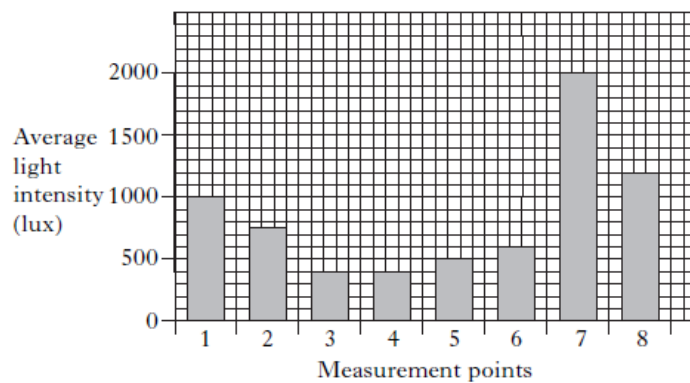
Measurement points	Ground cover of the plant (%)
1	85
2	65
3	20
4	20
5	30
6	35
7	100
8	90

a (i) What is the light intensity in the garden where the ground cover of the plant is 100%?

(ii) What was the percentage ground cover of the plant when the light intensity was 750 lux?

(iii) What is the relationship between light intensity and percentage ground cover of the plant?

b. **Explain** how light intensity affects the distribution of the plants in the garden.

2. Marsh marigold is a waterside plant which grows beside burns.

The abundance of marsh marigolds was estimated in five sampling areas beside a burn in the Scottish borders. Average values of three abiotic factors were also calculated for each area.

The results are shown in the following table.

Sample area	1	2	3	4	5
Abundance of marsh marigold	zero	high	high	medium	low
Average soil pH	5·6	6·7	7·1	6·5	6·4
Average soil nitrate concentration (ppm)	4	10	7	6	5
Average soil water content (units)	8	4	9	3	5

a. Name one abiotic factor which does not affect the abundance of marsh marigolds.

b. The soil pH for each sampling area was measured using a pH meter with a probe which was pushed into the soil to obtain each reading.

(i)**Identify** a possible **source of error** in measuring a **named** abiotic factor and suggest how to **minimise** it.

(ii) How was the measurement of the abiotic factors in this survey carried out to reduce the effect of atypical results?

Success criteria:

1. I can measure various abiotic factors, state possible sources of error and how they can be minimised.

2. I can analyse data to assess how abiotic factors can affect the distribution of organisms.

Sampling plants and animals

Learning Outcomes:

1. To sample organisms using quadrats and pitfall traps.

2. To evaluate limitations and sources of error when using sampling techniques.

3. To use and construct paired statement keys to identify organisms.

It would be impossible to count all the organisms in a given area. Biologists take a sample in order to estimate the number and types of organisms in an ecosystem.
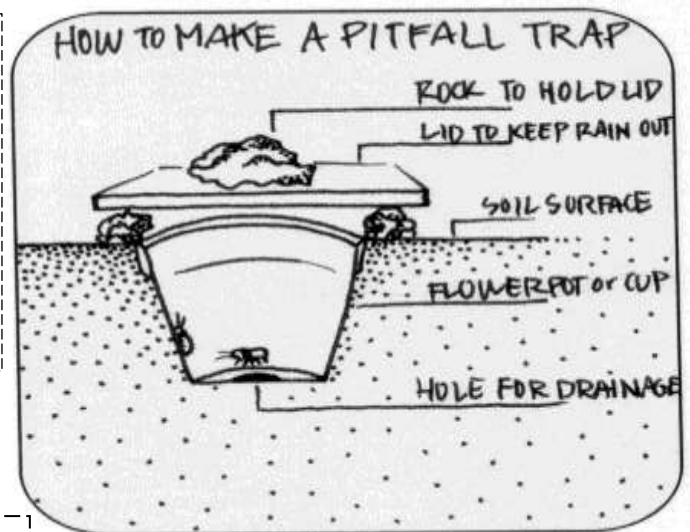

To sample plants (and slow moving animals) a **quadrat** is used.

A quadrat marks off a small piece of ground of known area so that different plants present within this sample can be **identified** and **counted** or their area of cover **estimated**.

This sample gives us an idea of the number and kind of organism present in the whole area.

Pitfall traps are used to sample small invertebrates such as spiders, slugs, beetles and other insects.

These small creatures fall into the trap and cannot escape. They can then be identified, counted and released.

HOW TO MAKE A PITFALL TRAP

ROCK TO HOLD LID

LID TO KEEP RAIN OUT

SOIL SURFACE

FLOWERPOT or CUP

HOLE FOR DRAINAGE

Line transect

A transect line is a length of string marked at 1m intervals. It can be laid on the ground and used to sample a particular area.

Task 1

Measuring the abundance of plant types

The abundance of a plant is a measure of the extent to which it occurs in an environment.

Copy the table below. In your group collect a transect line, quadrat and plastic cup. Your teacher will show you where to place your transect line.

1. Pick two plants to sample.
2. Place a quadrat at the 1m intervals along the line and count the number of squares containing the plants you chose to sample.
3. Record in your table.

Sample number	Number of squares containing plant 1	Number of squares containing plant 2
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Average		

Pitfall trap

1. Dig a small hole in the soil so that your cup sits in it with the top of the cup level with the soil.
2. Disguise the entrance with a stone or leaf supported on sticks.
3. Leave the pitfall trap and check its contents the next time you are in class.
4. Use a key to identify organisms captured.
5. Release organisms.

Task 2

In your group discuss any limitations or sources of error you discovered while using the quadrats and pitfall traps. How could these be minimised?

For both the quadrat and the pitfall trap make a list or construct a table detailing sources of error and how they can be minimised.

Using Paired Statement Keys

A key is a tool to help identify organisms. It is much quicker and easier than flicking through pictures in a book. It involves asking yourself a set of questions and following the instructions until you reach an answer. We will be focussing on **paired statement keys**. As the name suggests they are laid out in pairs of statements.
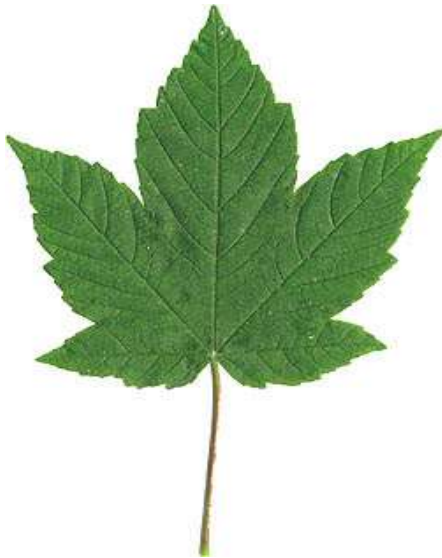
Task

Your teacher will show you a PowerPoint.

Try to identify each type of leaf from the clues given.

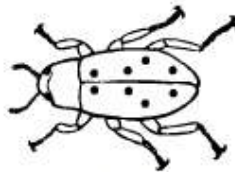Here are a group of organisms found in a pitfall trap.

Earthworm   Snail

Spider   Beetle   Woodlouse

1 Legs .... Go to 2

   No legs .... Go to [A]

2 12 legs or more .... Woodlouse

   Fewer than 12 legs .... Go to 3

3 Spots on body .... Beetle

   No spots on body .... [B]

4 Shell .... Snail

   [C] .... [D]

(i)   Complete the key by writing down the contents of boxes A, B, C & D.
(ii)   Write down three features of the beetle mentioned above (Hint- work backwards!).

The table below shows some features of five British butterflies.

Butterfly species	Wing shading	Wing tip	Wing spots
Large White	pale	black	yes
Orange Tip	pale	orange	no
Peacock	dark	blue	yes
Red Admiral	dark	white	yes
Wood White	pale	black	no

Complete the key using the information given in the table.

1   Pale wing shading . . . . go to 2

    Dark wing shading . . . . [A]

2   [B] . . . . [C]

    Orange wing tip . . . . **Orange Tip**

3. Spots on wings . . . . **Large White**

    No spots on wings . . . . [D]

4. Blue wing tip . . . . **Peacock**

    [E] . . . . [F]

Write down the contents of boxes A-F.

Success Criteria:
1. I can sample organisms using quadrats and pitfall traps.
2. I can describe limitations and sources of error when using sampling techniques.
3. I can use and construct paired statement keys to identify organisms.

Biomes

Biome

A **biome** is a group of ecosystems that have a similar climate and are therefore inhabited by particular plant (flora) and animal (fauna) species. Examples of biomes are freshwater, marine, desert, forests, grassland and tundra. The global distribution of biomes is affected by abiotic factors such as temperature and rainfall.

UG/GGS Information Services
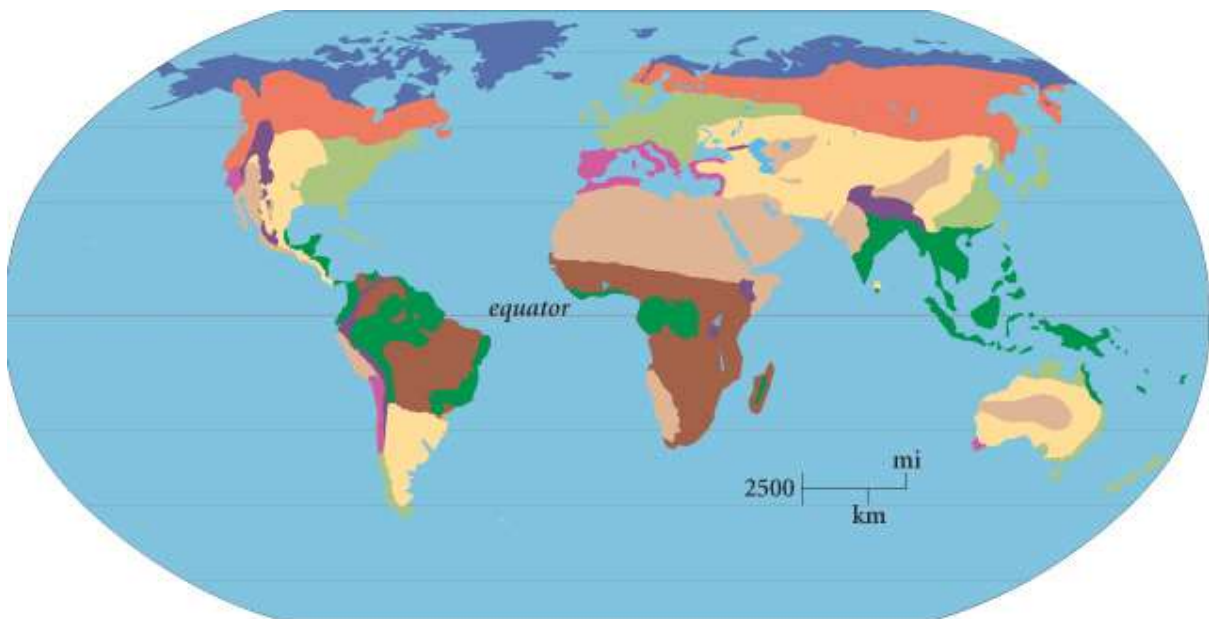
Task

Working as a group you will pick a type of biome, research it and produce a short Power Point presentation to deliver to the class.

Things to include:

1. Climate e.g. rainfall, temperature, light intensity.
2. Types of plants which characterise your biome.
3. Animals found in your biome.
4. Geography i.e. location and physical geography of the land.

Here are a few web sites to get you started.

http://www.saburchill.com/chapters/chap0051.html

http://www.blueplanetbiomes.org/world_biomes.htm   (/world_biomes.htm)

http://www.ucmp.berkeley.edu/glossary/gloss5/biome/

http://www.enchantedlearning.com/biomes/

The Eden Project

The Eden Project is a visitor attraction in Cornwall that has two enormous, enclosed biomes. They have a Rainforest biome and a Mediterranean biome. The interior of each dome has a controlled climate exactly like those regions of the planet. This allows the characteristic flora of these regions to flourish.

Success Criteria:
1. I can describe what a biome is.
2. I have worked as part of a group to research one type of biome and am able to name several types.
3. I can state that abiotic factors such as temperature and pH can affect the global distribution of biomes.

What is an Ecosystem?

Learning Outcomes:

1.To describe what is meant by an ecosystem.

2. To define the terms habitat, population & community.

3. To identify ecosystem components.

An ecosystem is a natural biological unit made up of living and non living parts. Within a woodland ecosystem there are many different **habitats**. These can include the soil burrows where earthworms live or the tree leaves where caterpillars feed. Each habitat contains its own **community** of living things. The soil, for example, may support a community of worms, beetles, centipedes and mites. The number of individuals of one type of organism is called a **population** e.g. a forest of oak trees or a herd of deer.
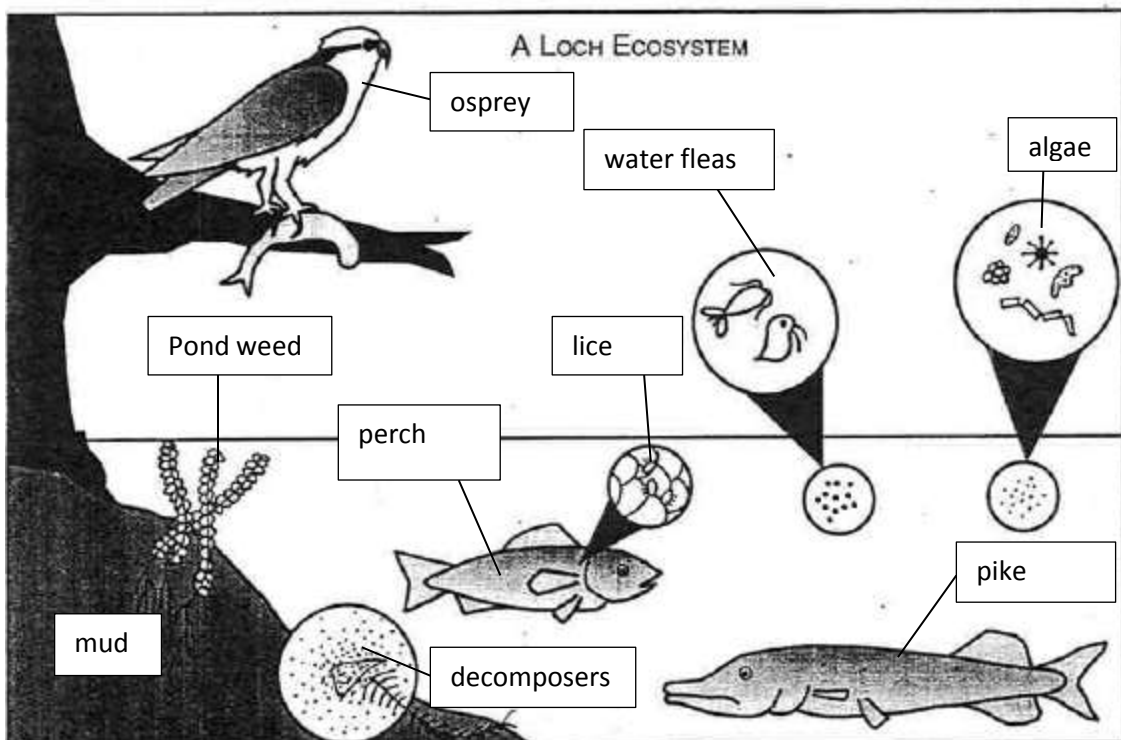
Copy the following definitions into your jotter.

Habitat – The place where an organism lives.

Population – The total number of living organisms of one type living in a habitat.

Community – All the living organisms of all types living in a habitat.

Ecosystem – A natural unit made up of on or more habitats and their communities of living things.

A Loch Ecosystem

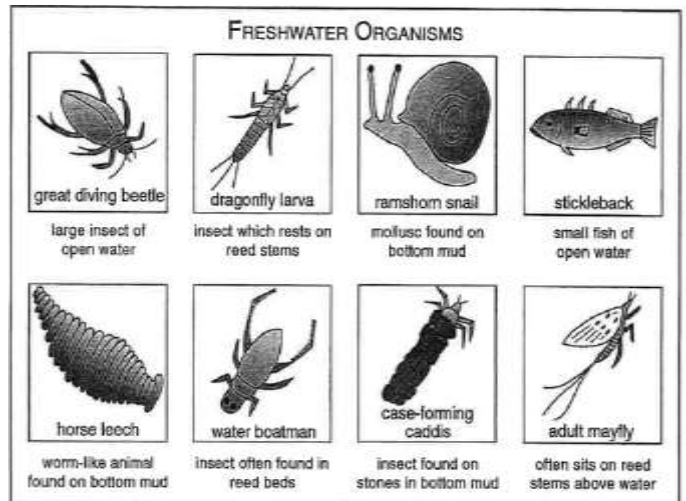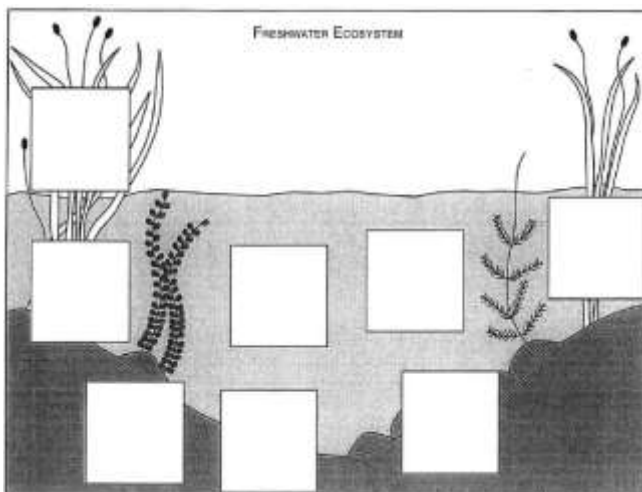*Task-* *Draw the table below and add one example of each term from the Loch Ecosystem on the previous page.*

Term	Example
ecosystem	
habitat	
population	
community	

Identifying Ecosystem Components

An ecosystem can contain many habitats. Each habitat contains its own community.

Task

1. *Collect the "Freshwater ecosystem" and "Freshwater organisms" cut-out sheets.*
2. *Cut out the organisms and glue them into the appropriate space in the "Freshwater ecosystem" sheet.*
3. *Glue the completed sheet into your jotter.*
4. *Make a list of three freshwater habitats and the community within each.*

FRESHWATER ECOSYSTEM

FRESHWATER ORGANISMS

great diving beetle — large insect of open water

dragonfly larva — insect which rests on reed stems

ramshorn snail — mollusc found on bottom mud

stickleback — small fish of open water

horse leech — worm-like animal found on bottom mud

water boatman — insect often found in reed beds

case-forming caddis — insect found on stones in bottom mud

adult mayfly — often sits on reed stems above water

A study has shown that Scotland's river otter population is increasing after falling sharply over the last 40 years.

Otters live along the banks of rivers, usually in reeds and gaps between tree roots. Fish are their main food.

(a) What term is used for the place where otters live?

_____

(b) What disadvantage might otters have if reeds are removed from riverbanks?

_____

_____

(c) Mink are North American animals introduced into Scotland. They feed on fish and live in riverbanks.

What effect would the mink have on otter numbers? Explain your answer.

Effect _____

Explanation_____

_____

Success Criteria:

1.I can describe what is meant by an ecosystem.

2. I can define the terms habitat, population & community.

3. I am able to identify ecosystem components.
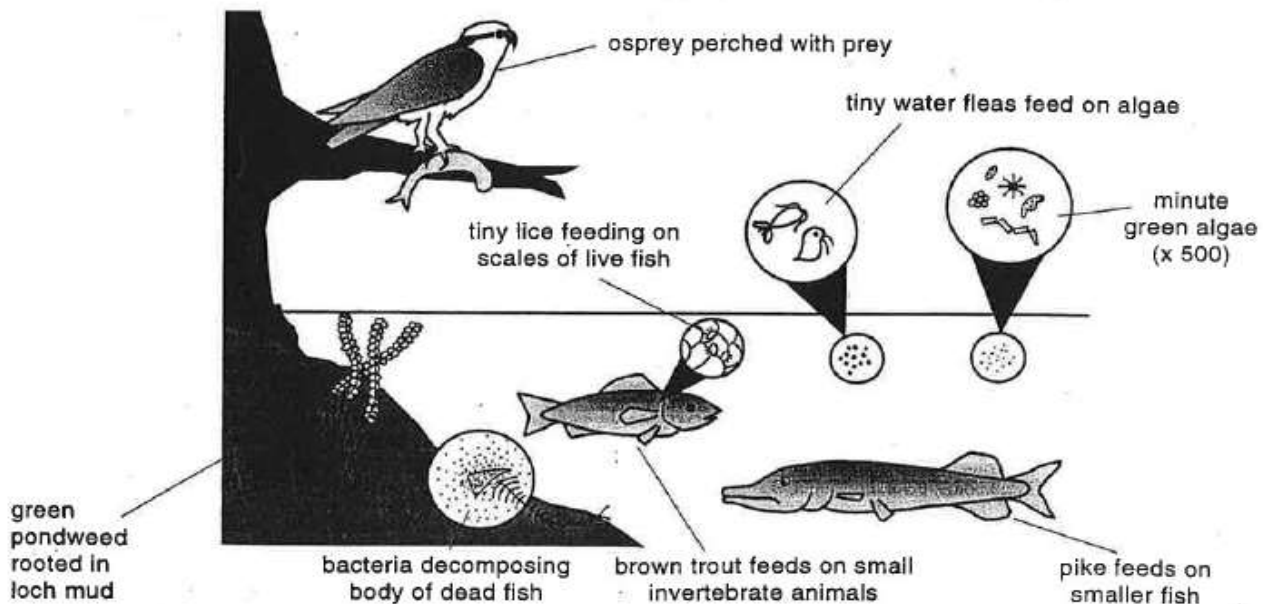
Role of a species in an ecosystem

A stable ecosystem has a wide variety of species linked in complex food webs. Each species is adapted to fit into its particular habitat and way of life.

Niche – the role that an organism plays within its community. It includes the use it makes of resources and its interaction with other organisms in the community.

Task

1. *Collect a copy of the diagram above and glue it into your jotter.*
2. *Copy and complete the table below for each organism in the diagram.*

Organism	Description of niche
	Fish eating bird of prey
	Medium sized swimming carnivore
	Rooted underwater producer
	Large predatory swimming top carnivore
	Small swimming herbivore
	Parasite feeding on fish scales
	Decomposer
	Microscopic floating producer

Question

A population survey of barnacles and mussels between the high and low tide marks of a rocky shore was carried out using quadrats.

The results are shown in the table below.

Tide mark	High									Low
Quadrat number	1	2	3	4	5	6	7	8	9	10
Number of mussels	0	2	15	31	32	34	50	55	58	60
Number of barnacles	52	51	37	40	40	23	15	17	15	10

(a) Calculate the average number of barnacles per quadrat.

(b) What is the trend shown by the number of mussels from the high tide mark to the low tide mark?

(c) The mussels and barnacles are in competition with each other. State one possible effect on the mussel population of **reduced competition** from barnacles.

(d) The following factors affect populations of barnacles and mussels. **Write down two abiotic factors from the list.**

Water temperature, disease, predators, salt concentration and food supply.

(e) A rocky shore ecosystem consists of a community of organisms and one other part. **Name the other part.**

barnacle

mussels

Success Criteria:

1. I can describe what is meant by a niche.

2. I can give examples of several organisms and their niches.

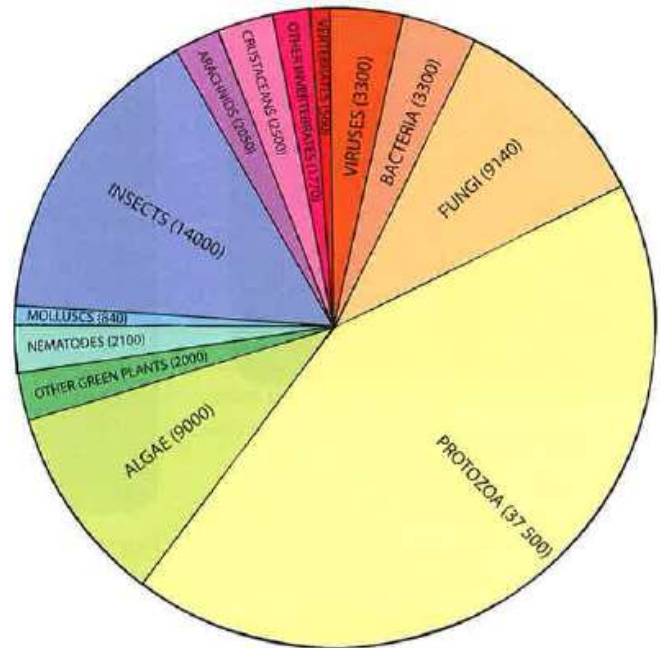# Factors affecting biodiversity in an ecosystem

Learning Outcomes:

1. To name and describe factors which can affect biodiversity.

Biodiversity is the total variation that exists among all living things on Earth.

Biodiversity within an ecosystem refers to the range of species present within that ecosystem's community.

A stable ecosystem contains a wide range of producers, consumers and decomposers that are interdependent. Animals and microbes depend on plants for food and oxygen. Plants depend on microbes to recycle nutrients. Plants rely on animals for seed dispersal and pollination.

Scottish biodiversity

Factors Affecting Biodiversity

Biodiversity can be affected by biotic factors (such as grazing and predation), abiotic factors (such as pH and temperature) and also human influences (such as pollution and habitat destruction).

Task

1. Collect a matching exercise for "Human influences on biodiversity".
2. Work with your neighbour to complete the exercise.
3. Use this information to write a short note under the heading "Human influences on biodiversity."
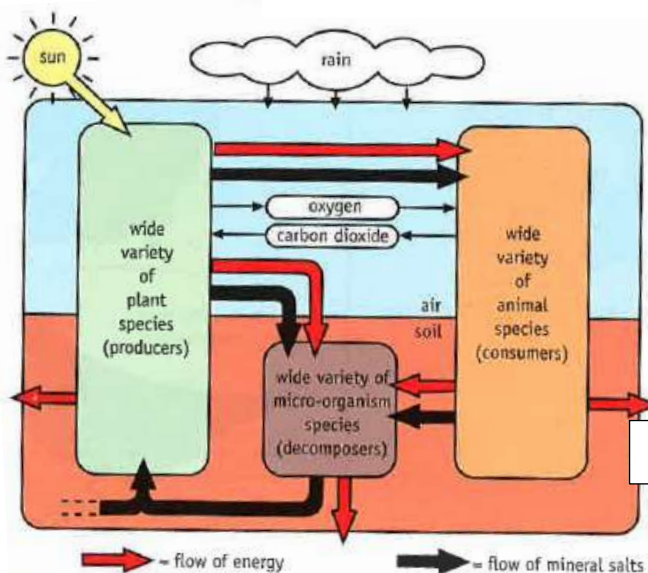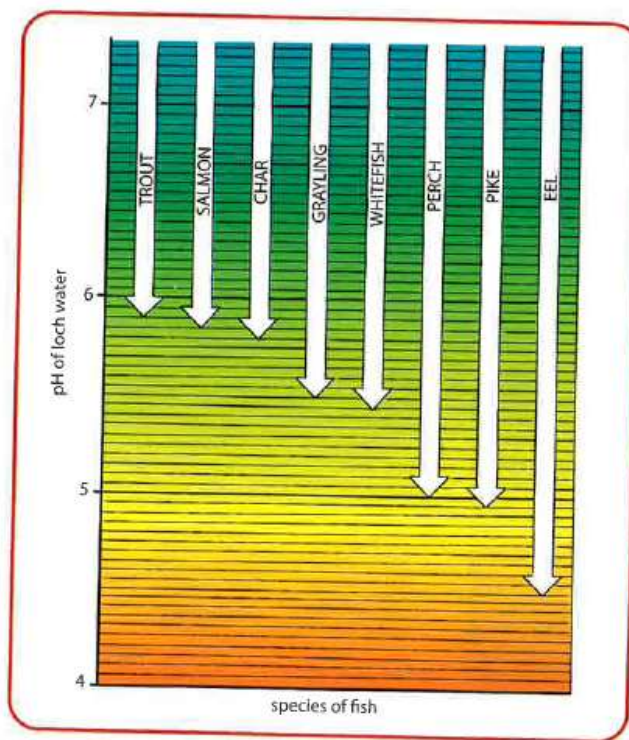
Inter-relationships in a stable ecosystem

The effect of abiotic factors on biodiversity

pH and temperature can affect the variety of fish species in a loch.

pH Task

1. Look at the diagram opposite. Write a sentence describing the relationship between pH and number of fish species.

2. Which species would be found over the greatest pH range?

Temperature

Increasing the temperature of water decreases the oxygen content.

Species of fish	Minimum oxygen concentration required for survival (mg/l)
Trout	4
Tench	0.8
Minnow	3.2
Perch	1.5
Roach	1.1

Oxygen concentrations in a body of water can decrease due to **thermal pollution** from power stations.

Task

1. Draw a suitable graph to present the information in the table above.
2. Which species of fish would be able to survive in the warmest water?
3. Calculate the average minimum oxygen concentration required for survival.
4. Calculate the percentage increase in the minimum oxygen concentration required for survival between the tench and the trout.

Tench

The effect of biotic factors on biodiversity

Grazing

Grassland contains a wide variety of plant species. Some species are hardy and grow quickly while others are more delicate and slow growing.

At low levels of grazing a small number of fast growing species will out compete less vigorous species and dominate. High levels of grazing increase biodiversity by keeping the fast growing species in check. Overgrazing will decrease biodiversity by damaging all the plant species present.

Task

**The table shows the effects of grazing by rabbits on the numbers of plant species.**

Number of rabbits per unit area	Number of species of flowering plants
0	5
10	11
20	35
30	53
40	44
50	26

Use this information to draw a line graph. (Think carefully about your axes).

1. *What number of rabbits resulted in the greatest biodiversity?*
2. *Why is there an optimum number of rabbits for richness of biodiversity?*

Predators and Prey
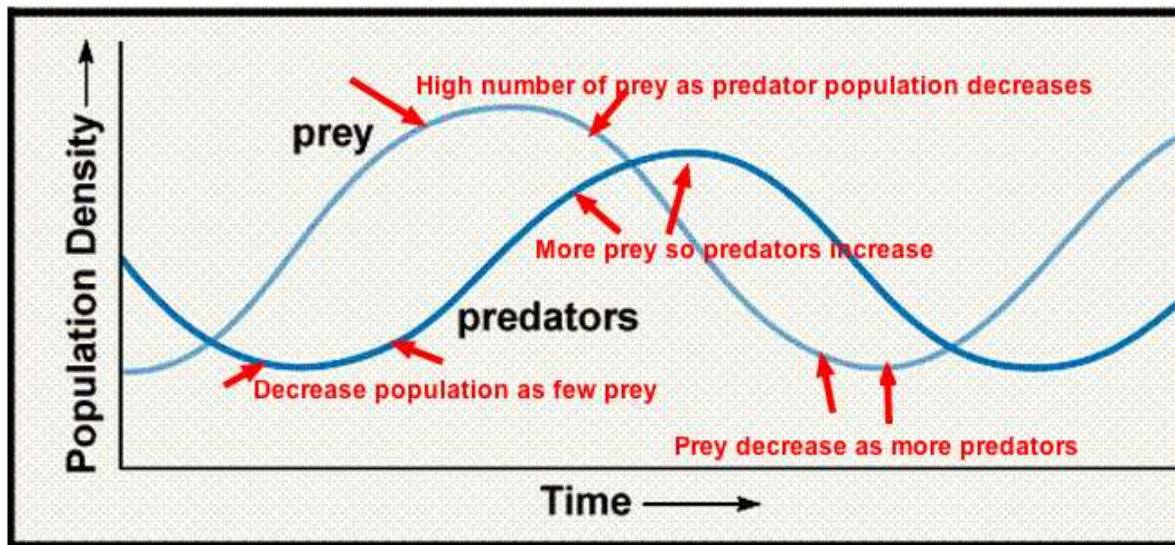
The graph above shows a comparison of predator and prey populations.

✏️ _Copy and complete the following passage_.

As the prey population in an ecosystem increases the predator population _____ due to an increased supply of _____. Growing predator numbers will eventually cause a _____ in the prey population. This means a _____ in food supply for the predator and eventually a decrease in _____. This allows prey numbers to recover and so on.

Word bank				
food	decrease	population	increases	decreases

http://www.barnowltrust.org.uk/

Task A

1. _Visit the following website and use the information to write a short note on Barn Owl habitat, prey and what pellets are._

http://www.barnowltrust.org.uk/

2. _Visit the next website and have a go at the dissection of a virtual owl pellet. (see next page for instructions)_

http://kidwings.com

1. Select Owl Pellet Dissection from the left hand menu.
2. Then select Virtual Owl Pellet.
3. Finally select Barn Owl from the "More pellets" drop down menu.
4. Follow on screen instructions.

Task B

Ladybirds are the predators of greenfly. The figures in the table below show how the numbers of each population change over three years.

Time	Jan 97	April 97	Jul 97	Oct 97	Jan 98	April 98	Jul 98	Oct 98	Jan 99	April 99	Jul 99	Oct 99
No. of ladybirds (1000's)	5	25	45	60	30	10	35	75	20	35	60	75
No. of greenfly (1000's)	10	80	10	30	20	70	110	50	30	50	80	50

1. Use the information in the table to plot a line graph. Use a different colour for each invertebrate.

Ja A Ju O Ja A Ju O Ja A Ju O
97   98   99
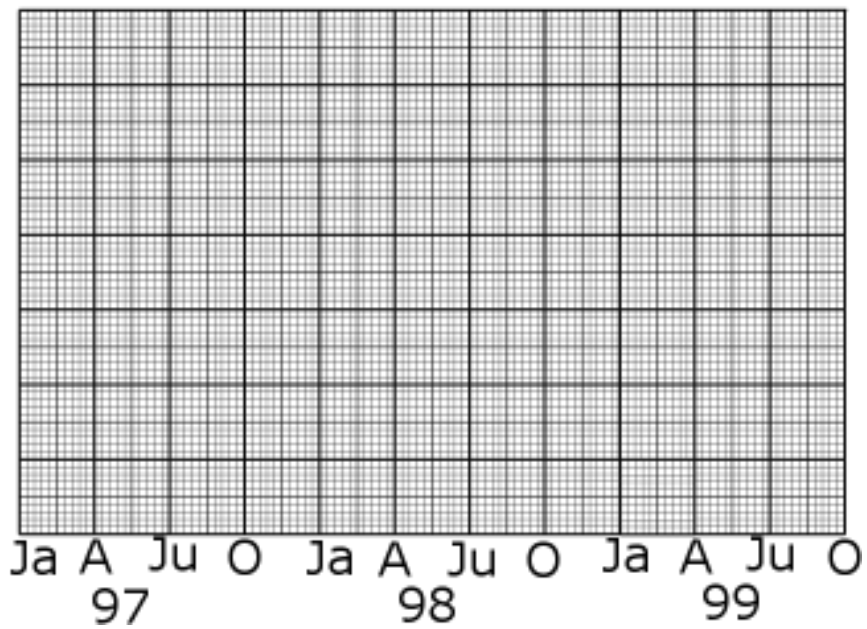
Hint

Set up your graph paper like this.

2. Write an explanation for the changes in each population.

Success Criteria:
1. I can describe how named human activities affect biodiversity.
2. I can name biotic and abiotic factors and state their effects on biodiversity.
3. I can identify and interpret a predator/prey graph.