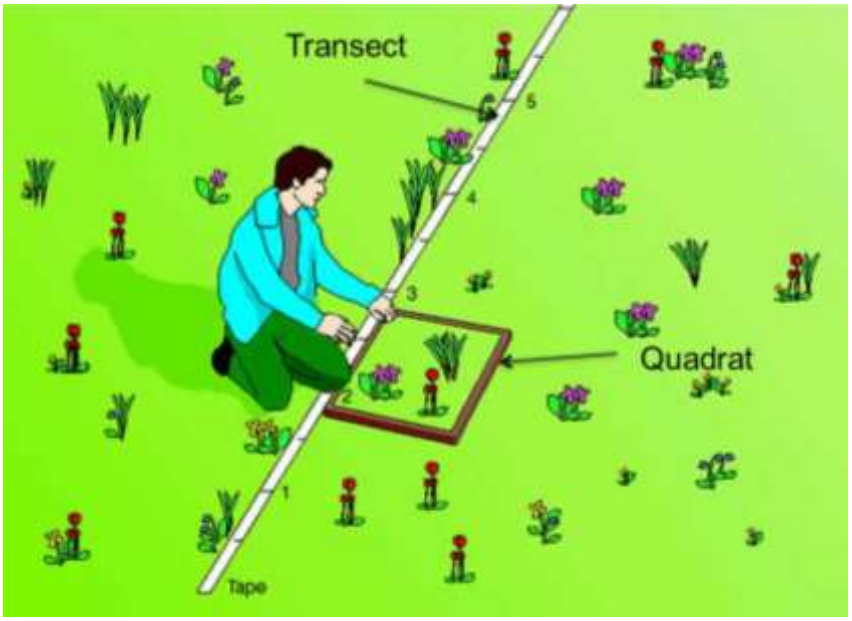
National 5 Biology

Unit 3 Life on Earth

3.2 Distribution of Organisms



Name _____

Class _____

Teacher _____

Biodiversity and the Distribution of Life

In this section we will consider the different factors that affect the distribution of organisms. As it is impossible to count all of the animals and plants that live in an ecosystem, biologists use various methods for estimating the types and numbers of organisms that live there. A sample can be taken to represent a population of organisms in an ecosystem. Abiotic and biotic factors also impact on an organisms ability to survive in a particular ecosystem. These are measured to examine their impact on organisms.

Learning intention

- To find out about abiotic and biotic factors.

Abiotic Factors

Hint: Do you know what each of these factors are or do you need to add information?

Abiotic factors are non-living or physical factors which affect organisms.

These include:

- L_____ intensity
- M_____
- _____
- T_____

Organisms can only survive in an ecosystem if the correct combination of abiotic factors are present.

Biotic Factors

Biotic factors are living things that influence or affect organisms in an ecosystem.

Hint: Do you know what each of these factors are or do you need to add information? Grazing and predation are expanded upon later in this section.

These include:

- C_____ for resources
- D_____
- F_____ availability
- G_____
- P_____

Learning intention

- To find out how abiotic factors including light intensity, temperature, pH and soil moisture are measured.

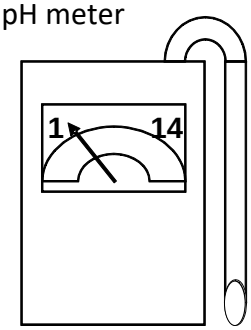
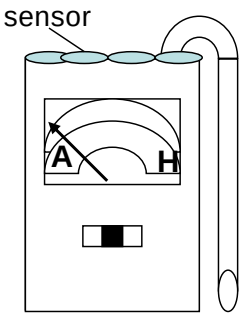
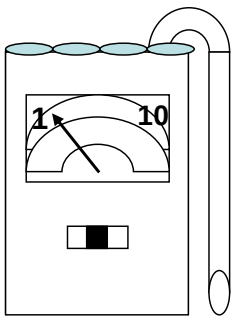
Measuring abiotic factors

An abiotic factor is a _____ factor often related to climate that can affect the distribution of organisms in an ecosystem. There is a range of modern instruments which can be used to measure these factors. Most have a _____ to contact the environment and an easily read _____ to show the result.

The table below shows the different types of equipment that are used to measure abiotic factors.

Abiotic factor	Measuring instrument
Light intensity	Light meter
Moisture level	Moisture meter
Temperature	Thermometer
Soil pH	Soil pH meter

Hint: Measuring abiotic factors is a technique that you need to know for your exam. Make sure that you know how they are measured and the name of the instrument used to take the measurement. E.g. Light meter.

Abiotic factor	Diagram of instrument used to measure	Brief description of how to use the instrument	Units
Temperature	Thermometer 	• Make a hole in the soil with a pointed object e.g knitting needle. • Push the thermometer into the hole ensuring that the bulb of the thermometer is fully covered. • Wait (about 5 minutes) until the liquid stops moving. • Read temperature from scale.	^{0}C
pH	pH meter 	• Make a hole in the soil with a pointed object e.g knitting needle. • Insert the probe into the soil (at least 5cm). • Read the pH number from the scale. • Wipe probe clean and dry before repeating.	pH 1-14
Light intensity	Light meter 	• Move switch to light (if using a combined meter). • Make sure you are not shading the sensor. • Point sensor at area to be measured. • Read the scale A-H.	A-H
Moisture	Moisture meter 	• Move switch to moisture (if using a combined meter). • Make a hole in the soil with a pointed object e.g knitting needle. • Insert probe into the soil (at least 5cm). • Read scale from 1-10. • Wipe probe clean and dry before repeating.	1-10

Learning intention

- To find out about the possible sources of error associated with measuring abiotic factors and how to minimise them.

Sources of error

As with sampling, errors can affect the measurement of abiotic factors. The techniques need to be applied with care, ensuring that all precautions are taken to obtain accurate results. Taking _____ numbers of readings and calculating _____ helps to improve reliability.

Remember: **ROAR**

Repeat

Obtain an

Average

to increase **R**eliability

Abiotic factor measured	Possible source of error	How to minimise error
Temperature	1. Thermometer not placed deep enough into the soil. 2. Too few samples taken. 3. Samples not selected randomly. 4. Thermometer may be in direct sunlight-so higher temperature recorded.	1. Ensure that bulb is covered and push as _____ as possible. 2. Take more _____. 3. Make sure samples are taken randomly. 4. Move thermometer to _____ area.
pH	1. Probe not inserted deep enough into the soil. 2. Too few samples taken. 3. Samples not selected randomly. 4. Soil left on probe from previous reading.	1. Insert probe by half its depth. 2. Take more samples. 3. Make sure samples are taken randomly. 4. Ensure that probe is _____ and dried between uses.

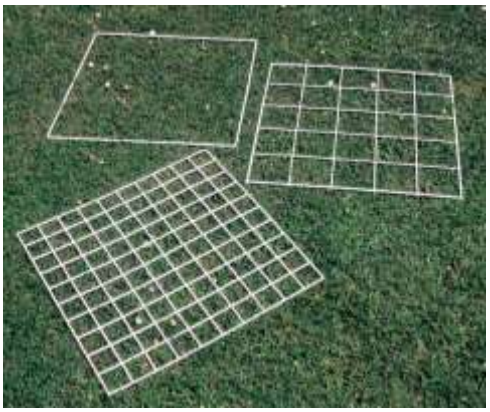
Abiotic factor measured	Possible source of error	How to minimise error
Light intensity	1. Shading of light meter, by object, user or observers. 2. Too few samples taken. 3. Readings taken at different times of day or different weather conditions.	1. Make sure sensor is pointed directly to the light source and _____ stand out of the way. 2. Take more samples. 3. Take samples at the same _____ of day and take multiple samples.
Moisture	1. Probe not inserted deep enough into the soil. 2. Too few samples taken. 3. Samples not selected randomly. 4. Moisture left on probe from previous reading.	1. Insert probe by half its depth. 2. Take _____ samples. 3. Make sure samples are taken randomly. 4. Ensure that probe is wiped and dried between _____.

Learning intention

- To find out how plants in an ecosystem are sampled.

Quadrat sampling

Quadrats are used to sample _____ growing plants, in order to estimate of the number of plants in a given area. Quadrats are _____ in shape and usually made of metal or plastic. They vary in _____, with some being just a single square, but more often they are a large square sectioned into many smaller squares.



Quadrats are placed at random, which improves _____. A quadrat marks off an exact area of ground, so that the organisms in that area can be _____ and _____. By taking a number of samples from within an area of known size an _____ of the average number of organisms can be obtained.

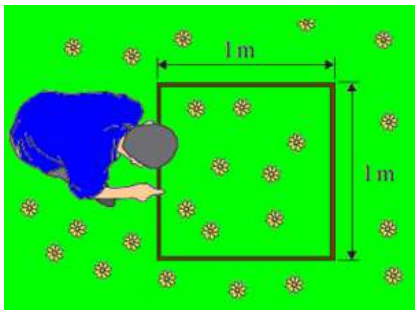
Remember: **ROAR**

Repeat

Obtain an

Average

to increase **R**eliability



The area sampled is 25m long and 25m wide. What is the total area? _____m^2

10 quadrats were thrown at random within this area and the total number of a particular plant species found was 58. What is the average number of plant species per quadrat? _____

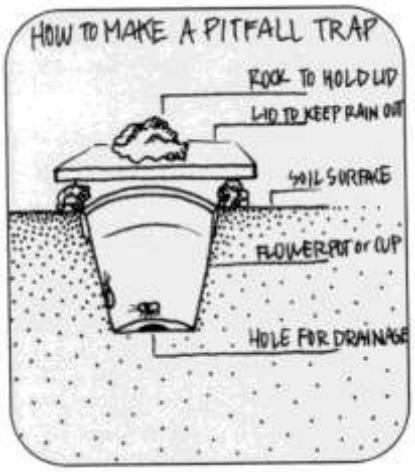
Each quadrat was $1m^2$. What is the estimate of total population size in this area?

_____

Learning intention

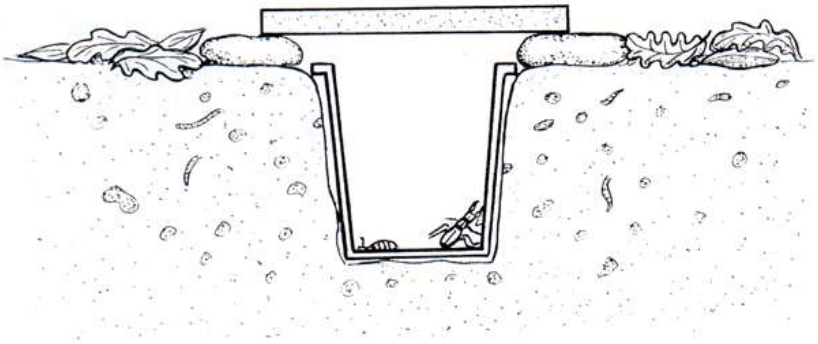
- To find out how animals in an ecosystem are sampled.

Pitfall trap sampling



Pitfall traps can be used to sample _____ invertebrate animals living on the _____ surface or in the _____ litter. A hole is dug in the soil and a cup or pot with drainage holes is placed inside level with the soil surface. The trap is covered to protect it from _____.

Animals fall into the trap and are unable to _____ out again. The traps are usually set in _____ locations within an area. Traps must be checked regularly, since _____ and scavenging can occur within traps they are left for too long.



Hint: Measuring the distribution of a species is a technique that need to know for your exam. Make sure that you know how plants and animals are sampled.

Learning intention

- To find out about the limitations and sources of error in the use of quadrats and pitfall traps.

Sources of errors

There are three main reasons for errors occurring during sampling:

- Poor selection of technique,
- Lack of _____ taken,
- Human _____ in carrying out the technique.

Remember the 4 R's:

Repeat,
Random
Reliable
Representative

Limiting errors when sampling

When sampling takes place in an ecosystem it is important that investigators _____ their sampling, by choosing the _____ sampling technique and take a suitable _____ of samples. Large numbers of _____ samples should be taken and extreme care taken when carrying out the technique.

Complete the table below to show the limitations and errors associated with using quadrats and pitfall traps.

Sampling Technique	Limitations	Possible errors
Quadrats	Only suitable for low growing rooted _____.	Quadrats may not be placed _____.
	Quadrat size.	Inappropriate _____ of quadrat selected.
	Reliability limited by number of _____ possible.	Too few samples, especially if plant grows in clumps.
		Organisms wrongly _____.
		Organisms wrongly _____.

Sampling Technique	Limitations	Possible errors
Pitfall traps	Only suitable for small surface-crawling _____.	Traps may not be placed randomly.
	Pitfall trap size.	Inappropriate size of trap selected.
	Reliability limited by number of traps set.	Too few traps used.
		Traps badly set or not emptied on time; invertebrates _____ or lost from sample.

Qualitative results

Very often, quadrats and pitfall traps are used to give qualitative results. They simply show if a species is present or absent in the sampling area. Therefore investigators must ensure that sampling is _____. This means that the samples taken will give an accurate reflection of the different types of species living in a particular area.

Quantitative results

Quadrats and pitfall traps can be used to estimate populations of organisms quantitatively. This means that the results can be converted into actual figures. To ensure the reliability of the results, _____ replication of the sampling technique must take place.

Learning intention

- To find out how to use and construct paired-statement keys to identify organisms.

Keys are used to help identify a species. Keys can either be **branching** or a **series of paired statements** and are based on the physical characteristics of the species.

A key to identify simple farm animals would be:

Statement	
1. Does the animal have four legs	Yes – go to statement 2
	No – go to statement 4
2. Does the animal have a curly tail?	Yes – pig
	No – go to statement 3
3. Does the animal have a hoof divided into two parts?	Yes – cow
	No - horse
4. Does the animal have webbed feet?	Yes – duck
	No - human

Complete the following paired statement keys:

The following table gives information on different types of bacteria.

Bacteria	*Gram stain reaction*	*Shape of cells*	*Reaction to penicillin*
P	positive	round	resistant
Q	positive	rod	resistant
R	negative	rod	resistant
S	positive	round	sensitive

Use the key to identify the four types of bacteria.

1	Gram stain positive	Go to 2
	Gram stain negative	*Escherichia*
2	Round shaped cells	Go to 3
	Rod shaped cells	*Clostridium*
3	Sensitive to penicillin	*Micrococcus*
	Resistant to penicillin	*Staphylococcus*

Use the key to name the four bacteria.

Bacterium P _____

Bacterium Q _____

Bacterium R _____

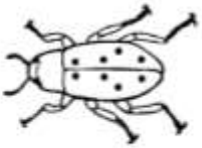
Bacterium S _____

The diagrams below show invertebrates collected by pupils.
They are not drawn to scale.

Earthworm

Snail

Spider



Beetle

Woodlouse

Complete the following key using information from the diagrams.

1	Legs	Go to 2	
	No legs	Go to	
2	12 legs or more	*Woodlouse*	
	Fewer than 12 legs	Go to 3	
3	Spots on body	*Beetle*	
	No spots on body		
4	Shell	*Snail*	
	.....		

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 in the table.

1 Pale wing shading . . . . . go to 2

Dark wing shading . . . . . [ ]

2 [ ] . . . . . [ ]

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

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

No spots on wings . . . . . [ ]

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

[ ] . . . . . [ ]

Learning intention

- To find out about biodiversity and the factors that affect biodiversity.

Biodiversity

Biodiversity is the term used to describe the _____ and abundance of plants and animals in an ecosystem.

There are various factors that affect biodiversity in an ecosystem. These are:

- _____ factors.
- _____ factors.
- Human _____ (that influence both abiotic and biotic factors).

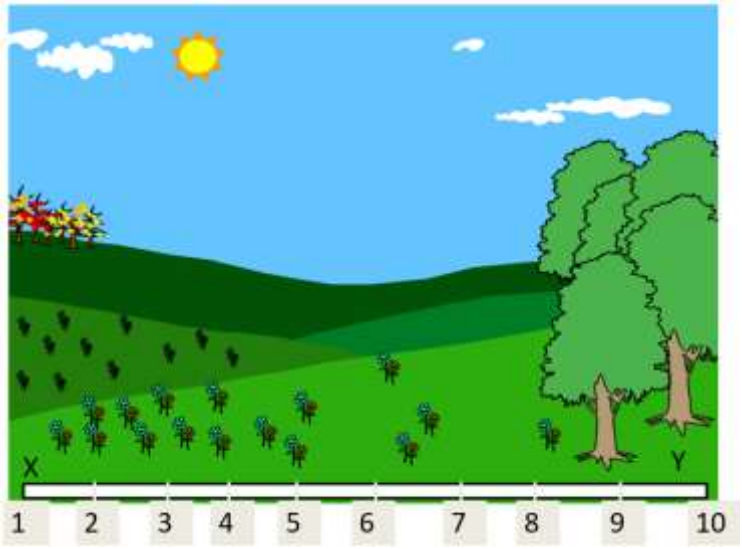
These factors can _____ or _____ the biodiversity in an ecosystem.

Learning intention

- To find out about the effect of abiotic factors on biodiversity and the distribution of organisms.

Belt transect

A belt or line transect is used in Biology to estimate the _____ of organisms in relation to a certain area. The transect line is measured across a _____ or part of a habitat. It can be as simple as a string or rope placed in a line on the ground. The number of organisms of each species can be observed and recorded at _____ intervals along the transect. Abiotic measurements are taken at each sample point to find out how abiotic factors affect the distribution of organisms.



Hint: Using a transect line is a technique that need to know for your exam. Make sure that you know how it is used.

- Belt (line) transect.
- Pegged out from point X to Y.
- Marked at 1m intervals.
- Organisms and abiotic factor sampled at each site.

Sample site	1	2	3	4	5	6	7	8	9	10
Abundance of daisies (score out of 25)	19	20	18	21	12	8	4	1	0	0
Light intensity (A=low, H=high)	H	H	H	H	G	F	E	D	C	C

The relationship between distribution of daisy and light intensity:

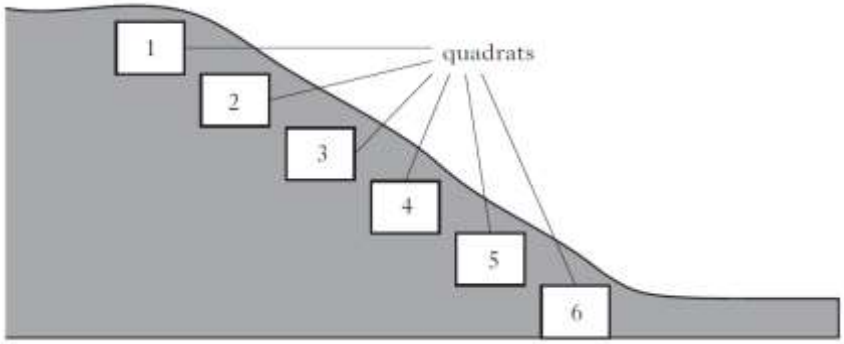
- The _____ the light intensity the _____ abundant the daisies.

Why?

- Plants need light to _____.
- In low light levels plants cannot photosynthesise, so cannot _____.
- Light intensity determines the distribution and biodiversity of plants.
- All abiotic factors affect distribution and in turn affect biodiversity.

Complete the question below. (SG C 2013)

In an investigation into the distribution of heather plants, six quadrats were placed in a line from the top to the bottom of a hill. Soil moisture, pH, surface light intensity and heather abundance score were recorded for each quadrat.



The following table shows the results.

Quadrat	*Soil moisture (%)*	*Surface light intensity (lux)*	*pH*	*Heather abundance score*
1	10	10 000	5·5	25
2	15	11 000	5·4	22
3	40	10 000	5·5	15
4	63	10 500	5·5	9
5	71	12 000	5·6	6
6	81	11 000	5·4	0

1. Describe the distribution of heather on the slope of the hill.

   _____

   _____

2. Which of the abiotic factors recorded has the greatest effect on the distribution of the heather plants?

   _____

3. Which quadrat would be most likely to contain a species of plant which grows best in wet soil with a low pH?

   _____

Learning intention

- To find out about the effects of biotic factors on biodiversity and the distribution of organisms.

The effects biotic factors on biodiversity

Biotic factors are related directly to living organisms and include factors such as; availability of food, disease, competition for resources, grazing and predation.

Competition

Competition for these resources can be intraspecific or interspecific. _____ competition occurs between members of the same species. _____ competition occurs between members of different species.

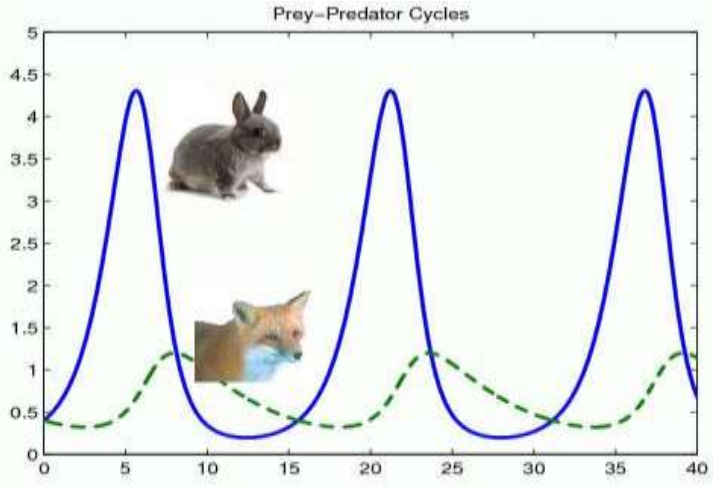
Grazing

Grazing is carried out by animals such as rabbits and sheep that feed on a variety of plant species.

Type of Grazing	**High or low biodiversity**	**Why?**
Low		Aggressive dominant grasses are not kept in check.
Moderate/high		Aggressive species kept in check, while others survive long enough to reproduce
Very high		Few species survive long enough to reproduce.

Predation

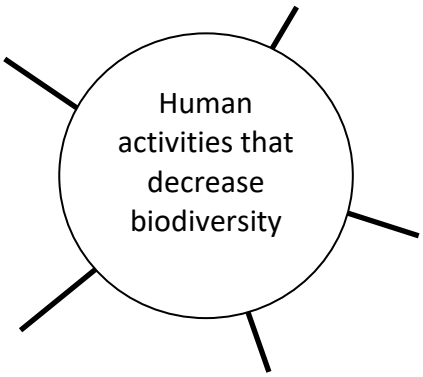
A _____ in the number of predators can lead to an _____ in the number of prey. High numbers of prey can lead to overgrazing, which can reduce biodiversity.



Learning intention

- To find out about human activities and how they affect biodiversity.

Human activities that affect biodiversity include:



These activities influence both abiotic factors such as pH and temperature and biotic factors including grazing and predation, which then affect the organisms within an ecosystem.

Learning intention

- To find out about indicator species.

Indicator species

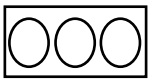
Organisms that thrive under certain environmental conditions are called indicator species. Their _____ or _____ indicate environmental quality/levels of pollution. Examples of biological indicators of pollution are fresh water invertebrates that indicate water pollution.

Indicator species present	Oxygen conc. of water	Level of water pollution
Mayfly nymph	High	Absent or very low
Stonefly nymph		
Shrimp		Low/medium
Caddis fly larvae		
Bloodworm		High
Waterlouse		
Rat-tailed maggot		Very high
Sludgeworm	Low	
No animals present	Zero	Extreme

Certain fresh water invertebrates reveal information about the oxygen concentration of fresh water. Rivers with water that is clean and well oxygenated will usually have a greater variety of different species than one that has a low oxygen concentration.

Mayfly nymph and stonefly nymph are examples of freshwater invertebrates whose presence indicates clean, well oxygenated water conditions.

Rivers that have a low oxygen concentration have a small number of different species. Those organisms that can tolerate the low oxygen concentrations will increase in number. They have adaptations that allow them to survive in these low oxygen conditions. Sludgeworms contain haemoglobin that allows them to pick up the limited oxygen in the water and where these species are abundant a high level of pollution is indicated.

I can:	
State that light intensity, moisture, pH and temperature are abiotic factors.	
State that competition for resources, disease, food availability, grazing and predation are biotic factors.	
Describe how abiotic factors including light intensity, temperature, pH and soil moisture are measured.	
Describe the possible sources of error associated with measuring abiotic factors and how to minimise them.	
State that plants can be sampled using quadrats and animals can be sampled using pitfall traps.	
Describe how quadrats are used to sample plants.	
Describe how pitfall traps are used to sample animals.	
Evaluate the limitations and sources of error in the use of quadrats.	
Evaluate the limitations and sources of error in the use of pitfall traps.	
Use and construct paired-statement keys to identify organisms.	
Describe the effect of biotic and abiotic factors on biodiversity and the distribution of organisms.	
State that indicator species are species that by their presence or absence indicate environmental quality/levels of pollution.