Environmental surveys -–Student sheet

All the skills listed are important in environmental science careers. While watching the video, make a note in the second column of any skills the scientist mentions that they use in their work and what they say about them.

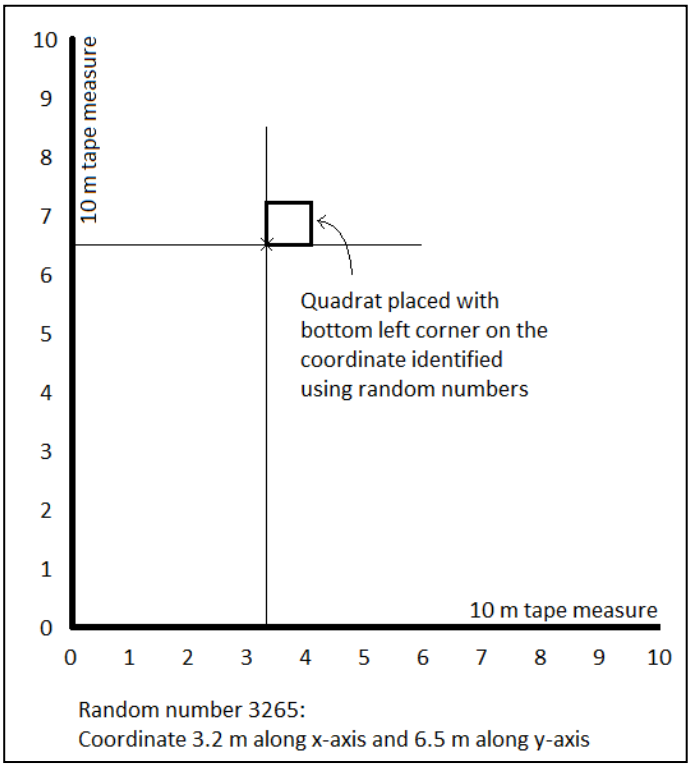
Skill set	**What the scientist says about the skills they need**	**When and how you used the skills (to complete later)**
Accuracy and attention to detail		
Communication skills – written		
Communication skills – verbal		
Record keeping		
Presentation skills		
Technical skills (using equipment in the right way)		
Ability to work as a member of a team		
Enthusiasm		
Self-discipline (keeping focussed on the task)		
Flexibility		
Patience		
Time-management		

Biotic sampling technique A: Quadrat

Equipment and materials

Per group

Tape measures, 2
Quadrat
Identification key
Paper and pen to record results



Procedure

1 To find the distribution of plants in an area, use quadrats to take random samples across the area. Random sampling avoids bias. One way to do this is to use two long measuring tapes to create 'X' and 'Y' axes in the area. Then use a table of random numbers as coordinates to select positions in the grid to place each quadrat, as shown in the diagram. Place enough quadrats to be a representative sample.

2 Identify (and note) all the plant species in each quadrat and estimate each species' percentage cover. Record the data in a table like this one:

Sample number	Plant species observed	Estimated % cover for each species	Notes
1			
2			

3 For each species, show how many quadrats it appears in (frequency), and calculate its average percentage cover. To calculate average percentage cover for each species:

- add together all the percentage cover values for one species
- divide by the number of quadrats.

4 Present a summary of the data as a bar chart or table with the species in alphabetical order.

5 Compare your data with another survey. Compare the list of species, the number of species, the frequency of occurrence of each plant species, and the percentage cover of each species.

Biotic sampling technique B: Point frame

Equipment and materials

Per group

Point frame with 10 pins
Identification key
Paper and pen to record results

Procedure

1 To find out the distribution of plants in an area, choose a line through your environment at random and start with the point frame at one end. For each species, record how many pins are touching an example of the species. If a plant is touching any single pin in two places, count that as 1 pin touched.

2 Add up the numbers of pins touched for each species of plant and record the data in a table like this one:

Sample number	Plant species observed	Number of 'pin touches' for each species	Notes
1			
2			

3 Move the point frame along the line, taking samples at one metre intervals.

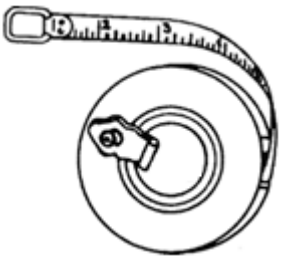
4 Compare samples to see how the frequency of each species changes along the line. Look to see if each species occurs all along the line, or if some occur in clusters.

5 Present a summary of the results by listing all the species in alphabetical order. Show in a table the frequency of each species, by showing the total number of pins touched. In addition show the distribution of species along the sampling line.

6 Compare your data with another survey. Compare the number of species you find, the range of species you find and the frequency of occurrence of each plant species. Also compare how the species are distributed along the sampling line.

Biotic sampling technique C: Continuous line transect

Equipment and materials:



Per group
Long measuring tape
Identification key
Paper and pen to record results

Procedure

1 To find out the distribution of plants along a transect, place a measuring tape in a straight line along the area to be sampled.

2 Work from one end of the tape to the other. Note the plant species which are touching one edge of the tape. Record the plant species and its distance along the tape (e.g. grass 10 cm-21 cm).

3 Present the results in a chart like the one below, showing the distribution of each species along the transect. Show the species in the chart in the order you found them as you worked along the transect.

	North																				**South**
	Dry land (0-22 m)				**Marsh (22-45 m)**								**Swamp (45-62 m)**				**Open water (62-65 m)**				
Rhododendron																					
Soft Rush																					
Alder																					
Wood Club Rush																					
Reed Mace																					
Marsh Bedstraw																					
Water Mint																					
Yellow Iris																					
Branched Burreed																					
Duckweed																					
C. Pondweed																					

(Based on data from www.countrysideinfo.co.uk/wetland_survey/trans1a.htm)

4 Compare your results with a later survey, or one from another area, by comparing which species are present, and their pattern of distribution along the line.

Measuring abiotic factors

Equipment and materials

Per group

Electronic or other data collection devices e.g.

- Temperature: An ordinary mercury thermometer or electronic temperature probe
- Humidity: An electronic moisture probe to measure the humidity of the atmosphere
- Windspeed: An anemometer
- Light: A light meter

Paper and pen to record results

Procedure

1 For each device think carefully about the following:

- Where to place it – ground level or higher?
- Where exactly to survey – randomly, or around identified features? For instance, it might be interesting to find out the effect of a hedge or building on windspeed, and on light levels.
- How long to leave the device before reading the result. Some devices take a while to settle.
- How to present your data. Will you link it to a map (or photograph) of the area, or show it as a table or graph?
- How to compare your data with data collected in another place.

2 Set up your device and leave it for the required time. Come back to it and collect the data when it is ready.

To plan

Read the information about the sampling technique(s) you are going to use.

When you carry out your survey you will need to:

Make a sketch map of the area showing the North–South direction, and any obvious features (such as large trees, ponds, paths or buildings) and the slope of the ground. You could take a photograph and add labels to it. If you have access to a device that gives you GPS information, then a map reference is also useful.

Use a *key* to identify the plants in the area. A key is a guide showing the species that are likely to be there, with detailed information allowing you to tell one species from another. Collect a single leaf or flower if there is a species you cannot identify from the key and bring it back to the laboratory to find out more about it.

1 Use this information to plan in your group what you are going to do. Think about these questions:

- What is the reason for making this survey?
- What area will you be surveying?
- What species are you expecting to find? (The key to grassland plants will help with this.)
- Which biotic sampling technique are you going to use?
- What equipment will you need?
- Who will carry out each of the tasks?

2 Now think about how you will record your data.

- How you will record your results? Make a table with the right headings.

The class will also be collecting information about the abiotic factors in the area (such as light and temperature). You might need to share this information with other groups.

- Agree with the other groups how to present information about abiotic factors.
- Make a table with the right headings to record the results.

To analyse and report

Go back to the original question which led to your survey.

Write a report explaining what you found out.

Your report should include:

- the reason for carrying out the survey
- a sketch of the area
- a description of the technique you used
- the equipment you used
- a chart or table summarising your observations
- a conclusion – an answer to the original question which is supported by your findings. If your results do not help you to answer the question, explain why.

Environmental scientists – skills and techniques

1 After completing your school grounds survey, go back to the skills table you used in lesson 1 and make a note of the skills you have used in the work.

2 Which skills do you already have for this work?

3 Which skills would you need to develop?

4 Do you think working in environmental science could be a good career for you? What skills do you have that would be useful in this career?

Learning structure of the lesson

The big picture

This lesson sequence is designed to exemplify an approach to practical work which makes strong links with careers that use related scientific skills and techniques.

These lessons take a less familiar 'spin' on a school field survey by providing a careers-related context with a real question to answer. Follow-up work based around careers in environmental science further emphasises that the context of this work is different. The video shows students that the techniques they use in school are genuinely similar to the techniques used by practising scientists.

Age range: 13–14

Timing: 3 x 50 minutes

1: Learning episode 1 (teacher-led) 15 mins

Students watch a video about an environmental scientist, and note the skills and techniques needed to do that job.

1: Learning episode 2 (student-led) 35 mins

Students work in groups to consider a local context for their own survey and become familiar with the apparatus and methods they are to use. They plan how they will collect and record their data.

2: Learning episode 3 (student-led) 35 mins

Students follow their plan to carry out a survey of an area of the school grounds and record their results.

2: Learning episode 4 (student-led) 15 mins

Students recall similarities between their survey and the work described by the scientist in the video.

They begin to write a report of their findings.

3: Learning episode 5 (teacher-led) 30 mins

Groups share their findings with each other and discuss the extent of agreement in their answers to the question being explored.

Students reflect on the skills and techniques they have used.

3: Learning episode 6 (student-led) 20 mins

They prepare a summary of their work referring to the techniques used.

Learning outcomes

Students will be able to:

- plan a survey of part of the school grounds using suitable equipment
- carry out a survey of part of the school grounds using suitable equipment
- explain the importance of environmental assessments in the workplace
- present the survey results

Equipment and materials

Teacher guidance

Practical guidance

Slide presentation

Video

Student sheets

Per class

Two measuring tapes, 10 m
Access to camera
One set of tools to measure abiotic factors:
- thermometer or electronic temperature probe
- electronic moisture probe
- anemometer
- light meter

Optional: Access to a device giving GPS data

Per group of students

Pen and paper
Key to grassland plants
Quadrat (0.5 m or 0.25 m square)
OR
Point frame
OR
Measuring tape (3 m or 10 m long)

Refer to the health and safety advice and practical guidance

Key words

Random sample, biotic, abiotic, bias, transect

Prior knowledge

It is assumed that students know the following.

- Plants grow in environments that are suitable for them.
- Species can be identified using keys.

Background information

People following careers in environmental science are often driven by:

- a desire to work outdoors, for part of the time at least
- a deep interest and passion for plants or animals or the natural world
- an ability to process data; handling numbers and presenting information clearly for others to understand
- attention to detail.

Some environmental scientists work in contexts that are difficult to relate to a school environment. For example, investigating issues with enormous societal impact such as climate change, food heritage, developing new food crops, future food security and finding new exploitable resources for medicine or other industries.

Other environmental scientists work in contexts that relate well to a school environment. Sampling and collecting techniques and identification keys used in schools for field surveys are similar to those used by these scientists. The most significant differences will be in how data is recorded. Professional scientists may record directly into laptops and use photographs and GPS data. The scale of the work is also different, with scientists often spending days or even months collecting and analysing data and reporting on the findings.

Field surveys are used by scientists for a number of reasons. They can be used to:

- describe an area (especially a previously unexplored area)
- identify the location of interesting species (and possibly new species in some parts of the world/habitats)
- allow comparison with another area
- provide a 'before' snapshot of what an area is like now to compare with a future 'after' analysis to show how much things change seasonally and over longer time-spans, or to assess the impact of a development or conservation plan
- identify rare or important species whose presence could support arguments that an environment should be protected from change.

Identifying and measuring differences between environments

To compare two environments, or to see how an environment changes, you need to be able to describe an environment in detail.

Living things are an important feature in any environment. Plants are easier to survey than most animals because they don't move around and they make a permanent framework in a particular place. Plants and animals make up what is called the *biotic* part of an environment.

Other features of an environment that are important include the temperature, humidity, windspeed and light levels. These are called *abiotic* factors.

It is impossible to notice every single living thing in an environment, or to measure all abiotic factors at every point. Surveying an environment involves sampling. This means looking more closely at small areas in detail and assuming that they represent the whole environment. If you are repeating a survey in the same area, or if you want to compare two areas, it is important that you use the same techniques each time.

Mapping an area

A useful part of any survey is an outline map of the area, or a series of photographs, showing the general layout. Important things to note are the North–South direction, any obvious features (such as large trees, ponds, paths or buildings) and the slope of the ground. If you have access to a device that gives you GPS information, then a map reference is also useful.

Using keys

Scientists identify species in an area using a *key*. This is a guide showing the species that are likely to be there, with detailed information allowing scientists to distinguish one species from another. There are keys to grassland plants that will help you identify the different species on a school field.

Collecting samples

When working in a new environment, scientists will often collect samples of plants to bring back to the laboratory for closer study. In a natural environment, collecting wildflowers and other plants is not good practice. Only when working on the school field, students could collect single leaves, or single flowers from a clump of plants to bring back and look at more closely in the laboratory. Alternatively they could photograph any plant and record data about its size etc. in order to be able to identify it later using keys in the laboratory.

Advantages and disadvantages of different survey techniques

Quadrat

- Quadrats allow you to collect a lot of data (information) about the frequency of organisms in an area quite quickly.
- Frequency counts are more consistent from one surveyor to another.
- Percentage cover is an estimate of plant frequency. Different people may get different results.

Point frame

- Point frames allow you to collect a lot of data (information) quite quickly.
- They give you trend information from one side of a site to another.
- Frequency counts should be consistent from one surveyor to another.
- They are useful for surveying plants in a mixed community where it can be difficult to identify distinct individuals.
- They are useful for recording the presence of overlapping plants in a vertical canopy.

- They sample only a very small proportion of the population, so you are more likely to miss rare plants or small plants.

Continuous line transect

- Continuous line transects show the changes taking place along an environmental gradient, such as a hill or from shade to light.
- They provide a summary of **which** organisms are present, but not an accurate measure of **how much** is present (frequency).
- Where the plant cover is very dense, continuous line transects are useful over only a short distance. Where individual plants are spread out along the line (for example in a desert, or on sand dunes), continuous line transects are practical over longer distances.
- If there are lots of plants touching the line, it can take a long time to survey a long distance. It is also difficult to present the data.
- It can be difficult to separate two or more species, for example, where moss and grass are growing together.
- If the plants are growing close together, you could note the plants at intervals, for example, alternate 10 cm or 50 cm blocks. This can be quick even over long distances, but you might miss some species altogether. You can also place quadrats along the transect at 2 m or 3 m intervals. These methods produce what are called 'interrupted' transects.

Suggested approaches

Reasons for surveying your own grounds could be to answer questions such as these.

- There's a plan to put an all-weather surface down for a sports pitch (or build a temporary classroom). If we do this, what habitat will we be losing? Does a similar habitat exist anywhere else in the school grounds?
- There are clear 'paths' where people walk on the school field. Have we reduced the biodiversity in those areas? If we plan to encourage people to use different routes through the field each term, can we restore biodiversity across the whole area?
- There's a plan to try to increase the biodiversity of the school field by leaving a 0.5 m strip un-mown by the hedge. What species are present now? What species are present after starting the new mowing system?
- The pitches on the school field are marked with white lines. Does the paint used affect which plants grow there?
- How much does our use of the school field through the summer affect the biodiversity of plants growing in the field?

If you choose a context requiring a 'before' and an 'after' survey, you could work with different teaching groups to make the assessments and compare the surveys when both are completed, or compare this year's survey with last year's. If you or your technician(s) have time to make a survey, that could form your baseline for comparison at any time. Then any future survey can be completed in one lesson and interpreted in the next.

The suggested approach is to brief separate groups so that each becomes

expert on one survey technique (as described on the Student sheets). Each group then uses their assigned technique to survey an area. The groups come together to compare their results. Students are asked to evaluate the process in terms of the context: do they think their procedure and results have helped to answer the question set? Using the information about the advantages and disadvantages of each technique will help you to decide if one of the techniques is entirely inappropriate for your context and should be left out. If you only have quadrats, or want to manage the group more closely, you could restrict the group to one technique only.

The Student sheet also suggests making an outline map of the area and covers methods for collecting some abiotic measurements. You could share out collection of abiotic data or brief one group to be the abiotic experts.

Terminology

The terms which students need to understand and use in this lesson are:

random sample – a sample selected by a method designed to eliminate bias

biotic – to do with living organisms, such as plants and animals

abiotic – to do with non-living factors, such as temperature, humidity, light and windspeed

bias – an unbiased sample will be representative of an area, and will not favour one feature over another

transect – a transect is a line (or path) through an area along which samples are taken

Optional extension activities

Create a careers mindmap with 'environmental survey' at the centre. This could be organised according to people who use environmental surveys (for example, ecologists, countryside officers, landscape scientists). It could also include notes on how the survey is used, what job roles are involved and what qualifications are needed for the work. Work in pairs, share in fours.

Use sources of information such as videos available on Futuremorph (www.futuremorph.org) or job profiles on the National Careers Service (nationalcareersservice.direct.gov.uk). Search for ecologist, countryside officer, landscape scientist and others.

The Hidden Science Map on Futuremorph (www.hiddensciencemap.org) lets you find biologists or people studying biodiversity and find out more about their career paths. This could be added to a poster/presentation or other report.

Taking it further

- Research other examples of how these survey techniques can be applied in real-life contexts. Use the Field Studies Council (www.field-studies-council.org), or Wildlife Trusts (www.wildlifetrusts.org) websites as a starting point.

- Find out about local bioblitzes from www.opalexplorenature.org. How does a Bioblitz compare with what you have done in the school field? What are the main reasons for the Bioblitz activities?
- Provide notes for another school on which would be the best survey method and why.
- Ask local STEM ambassadors or sixth form or undergraduate biology students/vocational students to school to talk about what they do. Make a poster/ presentation or other report on what is learned from them.

Useful weblinks

The Field Studies Council provides more information about environmental surveys in schools with examples of project work:
www.field-studies-council.org

Some of the techniques used in this lesson are based on information available from the Field Studies Council:
www.field-studies-council.org/documents/projects/sitp/sessions/esss/ESSS%20Quadrats%20and%20measuring%20plant%20cover%20information.pdf

Other techniques used in this lesson are based on information available from Offwell Woodland and Wildlife Trust:
www.countrysideinfo.co.uk/wetland_survey/line.htm

Lesson details – lesson 1

Task: In advance of the lesson, decide on the reason for the field survey and complete **slide 2**.

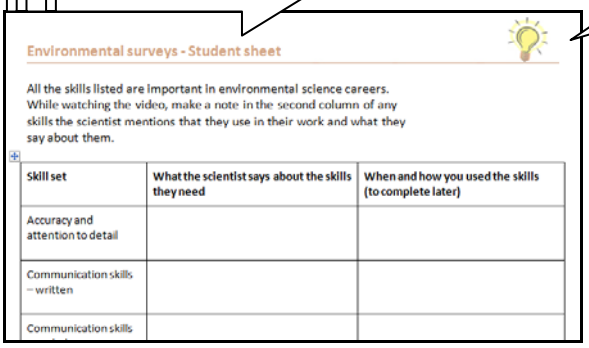
Suggestions for survey contexts can be found in **Suggested approaches** in this document.

Video

Explain: Some school science really is like the kind of work that people with scientific qualifications do for a living/ as a career.

Task: Present the video of an environmental scientist talking about their work.

Student sheet



Environmental surveys - Student sheet

All the skills listed are important in environmental science careers. While watching the video, make a note in the second column of any skills the scientist mentions that they use in their work and what they say about them.

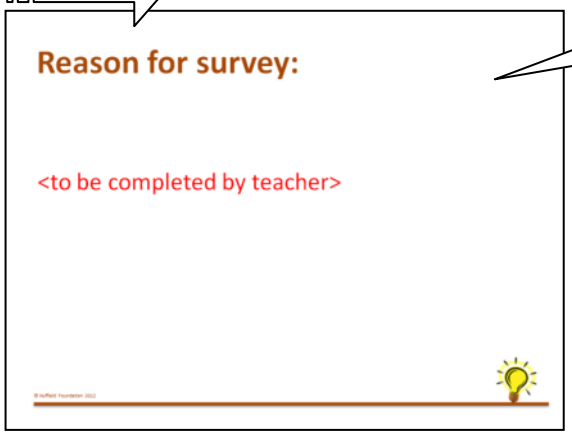
Skill set	What the scientist says about the skills they need	When and how you used the skills (to complete later)
Accuracy and attention to detail		
Communication skills – written		
Communication skills		

Task: While watching the video, ask students to notice and note any skills the scientist describes as essential for their work. Use the **Student sheet.**

You may want to show the video twice so that students are able to watch first then watch with a purpose during the second viewing.

Explain: Students will be carrying out their own environmental study and may use some of these skills. They will return to their list in the third lesson.

Slide 2

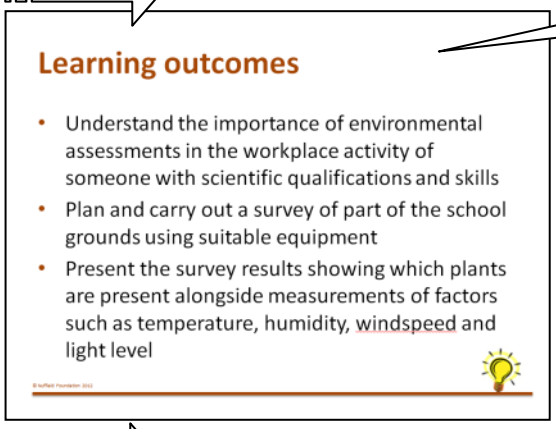


Reason for survey:

<to be completed by teacher>

Task: Use **slide 2** to present a 'real-life' reason for carrying out a survey of grassland in your school grounds.

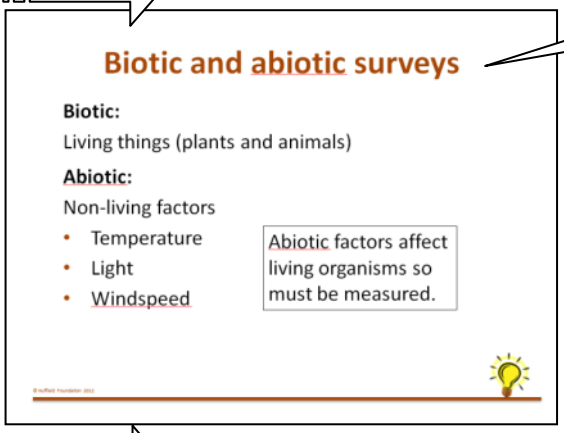
Slide 3



Task: Use **slide 3** to share the learning outcomes for this sequence of lessons.

Emphasise the connection between what students will do and techniques used by professional scientists.

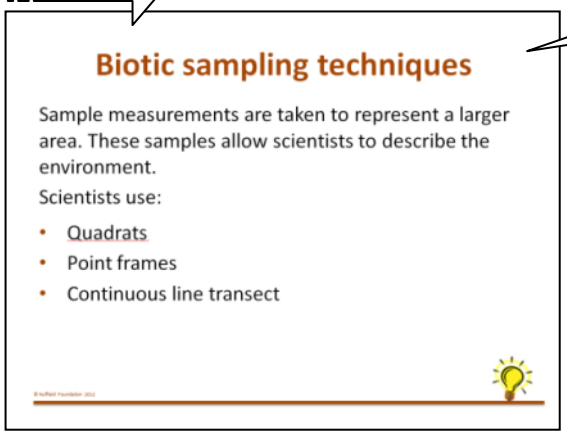
Slide 4



Task: Use **slide 4** to explain the difference between biotic and abiotic factors.

Explain: It is impossible to notice every single living thing in an environment, or to measure all abiotic factors at every point. Surveying an environment involves sampling. This means looking more closely at small areas in detail and assuming that they represent the whole environment. There are different techniques that scientists use to survey an area; most commonly quadrats, point frames and continuous line transects. Students will use one of these techniques, and may also measure abiotic factors in the areas.

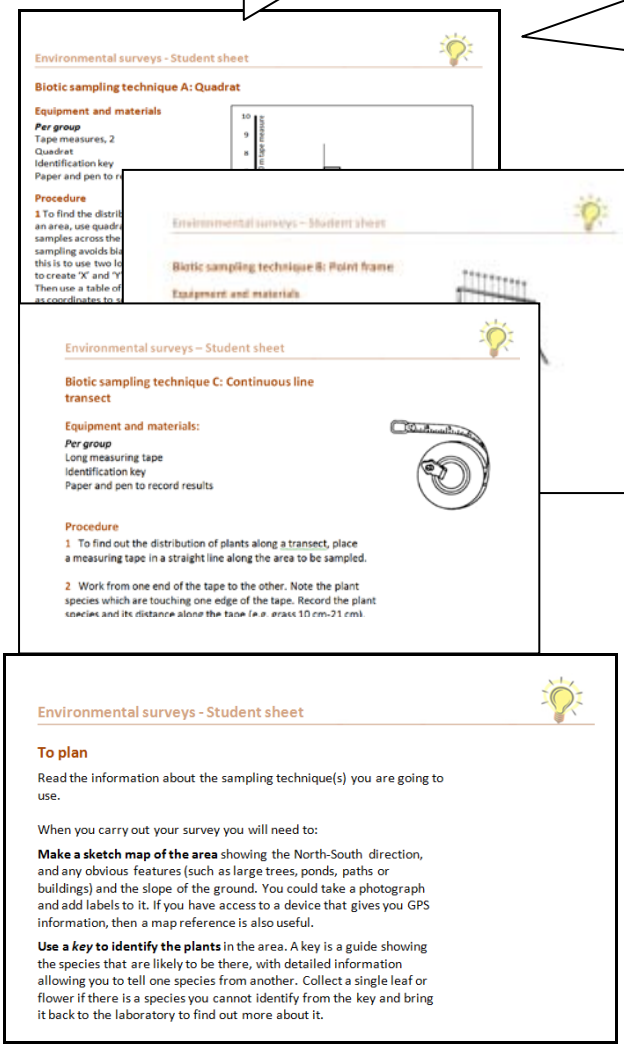
Slide 5



Task: Show **slide 5** and the apparatus available for surveying biotic and abiotic factors.

Environmental surveys – Teacher guidance

Student sheet



Task: Assign a sampling technique to each group of three or four students. Groups read about their allocated technique on **Student sheet** page 2, 3 or 4.

If all groups are collecting information about abiotic factors they should all be given page 5,

Task: Show students a grassland plants key and explain how to use it.

Task: Students spend 5 minutes in their groups using the information provided, and the guidance in part 1 on **Student sheet** page 6, to discuss and plan exactly what they will do when they approach the site to do their survey.

Differentiation: You may wish to provide additional support at this point specific to the context you have chosen for the survey.

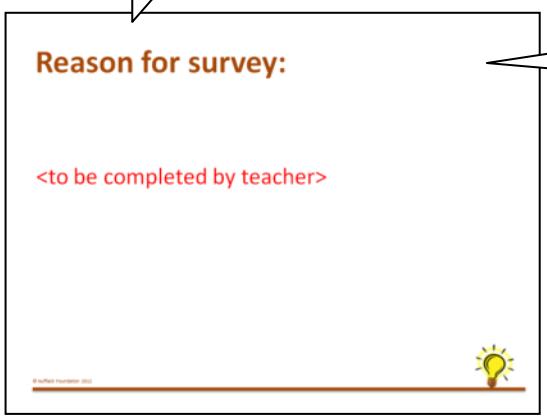
Groups should highlight the notes of exactly what will they do and assign roles to each group member.

Task: Students spend a further 10 minutes using the information provided, and the guidance in part 2 on **Student sheet** page 6, to plan how to record the data they will collect in the field and draw up a table.

Any unfinished planning can be completed for homework.

Lesson details – Lesson 2

Slide 2



Task: Remind students of purpose of survey (**slide 2**) and any specific health and safety issues. Ensure they are clear where they will be carrying out their survey.

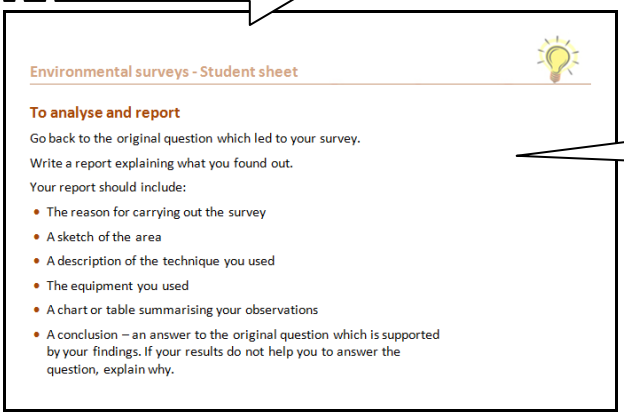
Task: Students collect equipment (including recording tools) from the laboratory.

Practical

Task: Students work in their groups to carry out survey and to record their findings. (See **Practical guidance**)

Help students with identification and use of equipment.

Student sheet


Environmental surveys - Student sheet

To analyse and report

Go back to the original question which led to your survey.

Write a report explaining what you found out.

Your report should include:

- The reason for carrying out the survey
- A sketch of the area
- A description of the technique you used
- The equipment you used
- A chart or table summarising your observations
- A conclusion – an answer to the original question which is supported by your findings. If your results do not help you to answer the question, explain why.

Task: Ask students to recall similarities between their survey and the work described by the scientist in the video.

Task: Students begin to present their results using **Student sheet** page 7 as a guide.

The report should describe the technique, present the observations and relate the findings to the question that was the context for the work.

Completing the reports for homework is an option.

Lesson details – Lesson 3

Task: Each group writes a short summary of what they found in their survey.

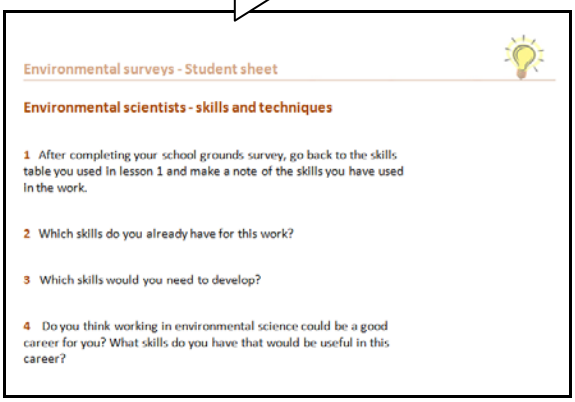
Task: Divide each group up so that each student is now an envoy. Make new groups of three with envoys from different original groups. Each envoy has 2 minutes to present their report to the others.

Task: Discuss the extent of agreement in their answers to the question being explored. Evaluate the results in terms of their confidence in the procedure used as a way of assessing the environment.

If groups used different sampling techniques, discuss the value of the each sampling technique, e.g. transects may have highlighted change along an environmental gradient but quadrats provide a quick survey allowing comparison of one area with another.

Task: Share some of the key thoughts from each group as a class.

Student sheet



Environmental surveys - Student sheet

Environmental scientists - skills and techniques

1 After completing your school grounds survey, go back to the skills table you used in lesson 1 and make a note of the skills you have used in the work.

2 Which skills do you already have for this work?

3 Which skills would you need to develop?

4 Do you think working in environmental science could be a good career for you? What skills do you have that would be useful in this career?

Task: Students reflect on the skills and techniques they have used to do this work, using **Student sheet** page 8 and the completed page 1.

Task: Students prepare a summary of their work referring to the techniques used by their own and other groups.

The summary should use rich media/visuals (e.g. a *Photo Story* account of their survey and results, a short video, or a leaflet aimed at the specific audience such as other students or school governors or a scientific poster). The approach taken will depend on the question they were answering in their survey.

Equipment and materials

Per class

Two long measuring tapes, 10 m
Access to camera
One set of tools to measure abiotic factors:

- thermometer or electronic temperature probe
- electronic moisture probe
- anemometer
- light meter

Optional: Access to a device giving GPS data

Per group

Pen and paper to record findings
Key to grassland plants (see note 1)
Quadrat (0.5 m or 0.25 m square)
OR
Point frame
OR
Measuring tape (3 m or 10 m long)
Optional: Random number tables

Health and Safety and technical notes

Before carrying out these practical activities, users are reminded that it is their responsibility to carry out a risk assessment in accordance with their employer's requirements, making use of up-to-date information.

Read our standard health & safety guidance.

1 Follow your school's procedures for taking students out of the classroom. Some key things to consider are:-

- Level of supervision
- Student behaviour
- Hazards in area used e.g. ponds etc.
- Student experience in using equipment
- Weather and appropriate clothing.

2 The Field Studies Council (www.field-studies-council.org) has produced a risk assessment form for outdoor work which might be useful to you. The risks will vary according to the location and layout of your school grounds. The equipment used for field surveys is not hazardous in itself, if handled for the purpose intended by students whose focus is on the work in hand and whose behaviour is appropriate to the situation.

3 A good key to grassland plants is available from the Field Studies Council (www.field-studies-council.org/publications/pubs/guide-to-grassland-plants-1.aspx). It includes illustrations of the plants that are likely to be found in

school grassland areas. This key can be used by matching plants to the pictures rather than following a series of Yes/No questions.

Procedures

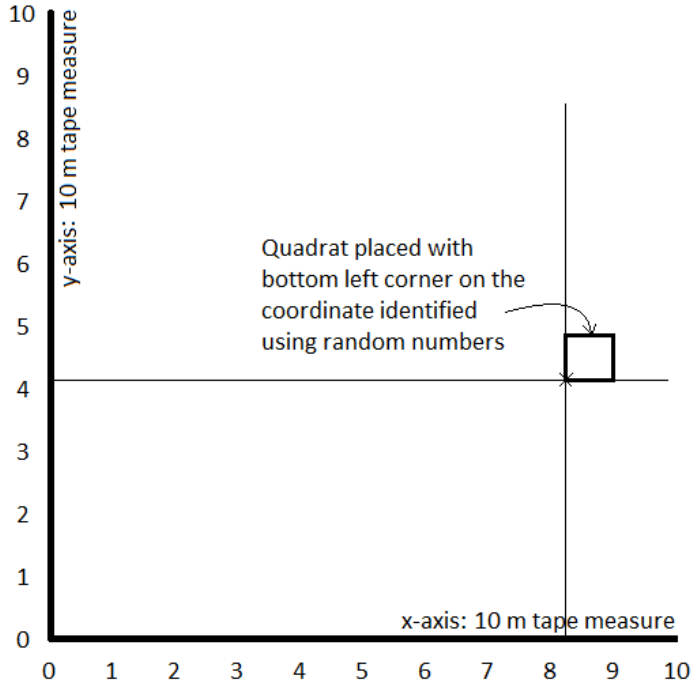
The procedures are detailed on the Student sheets.

Random number tables

Use a random number table to place quadrats on the grid. Start anywhere in the table and then work along each row left to right (start back at the beginning if you need to). Use the four figures to give two coordinates

e.g. 8241 gives *x*-axis coordinate 8.2 m, and *y*-axis coordinate 4.1 m.

8241	4866	4664	2395	9702	4908	9292	1640	4468	0855
4224	1589	2394	7233	5088	4597	3324	6844	6284	0610
4885	9559	0711	9954	2252	2806	5670	9804	0077	1985
8248	4623	9749	9216	4408	4166	6495	0208	9240	6955
4215	7469	3249	0971	3528	2985	5439	0988	8715	2840



Random number 8241:
Coordinate 8.2 m along x-axis and 4.1 m along y-axis