TEACHING AND LEARNING NOTES

KEY STAGE 4 RESOURCES [TIME REQUIRED = ONE HOUR+]
Starter activity: Case study and questions
Foundation activity: Comparing the diversity of habitats
Higher activity: Habitat networks and biodiversity
Extension activity: Investigating habitat networks
Plenary activity: Biodiversity in the UK

AIMS

Careers education

Motivate and engage young people so more of them want to continue to study science and make it their career.

How science works

Pupils should be taught to:

- collect data from primary and secondary sources, including using ICT sources and tools
- work accurately and safely, individually and with others, when collecting first-hand data
- evaluate methods of collection of data and consider their validity and reliability as evidence.

Experimental and investigative science

Pupils should understand that the effects of human activity on the environment can be assessed using living and non-living indicators.

KEY VOCABULARY

biodiversity · sequential comparison index · habitat · habitat network

STARTER ACTIVITY: CAREER CASE STUDY AND QUESTIONS

Ask pupils to read the career case study and watch the video. This may be projected to the whole class or students may watch it in small groups. They may discuss the questions in groups, noting answers for a brief class discussion. Use this to establish what Amy does and why she enjoys doing it. The longer version of the video could be used or made available to interested pupils. A job profile for an ecologist may be found at:

https://nationalcareersservice.direct.gov.uk/advice/planning/jobprofiles/Pages/ecologist.aspx.

Answers

Pupils may give various answers depending on what they remember. Transcript of video:

"My name's Amy Eycott and I'm a landscape ecologist for the Forestry Commission. And what that means is that I think about all the different species that live in forests in the UK and how they get around in forests and how they move between forests.

"I wasn't very academic at school. Anyone who wishes to see my school reports is welcome to. They're not very shining. But I love learning stuff on my own terms. I don't like being told, 'today you will read this chapter of this book'.

"It's like I wake up in the morning and I'm like, 'what do I want to learn today? What do I want to find out about? What's curious today?' Then I got to university and started kind of doing independent research as part of my degree and liked it so much that I wanted to stay in research.

"After I finished my PhD, I did some really odd contract work. Really kind of short things. Things like two-week contracts for almost a year. By that point I'd got really specialised so there weren't many jobs coming up. So I was maybe only really getting a job come up every couple of months. This was the second interview I went for and I got the position. I get to do original research same as I would if I was in a university, but I actually get to see what I've kind of found out translated directly into action on the ground in a really immediate way."

FOUNDATION ACTIVITY: COMPARING THE DIVERSITY OF HABITATS

The worksheet introduces the concept of diversity contrasted with species richness. Ask pupils to read the sheet and instructions. You may wish to go over key points with them. Pupils follow the procedure to compare diversity in two habitats by finding values for Cairn's Sequential Comparison Index. Ideally, one of these habitats should be a woodland. If necessary, school fields can be used and a comparison might be made between areas that are lightly or heavily trampled, regularly or infrequently mown or treated/not treated with herbicide or fertiliser.

Pupils may work in pairs or threes. If time is short, results can be combined to obtain samples of 100 individual plants.

The technique does not require the identification of species, but this is a good opportunity to give pupils experience of the use of keys.

Comparison of the class results should reveal the reliability of the method. A sample size of 100 should give reasonably consistent results. Calculations for smaller samples should reveal the effect of having too small a sample.

Random sampling techniques may be discussed. The pencil sampling method used is not strictly random as there is still the opportunity to manipulate the direction in which the pencil is dropped.

More time may be spent on the practical if follow up work is done for homework and/or in other lessons. The questions under 'More about diversity' may be set for homework and followed up with small group or class discussion. Answers depend on the pupils suggestions, but misunderstanding may be determined and discussed.

HIGHER ACTIVITY: HABITAT NETWORKS AND BIODIVERSITY

Pupils who complete the practical in good time could be given the higher activity to begin. It may be set in whole or part as homework. There is a lot of good information on the Forestry Commission web pages, but the language used is often difficult and technical. The section of the website recommended in the student document is more amenable and the answers to the questions are accessible.

Answers

a) By linking and expanding the best habitats that can sustain diversity.

b) Forest (and woodland) habitat networks.

c) Because they show biodiversity but have undergone a great deal of fragmentation.

d) The scientists have recognized that these need to be considered as well to avoid further fragmentation, so they are trying to develop integrated habitat networks that will increase the biodiversity of all habitats.

e) Biological and Environmental Evaluation Tools for Landscape Ecology.

f) Oak.

g) Reasons include as a source of food for other animals and as pollinators. They may also limit the growth and spread of some plant species by feeding on them or spreading disease.

h) The same tree species may be found in different climatic conditions which can effect animal distribution. Maturity of trees also affects the associated animals.

i) Some species may support a large biomass of one or two insect species. These could be important as food in food chains.

j) The data quoted were obtained in 1961 and significant changes may have occurred since then.

EXTENSION ACTIVITY: INVESTIGATING HABITAT NETWORKS

Use of Google Earth aerial views can allow pupils to see the areas that they have investigated in the context of their surroundings and they can make a preliminary assessment of the opportunities for connectivity and movement of species between areas. The extent to which habitats are fragmented may be seen. It may be possible to relate differences in diversity to fragmentation, or there may be other reasons depending on the habitats which have been investigated.

PLENARY ACTIVITY: BIODIVERSITY IN THE UK

Pupils are asked to work in small groups to support the argument that biodiversity may increase or decrease in the next 50 years. The discussion opens the opportunity to explore the need for specialist scientists, including plant biologists, who will be able to recognise and implement effective strategies. The work of Amy Eycott and others has identified the problems of the previously unsuccessful site-oriented efforts at conservation and provided new tools to analyse and map areas. It has also helped to develop more effective measures, including the development of habitat networks.

TECHNICIAN NOTES

CAREER CASE STUDY

The video is at http://icould.com/videos/amy-eycott/?length=short, and a longer version and transcript is at http://icould.com/videos/amy-eycott/. Pupils could watch in groups if Internet connected PCs are available.

FOUNDATION ACTIVITY: COMPARING THE DIVERSITY OF HABITATS

Equipment and materials, for each two or three pupils:

- Pencil.
- Rope knotted at 1 metre intervals (optional) [Cheap rope may be bought at 'pound' shops, or may be substituted with washing line. Intervals may be marked by contrasting tape or permanent marker pen].
- Relevant identification keys (optional) [Obtain identification charts and keys from, http://www.field-studies-council.org/publications/pubs/playing-field-plants.aspx].

Summary of method

Two habitats are compared for diversity. Pupils lay down a rope or walk a line (line transect) indicated by dropping a pencil over a shoulder. Plant species are sampled by knots in the rope (or other marks) at metre intervals, or a pencil is dropped at one pace intervals. The number of individuals is recorded together with the number of runs of the same species – each change to a new species is noted. A total of 100 individual plants are sampled and the Cairns sequential comparison index (SCI) is calculated from number of runs/ number of individuals in sample (100).

Safety

Risk assessments should be carried out for all activities, see your local guidelines (e.g. CLEAPPS or SSERC). Check for local guidelines for outdoor activities or visits, such as CLEAPSS Supplementary Risk Assessment (SRA 08) for planning work outdoors, which includes consideration of:

- How students behave when outdoors – the normal staff: student ratio for classrooms or laboratories may not be adequate to ensure safe working outdoors.
- Provision for handwashing needs to be available when plants and soil are handled. Alcohol gels or other hand sanitisers with paper towels might be considered.
- Covering grazes or cuts, ensuring pupils do not eat snacks and hand washing can reduce the risk of diseases such as toxoplasmosis and toxocariasis from plants and soil contaminated by cat or dog faeces.
- Being alert to allergic reactions or asthma symptoms in response to such things as pollen, plant sap, contact with leaves, insect bites and stings, and some hairy caterpillars. Deal with these according to your institutions normal policy.
- Being aware of the risk of sunburn on sunny days if exposure exceeds 20-30 minutes.
- There is a risk of injury when using or carrying tools or heavy loads of unfamiliar equipment.
- Check the area in advance for hazards that may cause injury; remove or identifying them with warning signs.

Further information can be found in the Royal Geographical Society guidelines at http://www.rgs.org/OurWork/Schools/Fieldwork+and+local+learning/Fieldwork+safety/Fieldwork+safety.htm.

And the FSC code of practice at http://www.rgs.org/NR/rdonlyres/F415E7EB-47A3-4DB8-950A-26DA498779E1/0/FW_Safety_FSC_Code.pdf.

Amy Eycott

Landscape ecologist

Science &Plants for Schools

CAREER CASE STUDY

Amy Eycott made a short video about her career as a Landscape Ecologist working for the Forestry Commission. She explained that she studies all the species that live in forests in the UK and how they move around in forests and between forests.

She makes use of computers to be able to find, record and analyse data, but also goes out to collect her own original data on woodland species. She uses scientific techniques to "…find out whether the assumptions we've made about how things move between woodlands are actually true".

Forestry Commission scientists are interested in biodiversity and 'habitat networks" – how habitats connect and allow species to move between them. Biodiversity is short for biological diversity. It encompasses the diversity of all living things, the diversity of all the habitats in which they live and the genetic diversity of individuals within a species.

Despite conservation at local sites, biodiversity in the UK has declined. This is now thought to be due in part to the breaking up and separation of habitats. The creation of habitat networks is designed to link and expand those habitats that can support greater biodiversity.

She told us, "One of the first things I did when I came here was a contract which was looking at how the woodlands in Wales are connected, and that's been taken by CCW, the Countryside Council for Wales, and they've turned that into a whole policy about where they're going to target their woodland creation grants. So I've had a big impact fairly soon and that's why the Forestry Commission's a really pleasing employer to work for. "

a) Watch the video in which Amy explains why she became a landscape ecologist.

QUESTIONS

Use the information above and in the video to answer these questions:

a) Why did Amy want a career in scientific research?

b) What is it about her research that she finds very rewarding?

c) Try to explain why encouraging biodiversity is important?

You will study biodiversity in the investigation: *Comparing the diversity of habitats*.

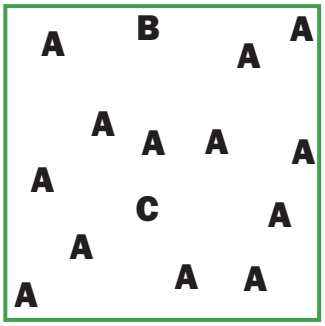
COMPARING THE DIVERSITY OF HABITATS

Ecologists such as Amy are interested in the abundance (how many?) and distribution (where are they found?) of plant and animal species. But they also investigate, measure and try to increase the diversity of habitats.

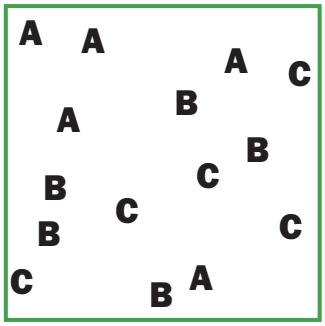
Diversity is not just about how many species are present ('species richness'). You can go and identify and list all the species that you can find in a particular area, but two areas that have identical species in them may show different diversities.

This is because diversity depends on abundance. Two areas may have lots of different species. If one has one or two dominant species, it will have lower diversity than another area with exactly the same species but all present in larger numbers.

For example, suppose you record plant species in a square metre of a habitat and find species A, B and C. If A occurs 13 times and B and C occur once each, this will show lower diversity than if A, B and C all occur five times each:



lower diversity



higher diversity

Landscape ecologists like Amy are helping to plan and create habitat networks to encourage the movement of plant and animal species between areas. Computer models can be used to produce maps of potential forest networks suitable for particular woodland species. The maps are then used to target forest management, including new planting.

How do ecologists know if their recommendations are increasing diversity? They need to be able to measure diversity to know if the networks are being effective.

The Australian ecologist John Cairns devised a simple but effective method called the sequential comparison index for comparing the diversity of different areas. It is not as sensitive as more sophisticated methods, but you can use it to compare different types of habitat in your school or the nearby area.

Safety

Risk assessments must be carried out before any fieldwork is undertaken.

THE SEQUENTIAL COMPARISON INDEX

In a habitat with high diversity you will find many species, all abundant. In a random sample you will continually find different species. With low diversity the same species will turn up again and again.

In the sequential comparison index you record how often new species turn up in a random sample compared to the number of individuals found in the sample.

EQUIPMENT

Pencil · Rope knotted at 1 metre intervals (optional) · Identification key (optional)

PROCEDURE

01) Work with one or two others. Decide on two areas to compare for the species diversity of the plants. Your teacher will give you guidance.

02) In a habitat, drop a pencil over the back of a shoulder and use this as the starting point.

If using a rope: lay it out in as near a straight line as you can, following the direction indicated by the pencil. Note the plant touching or nearest to the knots in sequence.

If a rope is not available: note the plant nearest the point of the pencil, walk one pace, drop the pencil over the back of a shoulder and note the next plant nearest the point. If your route takes you through a tree, record this as the next plant.

If you can, identify plants in the sample. Give species that you cannot identify a code letter (A, B, C, etc.)

If your route takes you out of the habitat, use the pencil to start a new route.

03) Count the number of runs of the same plants in the sample – add 1 in the second row of the table each time there is a change of species. For example, for species A, B, C, D in the first sample of 15:

A	A	A	B	B	C	A	A	D	D	D	D	A	A	A
			1		1	1		1				1		
number of runs = 5														

04) Continue until 100 plants have been sampled. (You may need to start your rope again.)

05) Count the total number of species you have sampled and calculate the sequential comparison index (SCI) by dividing the number of runs (number of times a change occurs) by the number of plants sampled – in this case 100.

$$\text{sci} = \frac{\text{number of runs (changes in species)}}{\text{number of individual plants in the sequence}}$$

06) Repeat in your second habitat. Note any differences you observe between your two habitats.

INTERPRETING YOUR RESULTS

a) What is the lowest and highest value that you could get for the SCI?
b) Which of your habitats shows the greater diversity?
c) Calculate the SCI for your first 10, 25 and 50 samples. Does sample size affect your results?

CLASS RESULTS

a) Record your class results in a table. Was your sample size large enough?
b) Suggest possible reasons for any apparent difference or similarity in diversity.
c) What are the possible sources of error in the investigation?
d) Suggest how the investigation might be improved.

MORE ABOUT DIVERSITY

a) Suggest how increased biodiversity can make a habitat more resilient (less likely to suffer major changes), for example if affected by disease or invasion by an alien species.
b) Suggest and explain a measure that might be taken to increase diversity in the habitats you investigated.
c) Find two or three descriptions of biodiversity. Choose the description you think is best and explain your choice.

HABITAT NETWORKS AND BIODIVERSITY

You will need a computer with an internet connection. If the suggested websites are no longer available, search for other sources of information to answer the questions.

Find information on the work being done by Forestry Commission scientists on woodland biodiversity and habitat networks. Use URL: www.forestry.gov.uk/fr/habitatnetworks or use a search engine to find: 'forestry commission habitat networks'.

Read the summary and make notes to answer the questions.

a) How are habitat networks 'intended to reverse this decline' in biodiversity?

b) What does FHN stand for?

c) Why did Forestry Commission scientists focus on FHNs to start with?

d) Why are the scientists looking at lowland habitat networks (LHNs) now?

e) What does BEETLE stand for?

Look at the datasheet and 'important notes' on the following two pages.

f) Which British tree has the most insect species associated with it?

g) Suggest some reasons why insects are important in ecosystems.

h) Why might trees of the same species have different sets of associated animals (fauna)?

i) How might tree species with few associated insects still have great value to other wildlife?

j) Suggest a reason why the data in the table may not be valid.

THE VALUE OF TREE SPECIES FOR INVERTEBRATES AND LICHENS

The table below shows the number of insects and epiphytic (growing on plants) lichens which have been recorded in association with common trees and shrubs in Britain. The figures in brackets include mite species as well as insects. The information has been adapted from:

http://www.countrysideinfo.co.uk/woodland_manage/tree_value.htm

Tree or Shrub	Associated Insect Species	Associated Lichen Species
Oak (pedunculate & sessile)	284 (423)	324
Willow species	266 (450)	160
Birch (silver & downy)	229 (334)	126
Hawthorn	149	no data
Blackthorn	109	no data
Poplar species (including aspen)	97	no data
Crab Apple	93	no data
Scots Pine	91	132
Alder	90	105
Elm	82	187
Hazel	73	160
Beech	64 (98)	206
Ash	41	255
Spruce*	37	no data
Lime	31	83
Hornbeam	28	44
Rowan	28	125
Field Maple	26 (51)	93
Juniper	20	no data
Larch*	17	no data
Fir*	16	no data
Sycamore*	15	183
Holly	7 (10)	96
Sweet Chestnut*	5	no data
Horse Chestnut*	4	no data
Yew	4	no data
Walnut*	4	no data
Holm Oak*	2	no data
Plane*	1	no data
Rhododendron*	0	no data

* Introduced Species

IMPORTANT NOTES:

The table above is a useful tool, although it does not indicate the value of different tree species for wildlife. It should by no means be assumed that because the table shows relatively few animal/lichen species associated with a particular tree species, that this species is therefore of little value for wildlife.

The table should be read with the following cautionary points in mind:

No one individual tree of a particular species will harbour all the species of insects/mites/lichens known to be associated with that tree species. Indeed, no single woodland is likely to contain all of the species associated with its particular tree species.

Trees of the same species in different geographical areas of Britain will have different sets of associated fauna and lichens. Climatic and geographical variations, as well as the mobility of the associated species, will all influence which insect/mite/lichen species can colonize individual trees and survive in a particular area.

Species diversity is not the same as biomass. A tree species may have relatively few insect species associated with it, but if the insects which are associated with it occur in huge numbers (e.g. aphids) then that tree may harbour an enormously important source of food for other animals. A tree's value for wildlife does not therefore necessarily equate to the number of species directly associated with it.

Much of the table above is derived from a paper by Southwood (1961). The data from this immensely useful paper is based upon tree foliage eaters. However, trees obviously provide a range of resources for species other than those simply eating their foliage. Southwood also concentrated on species specifically linked to particular tree species and deliberately omitted those species feeding on a wide range of host tree species

(This point is related to the above.) The value of individual trees for wildlife depends upon the age of the tree. Different species may be associated with an individual tree at different stages of its lifecycle. For example, insects associated with flowers and fruits, will only be able to benefit from a particular tree once it has grown sufficiently and is mature enough to flower. Older trees also have a much greater variety of microhabitats available for colonization.

INVESTIGATING HABITAT NETWORKS

Amy is interested in the movement of species between woodlands through habitat networks. Do the habitats you investigated show connectivity with other similar areas? Would it be easy for species to move between them?

You will need a computer with access to Google Earth.

Use Google Earth to obtain aerial views of the habitat areas for which you found diversity scores using the sequential comparison index. For each habitat:

a) Are there similar habitats nearby?

b) Are the similar habitats fragmented and isolated, for example are they separated from each other by roads or built up areas? Or are they connected by smaller tracts of similar habitat which might help to form habitat networks?

c) What other similarities or differences can you see in the habitats and their surroundings?

d) From your observations, suggest possible explanations for any differences (or similarities) in the diversity of the habitats that you investigated.

BIODIVERSITY IN THE UK

Despite the efforts of conservationists, biodiversity in the UK has continued to decline.

Working in a small group, discuss:

In the next 50 years, will biodiversity in the UK increase or decline?

Nominate a secretary to record your ideas. Make a decision and report the reasons for it to the rest of the class.