'It's the Pits' - life in a restored gravel pit

Exploring sand/gravel pit restoration options

QCA Science - Unit 7c: Environment and feeding relationships

'It's the Pits' – life in a restored gravel pit

'It's the pits' provides a stimulating way to fulfil the requirements of Unit 7c in a combination of four lessons (approx. 50 minutes per lesson), one four-hour practical fieldwork session and one practical session in the lab. Using their own data from fieldwork brings ownership and engagement to the work.

Pupils can learn about a working gravel extraction pit using the 'Virtual Quarry' resource and how this could be restored when the extraction is completed. By using secondary resources the pupils can learn about life in a still freshwater habitat and consider how habitats vary within a gravel pit, adaptations to living in different habitats, interactions between plants, animals and environment and feeding adaptations.

They can also design and carry out a fieldwork investigation in a local disused gravel pit, lake or pond and follow this up with the design and execution of individual experiments.

Unit 7c – Environment and feeding relationships
Science year 7
'It's the pits!' – life in a restored gravel pit

Teacher introduction and overview:
The themes explored in 'It's the pits!' are designed to be used in conjunction with the teaching of Unit 7c 'Environment and feeding relationships'.

- Using the 'Virtual Quarry' resource, pupils will learn about a working gravel extraction pit and how this could be restored when the extraction is completed.
- Using secondary resources the pupils will learn about life in a still freshwater habitat and consider
    - how habitats vary within a gravel pit
    - adaptations to living in different habitats
    - interactions between plants, animals and environment
    - feeding adaptations
- they will learn that food chains can be linked to form food webs
- the will consider the options for gravel pit restoration for both biodiversity and safe use by people

Pupils will also be able to design a fieldwork investigation at a local restored gravel pit, or, if one is not available, at a lake or pond, so, in relation to scientific enquiry, students will

- consider the importance of sample size in designing their own investigation
- measure environmental differences between habitats and changes within habitats over a short time (e.g. changes in shallow water temperature in a sunny spot over a few hours)
- survey the variety of living things in the habitat using pond-nets, then investigating feeding adaptations to obtain information to contribute to the construction of food webs
- select a suitable small invertebrate, e.g. the freshwater shrimp, and investigate its activity with relation to an environmental variable, e.g. dissolved oxygen concentration, considering uncontrolled variables, and relating their observations to what was discovered in the field investigation
- prepare a report giving advice on gravel pit restoration both for the benefit of freshwater life and for the minimisation of risks and health & safety hazards to humans.

'It's the pits' provides a stimulating way to fulfil the requirements of Unit 7c in a combination of four lessons (approx. 50 minutes per lesson), one four-hour practical fieldwork session and one practical session in the lab. Using their own data from fieldwork brings ownership and engagement to the work.

Curriculum links:

- ICT (preparation and use of spreadsheets for fieldwork, individual experiments, using dataloggers)
- Citizenship (caring for a restored quarry environment, carrying out risk assessments)
- ESD (the importance of quarry restoration in providing wildlife habitats)
- Numeracy (data collection, handling and interpretation)

Teacher preparation
The teacher in charge must follow the local authority guidelines on setting up a fieldwork visit. Since these vary slightly between authorities they are not outlined here.

Lesson details

Lesson 1:
Building on existing knowledge gained at key Stage 2 (unit 4B – 'Habitats' and unit 6A – 'Interdependence and Adaptation') and bringing in knowledge gained by accompanying parents or friends on fishing trips to old gravel pits.

have any pupils done any freshwater fieldwork? If so, what was involved?
What do pupils know about life in fresh water?

- **what kinds of animals live in or around fresh water (invertebrates, fish, birds, mammals)**
- **what do we know about their feeding habits?**
- **what do we know about their adaptations to life in fresh water (breathing, swimming)**

Setting coursework tasks, perhaps divided among groups of pupils with class presentations in mind:

- access virtual quarry site to look at local (if any) or regional working and restored gravel pits and extraction and restoration methods and to obtain contact information for permission to visit
- access English Nature site for conservation information
- access local Wildlife Trust site for information about local gravel pit reserves

Lesson 2:
Groups are given a short time (clear guidance is needed from the teacher here, but the time will be variable according to how many group presentations there will be) to prepare their presentation. The importance of everyone contributing is stressed.

Each group gives a short presentation of its findings

Presentations
Are there any local working or restored gravel pits? If so,

- how is gravel taken out of the working sites?
- when and how were the restored sites created?
- what special wildlife do they now hold? Are they nature Reserves?
- are they used for any other activities e.g. angling, water sports?
- are any of them suitable for a fieldwork investigation? (The teacher would need to research this beforehand)
- If there are no local pits, a suitable pond or lake can be used.

Lesson 3:
Preparation for the fieldwork investigation

Designing a fieldwork investigation

- setting parameters – what parts of the Unit are we aiming to satisfy?
- how can we sample
    - the invertebrates in the water
    - the water itself? What should we measure? How should we record it?
    - what habitats should we investigate (e.g. open water over a gravel bed, submerged vegetation,, dead leaves)
- how many samples do we need?
- pupils carry out risk assessments themselves –
    - what are the risks and how can they be managed?
    - what are the specific health and safety considerations in old gravel pits?
    - what safety equipment will be needed (e.g. throwing rope, first aid kits)
- what personal kit will we need? Waterproofs, wellies, rubber gloves, disinfectant, lunch
- what kit will the school need to supply? Nets, trays (old ice-cream cartons), sample pots, thermometers, light meters, metre rules, dataloggers, a few buckets to transport chosen invertebrates back to school, aerators

Coursework: designing suitable recording and data collation sheets (ICT – spreadsheets) (example given in appendix 3)

Fieldwork investigation

- On arrival a brief H&S talk is given and the parameters set for the visit (personal behaviour, contributing to the work, care for animals and for the site, litter)
- in small groups pupils examine the site and are asked to discuss what habitats they have seen (as in Lesson 3 above)
- pupils set hypotheses (make predictions) about what they expect to find in terms of environmental factors and numbers/variety of invertebrates I n each chosen habitat
- leader demonstrates sampling methods & reinforces need for scientific rigour
- small groups of pupils sample, identify (using FSC foldout chart) and count freshwater invertebrates
- water plants can be identified using FSC foldout chart
- careful records of invertebrate numbers and environmental measurements* are kept using recording sheets designed by pupils *and dataloggers if available
- if there is a very short interval between the fieldwork and Lesson 5 (e.g. 1-2 days) a sample of each suitable kind of common freshwater invertebrate (water fleas, freshwater shrimps, water hoglice, pond snails, pea-cockles, mayfly nymphs) is put in buckets with a good supply of freshly-collected and agitated (to oxygenate) lake/pond water and some vegetation or dead leaves. If there will be along interval invertebrates will have to be freshly collected just before experiments are carried out.
- recording sheets are collected in for safety

On return to school invertebrates are put in a cool place and an aerator put in each bucket. make sure that predators are kept separate from prey!

Groups of pupils choose an invertebrate to research (internet) and investigate (practical experiment).

Coursework/homework
Pupils are asked to write up the day's work as a scientific investigation, using scientific language, under the headings:

- **Aims** (what we set out to do)
- **Working site** (where we did it) – 6-figure grid reference (including 100km square letters) e.g. TZ 101202
- **Habitats investigated** (reed beds etc,)
- **Hypotheses** (predictions about environmental factors and about invertebrate numbers and variety)
- **Sampling methods and strategies** (how we collected invertebrates – show relevance to hypotheses)

Each group should research their chosen invertebrate; there is a wealth of information on the Internet (**give web site addresses)**

Lesson 4:
Fieldwork follow-up and preparation for experimentation

Follow-up
Each fieldwork group is asked to enter their data into a computer terminal and any datalogger data can also be downloaded. Data summary sheets are now printed and each pupil is given a copy.

Pupils are given 5-10 minutes in groups to prepare a presentation about a particular invertebrate, on such topics as

- feeding adaptations
- seasonal and/or daily changes and invertebrates' adaptations to them
- an example of a food chain (less able pupils) or foodweb based on the invertebrates they have found

Class discussion of the results follows. Pupils should be able to apply their research about their animals to construct hypothetical foodwebs for habitats within the gravel pit, and by looking at differences explain why a variety of habitats is important.

The relationship between food chains and energy transfer in freshwater can be drawn out here.

Preparation for experiments
The welfare of the invertebrates should be checked regularly.

Using the results of research into their chosen invertebrate each group now suggests an investigation into its activity.

Suggestions:

- response of water fleas to light

- response of freshwater shrimps, mayfly nymphs, pond snails to different dissolved oxygen concentrations
- response of freshwater shrimps, mayfly nymphs, pond snails to different water temperatures (5-15°C – no higher!)
- habitat choice of freshwater shrimps and mayfly nymphs

Details of how to set up and carry out these investigations are given in appendix 2: 'Experimental methods'.

Coursework/homework: prepare advice for quarry owners on desirable restoration methods (based on earlier internet research and practical fieldwork experience)

Teacher preparation – if invertebrates could not be kept over from the fieldwork then these will need to be collected just before the lesson.

Lesson 5
Experiments and bringing it all together

Small groups of pupils carry out their investigations and carefully record their observations. They then present their results and may be able to link these to what they found in the field. They are asked to describe how they controlled some variables but were not able to control others.

Finally pupils are asked to pool their ideas on ways in which a restoration programme for a working gravel pit can benefit wildlife by providing a range of habitats.

Gravel pits are often thought to be dangerous places, with steep sides and deep water - how can risks be managed and health and safety considerations be tackled in the restoration?

Unit 7C Environment and feeding relationships (Quarry-linked adapted unit) ‘It’s the pits!’ – life in a restored gravel pit.

Scienc
Year

About the unit

In this unit pupils learn:

- how habitats vary this will be done in the context of restored gravel pits, considering the restoration process and the habitats provided by restored gravel pits.
- how plants and animals are adapted to live in a particular habitat in the context of freshwater - restored gravel pits
- how plants and animals interact with their environment and with each other, including feeding relationships
- about adaptations for feeding
- how to link food chains to make webs

In scientific enquiry pupils:

- consider the importance of sample size
- make measurements of environmental changes and interpret these differences between different habitats in a restored gravel pit
- survey the variety of living things within a habitat
- investigate the activity of a small invertebrate, taking into account variables they cannot control

This unit is expected to take approximately 8 hours. 2 preparatory lessons + secondary research, half day fieldwork, 2 follow-up lessons

Where the unit fits in

This unit draws on ideas developed in the key stage 2 programme of study. It builds on unit 4B ‘Habitats’ (e.g. quarry-linked adapted unit 4b – ‘Herbivore Heaven’ and unit 6A ‘Interdependence and adaptation’ in the key stage 2 scheme of work. It also draws on Geography unit 8 ‘Improving the Environment’ (Quarry-linked adapted unit – ‘Quarry restoration – a haven for wildlife or a haven for people?’

Together, this unit and unit 6A ‘Interdependence and adaptation’ in the key stage 2 scheme of work could be used as a bridging unit.

The unit provides a foundation for unit 8D ‘Ecological relationships’ and for unit 9A ‘Inheritance and selection’.

The energy transfer ideas of unit 7I ‘Energy resources’ are used in considering feeding relationships between organisms. If this unit is covered before unit 7I ‘Energy resources’, then the treatment can be restricted to using the label ‘energy’ for what is transferred. If u 7I ‘Energy resources’ is covered first, then links can be made to the burning of fuels and foods and the Sun as the energy resource for plants.

There are opportunities for pupils to make presentations about, and take measurements in the environment. This links with unit 3 ‘Processing text and images’ [Here secondary sourc (Virtual Quarry web site, English Nature web site, local Wildlife Trust web sites) are consul in the preparatory stages] and unit 7 ‘Measuring physical data’ in the ICT scheme of work [dataloggers and light and oxygen meters can be used to record relevant comparative data which can then be incorporated into spreadsheets/databases].

Expectations

At the end of this unit

in terms of scientific enquiry

most pupils will:

- make a series of measurements of environmental variables appropriate to the tas in a restored gravel pit
- identify a question to investigate about the activity of an invertebrate, suggesting suitable approach and sample size; use their results to relate animal and plant activity to environmental changes using a selected freshwater invertebrate

some pupils will not have made so much progress and will:

- make measurements of environmental variables appropriate to the task in a restor gravel pit
- make suggestions about investigating the activity of an invertebrate using a selected freshwater invertebrate

some pupils will have progressed further and will: describe, in terms of approach and sample size, how strongly any patterns or associations identified are supported by the evidence

in terms of life processes and living things

most pupils will:

- identify differences between different habitats in a restored gravel pit and relate these to the organisms found in them;
- describe ways in which organisms are adapted to daily or seasonal changes in their environment (restored gravel pit) and to their mode of feeding;
- describe food chains within an environment (restored gravel pit) and combine these into food webs

some pupils will not have made so much progress and will:

- identify differences between different habitats and describe how familiar organisms are suited to the habitat in which they are found (restored gravel pit);
- describe some simple food chains in a restored gravel pit

some pupils will have progressed further and will:

- explain why a variety of habitats is needed in a community (restored gravel pit);
- describe how different organisms contribute to the community in which they are found and
- relate food chains to energy transfer in freshwater

Prior learning

It is helpful if pupils:
- know that different habitats support different plants and animals and have identified ways in which plants and animals in a particular habitat depend on each other
- have explored local habitats (restored gravel pits – secondary research via internet, looking at Virtual Quarry site, English Nature site, local Wildlife Trust sites) to establish the variety of living organisms within them
- know that some animals feed on other animals and some feed on plants

Health and safety

Risk assessments are required for any hazardous activity. In this unit pupils:
- plan and carry out their own investigation
- collect and handle small invertebrates
- work in an outside environment

Many employers have specific guidance on fieldwork. Model risk assessments used by most employers for normal science activities can be found in the publications listed in the *Teacher's guide*. Teachers need to follow these as indicated in the guidance notes for the activities, and consider what modifications are needed for individual classroom situations. Owners or managers of restored gravel pits will be able to provide specific advice and risk assessments for their own site but pupils will be able to consider for themselves the risks associated with working in water sites.

Language for learning

Through the activities in this unit pupils will be able to understand, use and spell correctly:
- words and phrases relating to feeding, *eg predator, prey, food web*
- words and phrases relating to seasonal changes, *eg migration, hibernation, overwintering dormant, insulation, climatic stress*
- words and phrases describing environmental conditions, *eg light intensity, availability of oxygen, water temperature, light penetration*
- words with different meanings in scientific and everyday contexts, *eg producer, consume*
- words with similar but distinct meanings, *eg carnivore and predator*
- words relating to scientific enquiry, *eg temperature sensor, sample size, reliable data*

Through the activities pupils could:
- organise, sequence and link what they say so listeners can follow it
- find information from secondary sources using contents, index, glossary, key words or hotlinks (restored gravel pits – secondary research via internet, looking at Virtual Quarry site, English Nature site, local Wildlife Trust sites)
- join ideas within sentences using links of cause (so, because, since)

Resources

Resources include:
- sensor and software for temperature, oxygen, light, pH measurement
- secondary sources, *eg photographs, video clips, preserved and live specimens*, showing predators and prey (Virtual Quarry site, English Nature site, local Wildlife Trust sites)
- pictures showing the range of organisms found in a variety of habitats
- secondary sources providing information about how animals deal with seasonal changes their environment
- secondary sources showing how some plants, *eg holly, nettles, bracken,* have defence mechanisms
- simulation software illustrating changes in populations
- secondary sources, *eg CD-ROMs, videos,* illustrating diets of animals

See appendix 1: resources for fieldwork

Out-of-school learning

Pupils could:
- visit other habitats, *eg nature reserves, nocturnal houses in zoos and nature centres* Lo Wildlife Trust reserves in restored gravel pits
- find out about the feeding requirements of a variety of species of animal
- attend evening or early morning activities, *eg bat watching, snake spotting, moth spottin and listening to the dawn chorus run by country parks, waterways and other organisatio*
- watch wildlife programmes on video and television, read accounts of life in a habitat supporting different plants and animals
- look for plants and animals in their immediate locality, *eg on the way to and from school*
- find out about wildlife conservation projects or ecology centres in their locality Local Wildlife Trust reserves in restored gravel pits
- search the internet for information about habitats and feeding relationships using key words, *eg zoo, food chain, habitat*

Pupils will have the opportunity to learn first-hand in a fieldwork visit to a restored gravel p (or pond/lake if no gravel it is available locally)

LEARNING OBJECTIVES PUPILS SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES PUPILS	POINTS TO NOTE
How does the environment influence the animals and plants living in a habitat?			
• that different habitats within a gravel pit have different features • that different habitats within a gravel pit support different organisms • that the distribution of organisms in different habitats within a gravel pit is affected by environmental factors, *eg light, nutrients or dissolved oxygen availability* • to organise, sequence and link what they say so listeners can follow it	• Lesson 1: Ask pupils about environments or habitats they studied at key stage 2 and explain that in the first part of the work in this unit they are going to look at features of a specific habitat – a restored gravel pit (or, if one is not available, a lake or pond. draw on any experience pupils may have of fishing in a restored gravel pit or lake. • Provide pupils with stimulus material, *e.g. video of a lake, fishermen on a lake.* Ask the pupils to describe the physical features of the habitat and identify major environmental factors, *eg light intensity, dissolved oxygen availability, temperature range*. • With pupils, decide on a limited list of animal and plant species for each habitat within the lake or gravel pit. Remind pupils of the importance of making sure listeners can follow their argument, and ask them, in groups, to use secondary sources to investigate how species are adapted to life in this habitat and to present their findings, *eg orally, using overhead transparencies (OHTs) or flip charts*.	• identify features, *eg light, temperature range, dissolved oxygen concentration*, which are different in different habitats • describe adaptations to life in water, *eg streamlined shapes help animals move through the water, water plants float or have long stems to reach surface waters* • pick out appropriate adaptations and explain clearly their significance • make an oral group presentation of their findings	• This activity is intended to help teachers find out what pupils know about habitats and how organisms are adapted to them. Teachers will need to take this into account in later work. • Pupils may need help to stay focused on the question of adaptations to the habitat and help in selecting appropriate material from a large quantity of general information on the lives of particular plants and animals. • This unit includes work on seasonal changes. It is useful to have a log of species sighted in the school and its surroundings and in any suitable local Wildlife Trust reserve(s). If possible, encourage pupils to note vegetation and other changes in the school environment over the academic year. • Extension: pupils could explore a wider variety of habitats through an interactive field trip or through the English Nature Web site.

LEARNING OBJECTIVES PUPILS SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES PUPILS	POINTS TO NOTE
How do environments vary?			
• that some animals are adapted to daily changes in their habitat • how to measure and record changes in environmental factors in a restored gravel pit, pond or lake • how to interpret patterns in data	• Ask pupils to predict how physical environmental factors in a restored gravel pit, pond or lake, *eg light intensity, temperature, dissolved oxygen concentration,* would change over a 24-hour period and how they could measure the changes. • Ask pupils to suggest how the population of plants and animals in a restored gravel pit, pond or lake would change over the same time. Using their ideas, secondary sources and first-hand observation in the fieldwork investigation, help pupils to generate comparative lists of animals active during the day, at dawn and dusk and those which are nocturnal.	• describe changes in physical environmental factors, *eg temperature, light intensity, dissolved oxygen concentration* over a 24-hour period • interpret data about daily changes and explain in simple terms, *eg beginning to get dark* • relate changes in variables, *eg light and temperature, dissolved oxygen concentration* to each other • relate plant and animal activity to environmental changes	• There is an opportunity to use datalogging equipment.
• how to frame a question to be investigated • how to decide what factors are relevant to a question • about the importance of sample size • to consider results in relation to the sample used	• Using first-hand observations of small in a restored gravel pit, pond or lake, ask pupils to generate a suitable question about how the activity of an invertebrate, *eg freshwater shrimps, mayfly nymphs, pond snails, daphnia,* varies with environmental changes, *eg dissolved oxygen concentration, water temperture, light/dark,* and to plan and carry out an investigation. • Help pupils to produce an account of what they did, focusing on the size of sample they used, the factors they could and could not control and how confident they were in their results.	• identify a suitable question for investigation • identify and control relevant variables • choose an appropriate way of obtaining an adequate sample • explain why they are, or are not, confident in their results, *eg 18 out of 20 times the shrimps remained motionless in the deoxygenated water, I think this is sufficient; we only used 6 water fleas and 4 of them chose the dark, I think we need to use more than 6 water fleas to be sure*	• Extension: pupils could find out about adaptations to daily changes in two or three plant or animal species. • If any animals are brought into the classroom, ensure that they are treated carefully and that they are returned to the habitat from which they came as soon as possible. **Safety** – teachers will need to check pupils' plans for health and safety before practical work begins – wash hands after working in freshwater and handling animals. Particular pupils may have allergies and these should be appropriately taken into account. Wipe benches with disinfectant

LEARNING OBJECTIVES PUPILS SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES PUPILS	POINTS TO NOTE
Checking progress			
• to summarise and make connections between key ideas about adaptation to a habitat	• Provide pupils with a list of adaptive animal and plant characteristics and ask them to decide on the six most important for the freshwater habitat. Ask them to explain their choices and ask others to evaluate these critically, identifying the advantages the adaptation gives the organism. Help pupils to use the results of the work to make generalisations about adaptation.	• identify adaptations for freshwater habitats • explain the advantages adaptations give an organism	
What is a feeding relationship?			
• that animals have features which are adaptations against predators • that animals are adapted to their particular food source • to collect sufficient data to reduce error and obtain reliable evidence	• Review pupils' knowledge of predators and prey by providing stimulus material, *eg posters, photos, pictures, video clips, preserved and live specimens,* of predatory animals and prey species, *eg osprey, pike, great water beetle, water spider, freshwater shrimp, midge larva, pond snail*, and in Lesson 4, asking pupils to describe how the predators are adapted for finding, catching and killing their prey and how prey species are adapted for detecting and avoiding predators. help pupils construct tables of general features of predators and prey, *eg predators may have eyes forward, acute vision and sense of smell, sharp claws/talons/beaks for piercing and tearing, may ambush or hunt by stealth, whereas prey may have eyes at the side, acute hearing and sense of smell, be easily startled, be nocturnal, camouflaged.*	• identify predators and prey from information about commonly encountered animals • identify features of predators, *eg a hooked beak, sharp claws, acute vision, ability to trap prey* • identify features of prey animals, *eg camouflage, acute senses, armour, speed* • state how many observations they made and explain why this was appropriate	• Nature centres, botanical gardens and zoological collections may have outreach teachers who can bring a selection of plants and animals into schools to illustrate adaptations to habitat and food source. In addition, they often have education programmes to support visits to their establishments. • Alternatively, pupils could use dough coloured with food dyes, or red and green wool, distributed on a marked-off stretch of grass to investigate the effectiveness of camouflage. **Safety** – wash hands after working in freshwater and handling animals. Particular pupils may have allergies and these should be taken into account. Wipe benches with disinfectant

LEARNING OBJECTIVES PUPILS SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES PUPILS	POINTS TO NOTE
What is a feeding relationship? (Cont.)			
• about characteristics of predator and prey species • to join ideas within sentences using links of cause, *eg so, because, since* • that all the organisms in a habitat can be linked together in food webs • that food webs are made up of a number of food chains which start with plants • that arrows in a food chain represent energy transfer	• In lesson 1, Establish by quick questions pupils' understanding from work in key stage 2 of terms related to food chains, *eg producer, consumer*. • Present pupils with stimulus material, *eg a habitat poster of a pond or l ake*, and challenge them, using information from the fieldwork visit, to make as many food chains as they can. Ask them to identify producers, consumers, herbivores and carnivores. Explain the direction of the arrows in the food chain and relate to energy transfer, with the Sun as the ultimate source of energy. Ask pupils to write a sentence about each food chain, using links of cause, *eg so, because, since*. • Ask pupils to find examples of animals that occur in more than one food chain and to explain what this shows about their food sources. Show pupils a food web and explain that it is a more accurate representation of feeding relationships. • Help pupils use the food chains they have generated to construct a food web display for each habitat investigated in the fieldwork. Show that some species are common to two or more habitats, and that the foosdwebs are therefore linked as part of the whole system. • Establish with pupils that food webs, food chains and terms, *eg predator* and *prey* are ways of describing feeding relationships.	• sort organisms into a food chain • explain what is meant by, and identify, carnivore, herbivore, consumer, producer • identify food chains within food webs and describe what a food web shows • explain the direction of arrows in a food chain, *eg energy from the leaves passes to the caterpillar*	• In unit 7I 'Energy resources', the idea that food chains show energy transfer is introduced. • Food chains may also start with bacteria or fungi. However, at this stage it is acceptable for pupils to be taught that food chains begin with plants. • Pupils do not need to be familiar with the term 'trophic level' at this stage. • Extension: pupils could be asked to find out about different predators and prey – especially those which are able to avoid capture, such as fish, birds and mammals inhabiting the gavel pit, lake or pond, and produce an account of how one of each is adapted.

LEARNING OBJECTIVES PUPILS SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES PUPILS	POINTS TO NOTE
What do food webs tell us?			
• to make careful observations of plants and animals and sources of evidence about animals' food • to link organisms together in food webs • that some plants have adaptations to deter animals from feeding on them • to interpret evidence about food sources and draw conclusions from it	• Ask pupils to suggest likely places to find plants and animals in the locality of the school, what species they think they might find and how the plants and animals might be linked in food webs. Encourage pupils to consider what evidence we use to find out what animals eat, *eg owl pellets, remains near lairs and nests, thrush anvils, observations, teeth marks, bird droppings showing coloured berries have been eaten.* • Show pupils how to use simple equipment and techniques, *eg direct observation, pond-nets during their fieldwork*. • Ask pupils to record any observations which help to identify a food source, *eg holes in water plant leaves, decaying dead leaves on the bottom of the gravel pit/pond/lake. Help them to understand that with freshwater invertebrates this may be difficult and could involve examination of gut contents; but that this would involve killing the animals so will not be done!* • Help the pupils to use the information gathered in their fieldwork to construct a database using a data-handling programme.	• identify plants and animals found in the fieldwork site, using a simple key, eg. the Freshwater Name Trail • state, using their first-hand experience, that a wide variety of organisms is found in quite small habitats • describe and explain what might provide evidence about animals' food • identify features of plants which may deter animals from feeding on them • interpret evidence about food sources, *eg the bird droppings are purple, so they could have eaten blackberries*	• This exercise can be done in very small-scale habitats, *eg flower bed, grass verge*. It needs to be clear that the focus of the activities is identification of food webs, because pupils may have visited an area local to their school in key stage 2 to identify organisms, using keys, and to identify food chains. • Pupils are likely to be familiar with using keys to identify living things from their work at key stage 2. Some may need more practice. • It is not necessary to quantify species at this stage, but it may be useful to count the number of species identified and the number of individuals of different feeding types for possible use in year 8. • If any animals are brought into the classroom, ensure that they are treated with respect, their needs are met and that they are returned to their habitat as soon as possible. **Safety** – all off-site visits must be carried out in accordance with school/LEA guidelines – pupils should wash and disinfect their hands after freshwater work and handling animals. Particular pupils may have allergies and these should be taken into account.

LEARNING OBJECTIVES PUPILS SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES PUPILS	POINTS TO NOTE
What do food webs tell us? (Cont.)			
• that all the organisms in a habitat can be linked together in food webs • to find information using contents, index, glossary, key words or hotlinks	• Provide pupils with secondary sources, *eg reference books, CD-ROMs, databases,* to find information about the diet of animals identified in the previous activity, and remind them how to use the index, contents section, key words and hotlinks. Ask them to add the information to the database. Ask them to use the information to construct food chains using the species identified in their fieldwork, and to describe what the food chains show. Help the pupils to link their food chains together into a food web. Challenge the pupils to explain any missing links, *eg absence of carnivores, such as fish or birds which will avoid capture during fieldwork.* Help pupils to produce a display of their food web(s).	• use organisational features of text to identify relevant information about the diet of animals • place food chains within a food web • describe how all the organisms in a habitat can be linked together in food webs • sequence a food chain • recognise that arrows in a food web or food chain show the direction of energy flow	• Pupils may need reminding that food webs are the focus of the activity, as they may have found out about the food source of a local animal in key stage 2. • Pupils often have difficulty with the idea that arrows in a food chain represent energy flow. This could be reinforced here.
• that factors influencing the number of organisms in one part of a food web have an effect on other parts of the web	• Challenge pupils to suggest where there is competition between species in the food web. Reinforce their ideas by removing a plant species or adding two or more consumers and ask the pupils to predict the consequences. • Extend the work by asking pupils to use food webs, *eg those generated in previous activities,* to practise predicting the effects of altering the numbers of various organisms in a web. Use ICT simulations to test out the predictions made.	• predict the effects of altering the numbers of an organism in one part of a food web • recognise that organisms living in a habitat compete with each other for food resources • recognise the importance of plants as the food source at the start of all food chains	• This activity provides opportunities to use ICT simulations.
Reviewing work			
• that organisms in a habitat compete for resources from the environment	• Construct a paper and wool model of a food web identified in the previous activity. Remove one animal species – for example water fleas or freshwater shrimps - from the web, *eg by cutting the strands of wool holding it in place.* Ask the pupils what will happen to the animals that feed on that species. Challenge pupils to identify any other effects on the food web. • Extend by providing pupils with a food web in which at least one animal –	• predict and explain the consequences of changes in the organisms making up a food web	• If the food webs generated earlier are very complex, it may be better to simplify them for this activity. • As an alternative, pupils could be given copies of a food web generated earlier, with an animal blanked out.

LEARNING OBJECTIVES PUPILS SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES PUPILS	POINTS TO NOTE
	e.g. Mayfly nymph, which is often present over the winter and early spring months, but as concealed eggs throughout the summer, is a seasonal visitor and asking them to identify differences in the food web in other seasons.		

Lesson 1:

Building on existing knowledge gained at key Stage 2 (unit 4B – 'Habitats' and unit 6A – 'Interdependence and Adaptation') and bringing in knowledge gained by accompanying parents or friends on fishing trips to old gravel pits.

have any pupils done any freshwater fieldwork? If so, what was involved?
What do pupils know about life in fresh water?

- **what kinds of animals live in or around fresh water (invertebrates, fish, birds, mammals)**
- **what do we know about their feeding habits?**
- **what do we know about their adaptations to life in fresh water (breathing, swimming)**

Setting coursework tasks, perhaps divided among groups of pupils with class presentations in mind:

- access virtual quarry site to look at local (if any) or regional working and restored gravel pits and extraction and restoration methods and to obtain contact information for permission to visit
- access English Nature site for conservation information
- access local Wildlife Trust site for information about local gravel pit reserves

Lesson 1 resources for coursework

- access virtual quarry site to look at local (if any) or regional working and restored gravel pits and extraction and restoration methods and to obtain contact information for permission to visit
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Lesson 2:

Groups are given a short time (clear guidance is needed from the teacher here, but the time will be variable according to how many group presentations there will be) to prepare their presentation. The importance of everyone contributing is stressed.

Each group gives a short presentation of its findings

Presentations

Are there any local working or restored gravel pits? If so,

- how is gravel taken out of the working sites?
- when and how were the restored sites created?
- what special wildlife do they now hold? Are they nature Reserves?
- are they used for any other activities e.g. angling, water sports?
- are any of them suitable for a fieldwork investigation? (The teacher would need to research this beforehand)
- If there are no local pits, a suitable pond or lake can be used.

Lesson 2 resources:

ICT:

internet access to QPA web site
computers with page layout software, PowerPoint

Flipcharts and pens for poster presentations

Lesson 3:

Preparation for the fieldwork investigation

Designing a fieldwork investigation

- setting parameters – what parts of the Unit are we aiming to satisfy?
- how can we sample
    - the invertebrates in the water
    - the water itself? What should we measure? How should we record it?
    - what habitats should we investigate (e.g. open water over a gravel bed, submerged vegetation,, dead leaves)
- how many samples do we need?
- pupils carry out risk assessments themselves –
    - what are the risks and how can they be managed?
    - what are the specific health and safety considerations in old gravel pits?
    - what safety equipment will be needed (e.g. throwing rope, first aid kits)
- what personal kit will we need? Waterproofs, wellies, rubber gloves, disinfectant, lunch
- what kit will the school need to supply? Nets, trays (old ice-cream cartons), sample pots, thermometers, light meters, metre rules, dataloggers, a few buckets to transport chosen invertebrates back to school, aerators

Coursework: designing suitable recording and data collation sheets (ICT – spreadsheets) (example given in appendix 3)

Lesson 4:
Fieldwork follow-up and preparation for experiments

Follow-up
Ask each fieldwork group to enter their data into a computer terminal and any datalogger data can also be downloaded. Data summary sheets are now printed and each pupil is given a copy.

Give pupils 5-10 minutes in groups to prepare a presentation about a particular invertebrate, on such topics as

- feeding adaptations
- seasonal and/or daily changes and invertebrates' adaptations to them
- an example of a food chain (less able pupils) or foodweb based on the invertebrates they have found

Class discussion of the results follows. Pupils should be able to apply their research about their animals to construct hypothetical foodwebs for habitats within the gravel pit, and by looking at differences explain why a variety of habitats is important.

The relationship between food chains and energy transfer in freshwater can be drawn out here.

Preparation for experiments
The welfare of the invertebrates should be checked regularly.

Using the results of research into their chosen invertebrate each group now suggests an investigation into its activity.

Suggestions:

- response of water fleas to light
- response of freshwater shrimps, mayfly nymphs, pond snails to different dissolved oxygen concentrations
- response of freshwater shrimps, mayfly nymphs, pond snails to different water temperatures (5-15°C – no higher!)
- habitat choice of freshwater shrimps and mayfly nymphs

Details of how to set up and carry out these investigations are given in appendix 2: 'Experimental methods'.

Coursework/homework: prepare advice for quarry owners on desirable restoration methods (based on earlier internet research and practical fieldwork experience)

Teacher preparation – if invertebrates could not be kept over from the fieldwork then these will need to be collected just before the lesson.

Lesson 4 resources

computer network ideally with terminal for each fieldwork group
Shared data summary sheets in Excel
Printer

Group no. 1

Freshwater invertebrate class data entry sheet

Name of animal	Numbers caught
Flatworm	
True worm	
Leeches	
Snails	
Pea cockles	
Swan mussels	
Dragonfly nymph	
Water hoglouse	
Freshwater shrimp	
Water mite	
Swimming Mayfly nymph	
Demoiselle nymphs	
Other Damsel Fly nymphs	
Dragonfly nymphs	
Stonefly nymphs	
Water Measurer	
Pond Skater	
Water Scorpion	
Greater Water Boatmen	
Lesser Water Boatmen	
Alder Fly larva	
Caseless Caddis larvae	
Cased Caddis Larvae	

Water Beetles	
Cranefly Larvae	
Rat-tailed Maggot	
Black Fly Larvae	
Non-biting Midge larvae	

Environmental measurements	
Average water depth in habitat (mm)	

	Measurement at (time)					
Water temperature °C						
Dissolved oxygen concentration mg/l						

Lesson 5

Experiments and bringing it all together

Small groups of pupils carry out their investigations and carefully record their observations. They then present their results and may be able to link these to what they found in the field. They are asked to describe how they controlled some variables but were not able to control others.

Finally pupils are asked to pool their ideas on ways in which a restoration programme for a working gravel pit can benefit wildlife by providing a range of habitats.

Gravel pits are often thought to be dangerous places, with steep sides and deep water - how can risks be managed and health and safety considerations be tackled in the restoration?

Experimental equipment and methods for lesson 5

Introduction

General – the animals

- **remember that the welfare of the invertebrates is important!**
- **never use the same individual animals for more than one experiment**
- **always put 'used' animals intoa bucket with some suitable 'habitat' material and an aerator**
- **release all animals as soon as possible after experiments have ended**

The experiments – good science

- **don't forget that pupils need to make predictions**
- **methods should allow them to test those predictions**
- **observations should also allow them to test the predictions**
- **pupils need to design suitable recording sheets**
- **they need to record at the correct times**
- **they need to interpret their results, test their predictions and draw conclusions**
- **the experiments should be evaluated**

Experiments

1. Response of water fleas to light

Equipment needed:

- bench lamp
- plastic sorting tray
- rainwater (not tap water)
- stop watch
- 2 clipboards
- Recording sheet
- pencils

Method

20 water fleas are placed randomly in a dish. This is then half covered by a clipboard and the uncovered half lit by a bench lamp (not too close).

The number of fleas in the light half is counted every 2 minutes for 20 minutes.

Results can be graphed as line graphs.

Does the proportion change over time?

2. **response of freshwater shrimps, mayfly nymphs or pond snails to different dissolved oxygen concentrations**

Equipment needed

- rainwater (not tap water) – 10 litres minimum
- 10 small clear plastic screw top bottles (30ml – 100ml but all the same size)
- stop watch
- clipboard
- Recording sheet
- pencils

Method

teacher preparation – don't let pupils do this!

Half the water is boiled for 10 minutes to drive off all the dissolved oxygen. The boiled water is carefully poured into strong airtight containers and allowed to cool – ideally to 8 – 10 °C. This cold water now has little or no oxygen dissolved in it.

Pupils can be involved from now on

The other half of the water is placed in a large open container and vigorously stirred **just before the experiment starts**. It should be at the same temperature as the deoxygenated water **(why?)**

5 of the bottles are carefully two-thirds filled with the deoxygenated water – avoid any splashing or bubbling.

In each bottle put 5 of the invertebrate being studied, i.e.

- freshwater shrimps
- mayfly nymphs
- pond snails

Observe carefully for 20 minutes and note down what is happening every 2 minutes.

Hints:

- **freshwater shrimps** swim around in oxygenated water but tend to keep still in deoxygenated water. However they move their 'ventilating legs' in deoxygenated water in order to pass more water over the gills
- **mayfly nymphs** have plate-like or feathery gills down the sides of their abdomen and these are moved faster in deoxygenated conditions. Like shrimps they move around more in oxygenated water.

- although **pond snails** have a lung they can also absorb oxygen through the body surface especially in cool oxygenated water. In deoxygenated water they may come to the surface more often to breathe atmospheric air.

3. **Response of freshwater shrimps, mayfly nymphs, pond snails to different water temperatures (5-15°C – no higher!)**

Equipment needed

- rainwater (not tap water) – 10 litres minimum
- 5 x 500ml beakers
- stop watch
- clipboard
- Recording sheet
- pencils

Method

The experiment is repeated 3 times with water at different temperatures – for example 5°C, 10°C, 15°C – **no higher than 15°C.**

In each case

- the water is thoroughly stirred and frothed in a half-full bucket to ensure thorough oxygenation **(why?)**.
- 5 beakers are filled to the same level (about half-full) with water and 5 animals put into each. Observations are made every minute for 5 minutes.
- At the end of 5 minutes the invertebrates and water are put in a bucket with an aerator and the experiment is repeated with **fresh animals** in water of a different temperature.

4. **habitat choice of freshwater shrimps and mayfly nymphs**

Equipment needed

- rainwater (not tap water) – 10 litres minimum
- 5 shallow freezer containers
- sand, gravel and dead leaves (beech or oak are ideal) all thoroughly washed with rainwater
- stop watch
- clipboard
- Recording sheet
- pencils

Method

Place sand, gravel and dead leaves in equal bands in each tray and very slowly fill with thoroughly oxygenated cold rainwater (best to pour the water into the gravel area as this causes least disturbance).

When the water has more or less cleared introduce 3 of the chosen animal into each of the 'habitats'. Record where the animals are every 2 minutes for 20 minutes.

Coursework/homework
Ask pupils to write up the day's work as a scientific investigation, using scientific language, under the headings:

- **Aims** (what we set out to do)
- **Working site** (where we did it) – 6-figure grid reference (including 100km square letters) e.g. TZ 101202
- **Habitats investigated** (reed beds etc,)
- **Hypotheses** (predictions about environmental factors and about invertebrate numbers and variety)
- **Sampling methods and strategies** (how we collected invertebrates – show relevance to hypotheses)

Each group should research their chosen invertebrate; there is a wealth of information on the Internet

Web resources for coursework

there is a great deal of information available on the **Field Studies Council's** Freshwater website:
http://www.lifeinfreshwater.org.uk/Species%20Pages/Intro%20Pages/Species.html