Woodland Management on Harpenden Common

A Key Stage 4 Science Activity

HARPENDEN TOWN COUNCIL
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Introduction to Key Stage 4 Woodland studies

Thousands of years ago, before humans impacted on the landscape, Harpenden Common was part of a vast area of woodland, dominated by Oak trees. When humans arrived and colonised the area, the first settlers used the trees for timber and firewood and fed the foliage to their livestock, then cultivated, or attempted to cultivate the cleared areas for growing crops.

Areas of infertile soil, unsuitable for growing crops, were often used as common grazing land, supporting a mixture of heath and acid grassland rich in wildlife. Regular grazing prevented invasion by trees and shrubs and so the open areas were maintained.

Today, some of these areas remain as commons and parklands, but the vast majority have been developed for housing, industrial sites or mineral extraction, converted into sports pitches and other amenity grasslands, or they have been unmanaged and allowed to develop into scrub and woodland, as has happened to some extent on Harpenden Common and many other sites in southern England.

Current management of the woodland on the Common is based on selective thinning (removal of weak or damaged trees), which allows light to reach the woodland floor and encourages greater diversity of plants and therefore of the invertebrate animals which are dependent on them.

Neglect of the woodland would lead to the shading out of ground vegetation species and an eventual reduction in diversity.

An investigation into the effects of management by selective thinning will help in teaching ideas about:

- recording plant and invertebrate abundance using random sampling with gridded quadrats for plants and plain quadrats for animals
- the importance of light to ground plants
- the effects of thinning management on biodiversity
- the importance of leaf-litter invertebrates in recycling mineral nutrients
- foodwebs in woodland leaf-litter ecosystems
- interdependence between plants and animals
- measurement of environmental variables e.g. light at ground level, wind at ground level, soil pH, soil infiltration, tree canopy cover

The investigation can be used to build on fieldwork experience at Key Stage 3 (see Footpath Trampling on Harpenden Common's Acid Grassland) and forms a good introduction to woodland conservation management at Key Stage 4.

Key Stage 4 Science:

Woodland management on Harpenden Common: curriculum relevance.

Knowledge, skills and understanding: 1a,b; 2a,b,c,d; 3a,b,c.

Breadth of study: 5a,b; 8a.

EXPECTATIONS FROM THE MODULE. At the end of this module pupils should:	
Understand how to research and use existing scientific knowledge	By using library facilities and internet research to access previous work on woodlands
Be able to decide on the appropriate use of first-hand observations or secondary sources	By looking at what is known about a suitable local site (information on local woodlands; Local Wildlife Trust and Woodland Trust websites) and deciding what further information is needed
Understand how to set up, carry out and interpret a pilot study	By visiting a local woodland site (real or virtual) and considering key factors and setting testable hypotheses
Be able to design and produce suitable recording and analysis sheets with appropriate levels of precision	Using Information and Communication Technology (ICT) facilities with the help and support of both Biology and ICT staff or downloading suitable worksheets from Harpenden Town Council website – www.harpenden.gov.uk
Be able to design and produce fieldwork equipment – e.g. quadrats and canopy cover tubes	Using Design and Technology (DT) facilities with the help and support of both Biology and DT staff
Use this and other equipment appropriately and safely, recording to appropriate levels of precision	After carrying out risk assessments and deciding on appropriate precision level for the different recordings (see resource sheets)
Decide on how to present observations	Using appropriate methods to show in the clearest way possible differences, similarities and relationships between data sets
Evaluate their own results	In the light of their own original hypotheses and scientific knowledge, considering anomalous data and the quantity and reliability of their own data

Suggest improvements to methods and design further investigations	Looking at the problems they encountered, any 'quick fix' solutions employed, and any other information which would be useful
Comment on the management methods being used in the woodlands which has been investigated and on the sustainability of the woodlands	Suggesting any management changes which would improve woodland ecosystems Commenting on the sustainability of the activities which they have carried out – i.e. trampling while working, collecting invertebrates

Follow-up work focuses on the use of the pupils' own data to relate to ecological theory and to use their results to demonstrate

- adaptation and competition
- the effects of different canopy regimes on photosynthesis
- the role of ground vegetation and trees in nutrient uptake
- the development of the idea of pyramids of numbers (which in woodland can be inverted with one tree supporting thousands of herbivores) into pyramids of biomass
- the importance of considering seasonal variation and the whole year cycle
- the importance of detritivores (comminution) in assisting microorganisms in their ecological role as decomposers

WHERE THE MODULE FITS IN	**CURRICULUM LINKS**
Following the National Curriculum at Key Stage 4, the following areas will be addressed: • Use of scientific knowledge • Decisions on use of first-hand observations or secondary sources • Pilot study • Consideration of key factors • Setting testable hypotheses (making predictions) • Sampling strategy and sample size • Safely and appropriately using a wide range of equipment • Making and recording reliable observations and measurements • Assessing reliability levels • Data presentation • Accurate calculations • Evaluating original hypotheses • Using scientific knowledge to explain and interpret	• numeracy, literacy • information and communication technology, design technology • chemistry • citizenship **KEY THEMES** • how does woodland regeneration affect adaptation and competition? • sustainability of the woodland • photosynthesis and nutrient uptake • pyramids of biomass and energy transfer • role of detritivores and microorganisms

• Considering anomalous data and reliability of data • Do we have sufficient evidence? • Suggest improvements to methods and ideas for further investigations	

Why use Harpenden Common?

- Woodland management methods used on the Common include thinning out the understorey, which allows more light into the ground layer;
- this gives an opportunity to investigate whether there are differences in ground vegetation and leaf-litter invertebrates in unthinned and thinned areas.

Preparation – site selection

The teacher should select two suitable sites on the Common, at either Bamville Wood or St Johns Wood (please contact Harpenden Town Council for advice). Ideally two adjacent areas of woodland, one thinned and one unthinned, are chosen. If possible aspect, altitude, geology and soils should be as similar as possible to minimise unwanted variables. Risk assessments must be carried out and the investigation should be fully costed (coach transport etc.) and all necessary permissions obtained.

Leaves from the trees and ground plants can be scanned to produce identification aids – printed at about life-size. Named and laminated, they will be very helpful. Alternatively resource sheets can be downloaded from the Harpenden Town Council website.

The lessons and practical sessions

The unit comprises five sections (four class sessions, one practical session in the field and one practical/class session) supported by homework/personal research.

Resources –requirements and sourcing

These are outlined on downloadable resource sheets

Classroom and practical sessions: lesson plans

Classroom session 1: introduction

In the first lesson the pupils are asked to tell the teacher what they already know about:	• food webs • pyramids of numbers • energy transfer • adaptation and competition
Pupils are then told that practical work will be carried out in the form of an investigation into parts of a local woodland.	• Maps showing the site are projected or handed out • Pupils are initially asked to research the chosen site using secondary sources • Information is needed on the age of the woodland, trees and other plants recorded, soil and underlying geology, local climate. Secondary data (internet – English Nature or local Wildlife trust, Geological Survey maps, Met Office). • Ideally groups of pupils choose a specific topic to research

Coursework/homework: sustainability of the woodland management methods

By asking the questions below pupils will be able to	• Decide on the appropriate use of first-hand observations or secondary sources • Research and use existing scientific knowledge • Decide whether the woodland management on Harpenden is Common sustainable
Questions to ask • should the woodland be allowed to grow naturally or should it be managed? Why? consider costs and benefits of the alternatives • is the management appropriate? Will current management lead to an increase in diversity? – secondary data (internet – English Nature or local Wildlife trust). • is the woodland large enough? – secondary data (internet – English Nature or local Wildlife trust). • what effects will our investigations have on the woodland? (trampling, removal of invertebrates). Will they affect the sustainability of the woodland?	

Classroom session 2: presentation of pupils' research, preparation for fieldwork

Pupils are asked to consider what happens as woodland grows up.	• how does woodland management affect adaptation and competition? • what happens to the trees? How do they affect the soil and climate of the woodland as they grow up? • what effect will this have on the ground plants and on invertebrates? What adaptations might be successful?
Pupils decide on what will be investigated	• what further information is needed? Can it be gained from secondary sources or is practical investigation needed? • preparation for pilot study – instructions on what to bring (lunch, suitable clothing, notebooks & pencils, digital cameras etc,) • equipment: If equipment is not readily available, discussions with the Design Technology department may give opportunities for pupils to make the necessary items such as gridded quadrats and canopy cover tubes. • Recording sheets can now be designed. These can be as simple as a series of pictures with boxes next to them or more sophisticated Excel spreadsheets. Levels of precision can be considered here – they will be different for e.g. tree height (cm) and soil depth (mm).

Practical session (fieldwork)

Pupils carry out a pilot study which involves:	• looking at an area just outside the working area and to try to match the plants they see and the animals they find with the picture sheets and Field Studies Council guides. A few minutes spent doing this will dramatically increase the reliability of recording! • setting up initial predictions (e.g 'there are more plants in area 1 than in area 2'; 'there is more light reaching the ground in area 1'; 'there is more leaf litter on the ground in area 2'; 'there are more invertebrates in the litter in area 2'; 'the soil will be different in the 2 areas' etc. • decisions on how to sample trees, ground vegetation and invertebrates – sample area, sampling strategy (random or systematic) and methods (quadrats – plain, gridded for plants, counting trees, volume samples for invertebrates in leaf litter; ways of measuring light) – (See Appendices) if the work is being compared with secondary data then the same strategies and methods should be used • a very brief pilot sample from each area • careful collection of whole leaves from each tree and ground plant species.

Pupils then:	• recap on the pilot study and secondary data • look at the predictions made during the pilot study and turn them into testable hypotheses.

Discussion might include:	• 'there are more plants in area 1 than in area 2', 'there are more invertebrates in the litter in area 2'
	  ▪ do we mean 'more individuals' or 'more kinds' or both?
	• 'there is more light reaching the ground in area 1'
	  ▪ this is already a testable hypothesis
	• 'there is more leaf litter on the ground in area 2'
	  ▪ what do we mean by 'more'? is it deeper, denser?
	• 'the soil will be different in the 2 areas'
	  ▪ what do we mean by 'different'? is it deeper in one area, more acid in one area?

Pupils then suggest, and agree on, hypotheses – trees, plants, ground vegetation, invertebrates: for example	1. there will be more trees in area 1 (the younger area) 2. the trees in area 1 will be smaller 3. less light will reach the ground in area 2 (the older area) 4. there will be more kinds of ground plants in the younger area 5. there will be more leaf litter in area 2 (the older area) 6. there will be more kinds of invertebrates in the litter in area 2 (the older area) **7.** the soil will be more acidic (the pH will be lower) in area 2 (the older area).

Working areas, sampling strategies and sampling methods which will test these hypotheses and suitable equipment are discussed, e.g.:	• working areas: need to be large enough to reduce impact but far enough from woodland margins, rides or footpaths to avoid 'edge effects'
	• strategies: random sampling gives least bias and fairest comparisons for ground vegetation, soil and invertebrates but trees are best counted and measured individually. Random number tables are needed; the random numbers should include zero and should be in increments which are the size of the gridded quadrat. For example, if the quadrat is 0.5m x 0.5m and the working area is 10m x 10m, then the numbers should include 0, 0.5, 1, 1.5, 2 …… 8.5, 9, 9.5
	• sampling methods:
	  • **trees**: count all trees and measure them. How do we measure trees? Simple clinometer, measure along a slope (see Appendices)
	  • **light:** 'canopy cover tubes'* to record canopy cover on a simple scale:
	  1. 0 = no branches or leaves visible
	  2. 1 = up to ¼ of the grid occupied by branches or leaves
	  3. 2 = ¼ - ½ of the grid occupied by branches or leaves
	  4. 3 = ½ – ¾ of the grid occupied by branches or leaves
	  5. 4 = more than ¾ of the grid occupied by branches or leaves
	  • **Ground plants**: gridded quadrat 500 x 500mm, subdivided into 25 equal squares; record number of squares in the quadrat containing each plant species
	  • **soil:** soil pins (charity shop knitting-needles!) to measure depth, soil pH kits to measure acidity
	  • **invertebrates**: after recording the plants in the gridded quadrat remove it and put all the leaf litter from the quadrat in a large labelled polythene bag.

*Canopy cover tubes, while not as sophisticated as light meters, are not expensive and do give as much useful information about light levels reaching the ground. If light meters are to be used it is necessary to obtain a matched pair of readings for each quadrat – one reading right out in the open (to give a reference point) and one at the quadrat position. Light at the quadrat position is then expressed as a % of the light in the open. Obviously there has to be a totally open area close by for this method to be practical.

Health and safety

- Safe use of equipment can be considered – it is not only non-random but also dangerous to throw gridded quadrats around. If ranging poles are to be used to mark out the corners of the working area then they are not to be used as javelins! Canes should have an inverted filmpot on the top to avoid potential eye damage. Care should be taken when walking through woodland to avoid tripping over roots or allowing low branches to whip back. Leaving litter is not a sustainable activity!
- Ideally there should be one member of staff per 8 pupils at the most and if suitably CRB cleared parent volunteers are available then 1:4 is ideal.

Fieldwork procedures

Each group writes their group number and the names of the recorders on their recording sheets before starting work. The class is then asked to carry out the recording of plants, soil pH, light levels and collection of leaf-litter invertebrates in a specific order:	• The first quadrat position is found using a pair of random coordinates (e.g. 1.5, 4) (see appendix). One member walks 1.5m up one side of the area while another walks 4m up the adjacent side. They then walk into the area and they meet at the sampling position. • The gridded quadrat is placed on the ground and for each plant species (the list may be complete, or selective, depending on the number of species present) the number of squares (out of 25) in which it occurs is noted. 1. The number of different kinds of plant in the total area of the quadrat is noted. 2. The leaf litter and surface soil within the area of the quadrat is carefully examined and the presence of different layers (if any) noted – are there differences in colour, degree of leaf brakdown? 3. The leaf litter and surface soil from within the area of the quadrat is put into a labelled plastic bag which is then sealed and kept in the shade. 4. The pH of the surface soil is measured and recorded. 5. One member of the group stands in the centre of the quadrat position (after removing the quadrat) and looks vertically upwards through the canopy cover tube. Canopy cover is scored.

Recording (continued)	• The total number of quadrats put down for plant recording should ideally cover 1 – 2% of the sample plot; i.e. in a 10m x 10m plot an area of 1 – 2 square metres (4 – 8 quadrats of 50 x 50 cm) but probably a minimum of 16 is needed to emphasise the need for reliable data. • For leaf-litter samples one bag per group from each of the 2 areas is as much as can be examined in a reasonable time. • When all the quadrats have been completed the whole group is lined up along one edge of the area and tree recording begins. A small group of pupils is assigned to help identify the trees and one is designated as recorder. The group advances across the area; each time a pupil comes into contact with a tree he or she shouts 'stop' and the tree is identified and tallied. • Trees are then measured as accurately as possible using the most suitable method available (see appendix). • Ideally invertebrates should be identified and counted (careful handling) as soon as possible after capture, then released on site. They should be kept in the shade while awaiting examination.

Handling and returning invertebrates – care and sustainability

It is critically important to handle invertebrates carefully and to return them to the place where they were found. They are fragile and slow-growing; careless handling and drying out will kill them and repeated removal will dramatically reduce populations; for example Pill millipedes need 10 -11 years to reach maturity and to reproduce! Not only will depletion affect the results of future fieldwork, it will also dramatically affect the woodland ecosystem!

Weighing invertebrates is not recommended, even though pyramids of biomass will be discussed later. Weighing is stressful and damaging to most invertebrates!

Leaving the site

Equipment is carefully checked back in and a litter sweep carried out. On return to the classroom, recording sheets are collected in for safe keeping. Before leaving pupils are asked to think about ways of collating presenting their findings

Classroom session 3/practical

Data collation and presentation	• hand data sheets back • pupils enter data into prepared spreadsheets • after auditing, printouts of all results are given to pupils • groups of pupils are allocated different sections of the data and asked to prepare displays which help to decide whether to accept or reject each hypothesis

Data collation and presentation is best done using networked spreadsheets designed by members of the group but examples are provided (appendices). Each spreadsheet should contain a summary sheet which can be accessed and a suitable chart type or types discussed

Preparing the presentations Pupils can be asked to work in small groups preparing 5-minute presentations of different sections of the results (plant abundance, species richness, number of trees, soil pH, leaf-litter invertebrates) and interpreting them, relating the results to the original hypotheses and suggesting improvements to the way the work was carried out	• decide who will present what (ideally each member of the group should have a specific task) and then prepare the presentation in which they:- ▪ outline the topic they have investigated ▪ restate the original hypothesis ▪ summarise the sampling method(s) ▪ summarise the results, with simple data tables and charts as appropriate ▪ draw conclusions about their results ▪ state whether the results fit in with the original hypothesis ▪ say what sources they have used in preparing the work (books, web sites, acknowledgements of personal help) ▪ suggest refinements of methods ▪ suggest follow-up work (e.g. looking at light penetration at other times of year)

Coursework/homework

- internet research on individual species and their adaptations
- preparation of presentation by each group - who will say what

Classroom session 4: summing it all up

This begins with a brief (5 minute maximum) presentation by each group as above.
Then the teacher looks at the class results as a whole, discussing any differences between sites and the possible reasons for them, and looking at pyramids of numbers. However it becomes obvious that there are far more consumers than producers – there are not many ground plants and trees, but probably hundreds of invertebrates - and this leads to the idea that pyramids of biomass are a better reflection of an ecosystem (but practically impossible because of the damage which will be caused to the system).

Seasonal variation can also be considered – many species are absent at the time of sampling – and the fact that the tree canopy was not sampled is brought out. Also, what about birds and mammals? They are rarely seen, let alone sampled!

Discussion points should include:	• adaptations of woodland plants to low light regimes, e.g. storage of resources in a bulb (Bluebell) or rhizome (Dog's mercury, Bracken) to enable the plant to grow and mature before the tree canopy forms • light - the reasons for using canopy cover tubes rather than light meters, changes in light intensity with season, movement of light patches within the woodland as the earth rotates during the day • the role of trees and ground vegetation in nutrient uptake • seasonal variations and the whole year cycle – the class sample is a 'snapshot in time' • the way in which leaf-litter is broken down by detritivores which leads to an increase in surface area and enables decomposers to act more efficiently (here some simple maths looking at the surface area of a 5x5cm cube (each of the 6 sides has an area of 25cm^2 giving a total surface area of 150 cm^2) and then at the same cube broken down into 1x1 cm cubes (each of the 125 cubes has a surface area of 6cm^2 giving a total surface area of 750cm^2).

Finally

- emphasise that biodiversity should underpin any management plan.
- remember to write to Harpenden Town Council and send a set of results (and photographs if possible). This will not only provide useful information but also generate goodwill.
- put the results on the school website – next year's classes will find them useful!