

# Foraging Behaviour in Bumblebees

Teacher Resource Pack



© Steve J. McWilliam

Patricia Stewart  
Principal Teacher of Biology  
Kelso High School



## Contents

	Page
Introduction	2
Materials Provided in the Pack	2
Aims	2
Syllabus Links	2
Objectives	3
Health & Safety Considerations	3
Organising a Bumblebee Field Visit	4
Teacher Notes	6
▪ General Information on Bumblebees	
▪ Identification	
▪ Practical Activities	
Creating a Bumblebee Friendly Habitat	19
References/Bibliography	21
Acknowledgements	24
Suppliers of Specialist Equipment	25
Appendix 1 – Trapping a Bumblebee	27
Appendix 2 – Bumblebee Identification Sheet	28
Appendix 3 – Bumblebee Body Parts Dice Template	29

## **Introduction**

Bumblebees are an ideal subject for secondary students to further their studies in animal behaviour and apply their practical investigative skills in a natural environment. They are a recognisable and popular group of insects that are undisturbed by careful class observation and as a result natural behaviours can be recorded.

Bumblebees are widely distributed throughout the British Isles so schools situated in both rural and urban areas are likely to have access to sites where studies can be carried out. In recent years many schools have developed gardens and wildlife areas. These offer an ideal opportunity to take the learning experience out of the classroom to the outside environment where personal attainment may be raised and positive attitudes developed, (*Whitelaw 2006*). Furthermore, results from studies in the school grounds may be applied to improve the habitat for bumblebees in future years. This may be an important consideration as concern for the survival of several bee species increases (*Edwards and Williams, 2004*).

Finally, an important consideration for many schools is the cost implication of practical work. The projects suggested here require very little, if any, equipment other than that found in the normal classroom or laboratory and where studies are carried out in the school grounds or vicinity transport costs may be avoided.

## **Materials provided in the pack**

- Background information on the six most common British bumblebee species
- Bumblebee Identification Guide including Powerpoint presentation
- Suggestions for Practical Activities with Teacher Notes

## **Aims**

This pack aims to:

- Enable students to identify the most common species of bumblebee.
- Introduce students to methods for observing, recording and analysing bumblebee behaviour in natural environments
- Enhance students' understanding of the process of conducting a scientific investigation
- Develop students' awareness of the environmental importance of bumblebees in pollination
- Encourage students' appreciation of, and care for, the natural environment

## **Syllabus Links**

Studies of bumblebee behaviour are relevant to students from lower to upper secondary in several subject areas of the Scottish and English curriculum including:

- 5-14 Environmental Studies
- S3/4 Standard Grade Biology
- Intermediate 1 and 2 Biology
- Higher Biology

- Advanced Higher Biology
- Intermediate 1 and 2 Managing Environmental Resources
- Higher Managing Environmental Resources
- GCSE Biology
- AS/A2 Biology
- AS/A2 Psychology

In addition to subject specific areas, materials in this pack may be relevant to collegiate initiatives such as the Ecoschool scheme (Biodiversity section), A Curriculum for Excellence (ACE), Grounds for Change, Outdoor Connections and the Health Promoting School scheme.

## **Objectives**

On completion of the introductory activity students in lower secondary (11 – 14 years) should be able to:

- Identify at least one species of British bumblebee
- Accurately observe and record preferred food source(s)
- Present results in an appropriate format (bar chart, pie chart, etc)
- Draw suitable conclusions from their results
- Research general information about bumblebees using internet and other resources

In addition, students in middle secondary (14 – 16 years) should be able to:

- Identify more than one species of British bumblebee
- Relate results to foraging preferences of bumblebees
- Evaluate methods used
- Suggest ideas for further study
- Discuss the relevance of their conclusions to habitat creation/improvement suitable for bumblebees

In addition students in senior secondary/college (16 – 18 years) should be able to:

- Identify several species of British bumblebee
- Use more advanced statistical analysis
- Discuss foraging strategies in relation to more detailed background research
- Suggest and plan ideas for further study
- Apply their findings to the management of habitat for bumblebees

## **Health & Safety Considerations**

It is a popular misconception that bumblebees are likely to sting. Bumblebees are not aggressive and do not sting unless threatened, such as being handled roughly or accidentally trodden on. Even then, they are more likely to roll onto their backs and wave their legs in a threat display.

The suggested projects in this pack involve students observing bumblebees in their natural habitat and will not be required to capture or handle them. As such the risk of getting stung by one of these gentle creatures is minimal.

However, it is strongly recommended that all teachers make a pre-visit to the study site and carry out a Risk Assessment before undertaking an outing with students. Specific Risk Assessment requirements and guidelines should be obtained from the relevant local authority and landowners.

It is essential that students are supervised throughout the outing and that they understand the aims and objectives of the visit, how to avoid specific dangers, why they should follow rules, what safety precautions are in place and why and what standard of behaviour is expected of them.

Teachers should also be aware of any medical conditions of students in their charge. Pupils with known allergic reactions to bee stings would not be recommended to participate. Similarly, the 'flowery' environments where bee studies are likely to be carried out may be unsuitable for pupils with hayfever.

Senior students carrying out more advanced investigations may wish, in the interests of scientific accuracy to check identification by examining species more closely. In this case, there is clearly a risk of being stung but it is very small provided that the following precautions are taken:

- Always use a net<sup>1</sup> which you can see through easily when capturing bees. This will allow the bee to be kept in view at all times.
- Transfer the bee into a suitable tube<sup>2</sup> or container for examination. To do this, trap the bee within one closed end of the net and bring the open end of the tube up to the bee, eventually 'sleeving' it with the tube. The bee will tend to move upward, so invert the tube and allow it to climb to the closed end. A cap should now be put onto the tube. Whilst tubing a bee do not talk to anyone – concentration is important.

In the interests of animal welfare tubed bees should be kept out of the sun and contained for a maximum of 15 minutes.

Refer to Appendix 1 for pictorial guidance to trapping a bumblebee.

## **Organising a Bumblebee Field Visit**

Field visits should be organised during the May to September when bees are active. It shouldn't be raining, although bright, but overcast weather is acceptable. This dependence on weather conditions makes it difficult to plan field visits in advance so 'on-site' (i.e. school grounds or nearby) visits are recommended to allow for a last minute change of plans due to inclement weather.

It is vital that teachers visit the study site, especially those outside the school/college grounds, for familiarisation purposes prior to the field visit. This will be essential if activity record sheets need to be prepared in advance (See 'Practical Activities' section).

---

<sup>1</sup> Refer to 'Specialist Equipment' section for suggested supplier.

<sup>2</sup> Refer to 'Specialist Equipment' section for suggested supplier.

Use the following check list:

Item	Complete?
Parental Consent Letter issued and reply slips collected	
Transport organised (if applicable)	
Risk assessment complete	
First Aid Kit	
Mobile Phone (if required)	
Record sheets prepared/copied	
Clipboards	
Other	

## **TEACHER NOTES**

### **General Information on Bumblebees**

#### **Life Cycle**

Although there are some species variations the life cycle of bumblebees follow the same basic pattern of events.

Bumblebees live in colonies which last throughout the summer months. A colony begins in the Spring when the queen bumblebee carrying her eggs, emerges from her over-winter hibernation to look for a nesting site. Suitable nesting sites include abandoned mouse holes, wall cavities and piles of dry leaves. It is essential that she find a supply of nectar (energy rich) and pollen (protein rich) to nourish her developing eggs during this time.

The eggs hatch into worker bees which in turn forage for nectar and pollen for subsequent hatchings. Hatchings later in the summer will produce females (young queens) and males. The males leave the nest to seek out and mate with young queens elsewhere. At the end of the summer the mated queens leave the nest and create an underground burrow in which they will hibernate until the following Spring. The old queen, workers and males die in the late Autumn.

(A detailed and student accessible account of the bumblebee life cycle can be found in '*Bumblebees, Gardens Need Bees; Bees Need Gardens*' by Christopher O'Toole.)

#### **The Common Species**

There are approximately three hundred species of bumblebee worldwide, 29 of which are found in Great Britain. Of these, 6 are ubiquitous and fairly abundant throughout the country. Because most of the bees encountered will belong to this group of six species, the materials in this pack will focus exclusively on them. For those who wish to extend their knowledge beyond this group the texts listed in the bibliography will provide a wealth of further information.

#### **Red Tailed Bumblebee (*Bombus lapidarius*)**



Easily identifiable with its black body and red tail, this species can be observed in a wide variety of habitats and seems to preferentially forage on yellow flowers. Nests are found in a variety of sites including cavities in walls or underground.

Previously less common in the north east of Scotland, increased sightings suggest that its range is extending, possibly due to the effects of climate change.

### **Common Carder Bee (*Bombus pascuorum*)**



This distinctive ginger coloured bee gets its name from its habit of *carding* (combing) moss to make a cover for the nest which is usually sited in ground vegetation, such as long grass. For this reason the Common Carder Bee needs a habitat which is left undisturbed – mowing or ploughing rough grass areas can spell disaster for colonies.

The Common Carder Bee with its long tongue particularly favours long tubular shaped flowers such as those seen on leguminous plants (peas, beans, clover, etc), dead nettles and foxgloves.

### **Garden Bumblebee (*Bombus hortorum*)**



This white tailed/yellow striped bee is the most widespread in Great Britain, although it is found in fewer numbers than many of the other species. As its name suggests, this species is likely to be seen foraging in gardens. With its long tongue the Garden Bumblebee seeks out long tubular flowers and particularly favours field bean clover, honeysuckle and delphiniums.

Nests are found among the leaf litter or just below the soil surface and as such are susceptible to habitat damage by mowing and ploughing.

### **Early Bumblebee (*Bombus pratorum*)**



A black/yellow striped bee with an orange tail, the Early Bumblebee is able to work at low temperatures and for this reason is one of the first bee species to emerge from hibernation in the Spring. Equally, it can be seen to be active early in the morning when temperatures are still too cool for other species. The tongue of the Early Bumblebee is somewhat shorter than the likes of Garden and Common Carder bees and as such it

might be expected that it would be restricted to foraging in flowers with a short, open shape, such as raspberry and bramble which it often visits. However, its small head means that it can also push itself into longer flowers too. Nests can be found in a variety of sites, including old nesting boxes and at the base of shrubs. This habit may make them less at risk to habitat damage than other species.

### **Buff Tailed Bumblebee (*Bombus terrestris*)**



Another early Spring emerger, the Buff Tailed Bumblebee with its black/yellow stripes and buff coloured tail can be difficult to differentiate from the White Tailed Bumblebee with which it has much in common. Apart from their markings they both have short tongues and so favour visits to flowers that face upwards with 'daisy-type' flower shapes. However in the absence of these other



species the Buff and White Tailed Bumblebees are both able to 'rob' the nectar from tubular flowers by cutting a hole in the base of the flower to reach in for the nectar. Large nests are created underground and may contain hundreds of workers. Because of the large numbers nest sites can be relatively easily spotted as the workers come and go. Although generally widespread, the Buff Tailed Bumblebee is less likely to be seen in the northern parts of Scotland. However climate change may result in an increased number of sightings in these areas.

**White Tailed Bumblebee (*Bombus lucorum*)**



See Buff Tailed Bumblebee.

The White Tailed Bumblebee in contrast to the Buff Tail has a more northerly distribution.

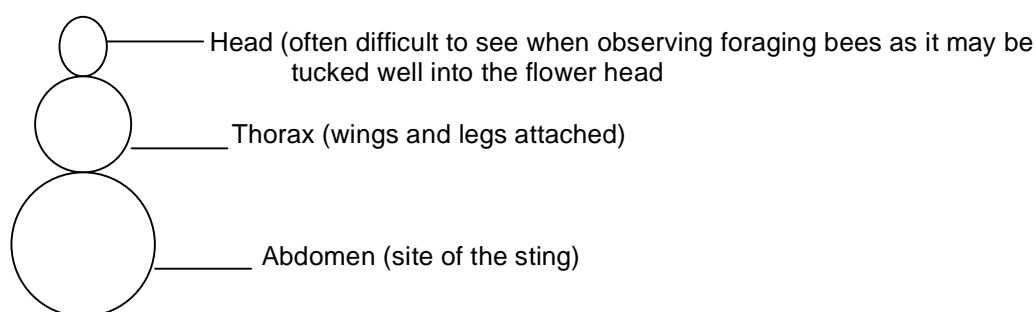
## Identification

There are distinct and easily observable differences between most of the common species. There are however complications:

- Males and females of the same species can have different colouration
- Some species are so similar so as to be indistinguishable in the field (Buff, and White Tailed Bumblebees)
- The distinctive colours can fade as the bee ages
- Hairs may be lost and the bee can take on a bald appearance
- Other insect species, such as some species of hoverflies, mimic bumblebees in appearance

For these reasons bumblebee identification can be a tricky and daunting process. However, the activities in this pack aim to simplify the identification process and focus only on the workers of the most common and widespread species. Whilst it is recognised that this may result in a reduction in the reliability of data it is hoped that this will be counterbalanced by an increase in the interest in bumblebees shown by students. This would be a valuable first step in progressing to the more advanced identification techniques and keys described in the texts listed in the Bibliography, eg Edwards & Jenner, Prys-Jones & Corbet, etc.

A knowledge of basic bumblebee morphology is useful as a point of reference when describing identifying features.



It is very helpful when trying to distinguish species if the observer identifies stripes and/or colours which may be situated on the head, thorax and/or abdomen. Refer to Rothamstead Research for a simple example.

Normally keys (branching or paired statement) would be used by secondary stage students for identification purposes and there are several published, detailed keys that may be suitable for more advanced students keen to confirm the identity of unknown species and/or hone their identification skills. Furthermore, identification skills may be re-enforced by instructing students to create their own branching or paired statement key as appropriate.

However, identification by key is deemed to be too slow and cumbersome to be of practical use whilst observing foraging bumblebees in the field. Instead pupils should be presented with the following familiarisation exercise prior to the field visit.

## Pre-Field Visit Identification Exercise

Equipment required:

- 'Which Bumblebee?' Powerpoint presentation that accompanies this pack
- Blank Bumblebee Identification Sheets (one for each student). See Appendix 2
- Colouring crayons, pencils or felt pens (black, yellow, orange, red, buff/pale brown)

### **Common or Scientific Names?**

Students will probably find it easier to use the common names, and there is no major difficulty with this, although problems in sharing information can arise when the common name for a particular species shows regional variation. As a result students, particularly senior students, should be encouraged to use the scientific nomenclature.

### Slides 1 – 7

Title page and named photographs of the 6 main species. The teacher should introduce each species using information above and point out distinguishing banding patterns.

NB Slide 7 shows the Buff and White Tailed species side by side. Point out the close similarities in the banding patterns. Although colours may appear to differentiate the two species this may not be obvious, and is not reliable in the field situation. Because of the close similarities students will not be expected to differentiate between these two species in the field or in class exercises. This effectively reduces the bee groups to five.

As an alternative to a teacher-led lesson, individuals or pairs of pupils may be given one species to research (texts, internet, etc,) and present their findings to the class using slides 1-7 as appropriate, or by making their own Powerpoint/poster, etc.

### Slides 8-13

Named species photographs are repeated, accompanied with generic bee template. Students are to name and shade in their paper copies with correct banding pattern and colours as shown.

### Slides 14-22

Some additional photographs are provided for students to practice their identification skills using the coloured sheets for reference. Can repeat these slides getting faster with subsequent viewings to improve speed of identification. This will prove to be useful practice for identification in the field.

Answers:

Slide 14 – Red Tailed Bumblebee (*Bombus lapidarius*)

Slide 15 – Early Bumblebee (*Bombus pratorum*)

Slide 16 – Common Carder Bumblebee (*Bombus pascuorum*)

Slide 17 – Garden Bumblebee (*Bombus hortorum*)

Slide 18 - Early Bumblebee (*Bombus pratorum*). This specimen has faded with age somewhat.

Slide 19 – Buff or White Tailed Bumble bee (*Bombus terrestris/lucorum*).

Actually the Buff Tailed, but it is indistinguishable in the photograph or in the field.

Slide 20 - Buff or White Tailed Bumble bee (*Bombus terrestris/lucorum*).

Actually the White Tailed, but indistinguishable from the photograph or in the field.

Slide 21 - Red Tailed Bumblebee (*Bombus lapidarius*)

Slide 22 – Common Carder Bumblebee (*Bombus pascuorum*)

### **Other Identification Practice Activities**

Younger students may re-enforce their identification skills with the following fun activities:

#### Bumblebee Pairs

Equipment:

- Two (or more) sets of the bee identification sheets (already shaded and cut into individual cards with the name labels removed).

Students to play in small groups.

Turn over all the cards face down. Each player in turn turns over two cards. If the cards don't match return the cards face down again.

If they do match they should name the bumblebee. If named correctly they keep the pair. If named incorrectly return the cards face down again.

The winner is the player who has the most correctly named pairs.

#### Bumblebee Beetle

Equipment:

- Unshaded bumblebee template for each player. Each player to be given a different species of bumblebee.
- Bumblebee body parts dice (template provided). Each face is shaded in a different colour to represent the different colours observed. One face has a 'free choice'

Each player rolls the dice in turn. Player to shade in one section of their bumblebee with the colour thrown if required. If the 'Free Choice' face comes up they can shade in one section with the correct colour of their choice.

The winner is the first player to complete their bumblebee correctly.

#### Who Are You?

One player thinks of a species of bumblebee. The other players in turn ask them questions which can be answered with either 'yes' or 'no', e.g. Do you have a red tail? Are you ginger all over?, etc

The first person to correctly identify the bumblebee wins and they take their turn at thinking of a species. If the bumblebee hasn't been identified after 10 questions the player can have another turn.

#### Who Am I?

This is a variation of 'Who Are You?' In this case a picture of a bumblebee species is stuck to the forehead of one player, without him/her seeing which species is on the picture. The player then has to ask other players 'yes/no' questions as above to identify him/herself.

## **Practical Activities**

Because of the variability of environments available to schools for study it is not possible to provide prescriptive practical activities with detailed instructions and worksheets. Rather, activity descriptors have been given which can be adapted by the teacher to suit local study sites. Similarly, record sheets can be altered accordingly.

Although any or all of the activities described can be used as a 'stand-alone' study it is recommended that Activity 1 is completed initially. This will provide a good introduction to the basic techniques used. Evaluation of this activity will hopefully raise many further questions on bumblebee foraging, some of which may be addressed by the Activities 2 - 6. This is a far from exhaustive list however and teachers and students will, hopefully develop the confidence to devise, plan and carry out their own studies.

### **Activity 1**

#### **What are the flower preferences of bumblebee species?**

Suitable for all levels

Skills Involved:

- Bumblebee identification
- Plant identification (optional)
- Planning, surveying, recording, analysis and presentation of results

Equipment:

- Completed Bumblebee Identification Sheets
- Clipboards
- Record Sheets
- Stop clocks
- Plant identification books (optional) and/or photographs of flowering plants.

Method:

Students will observe bumblebees in their natural habitat. They should keep a tally score of the number of bumblebee visits made to particular flower species in a given period of time.

There should be some class discussion prior to observation as to what is regarded as a 'visit', eg Should the bee be seen to be feeding or is a bee simply sitting on a flower enough to count as a 'visit'? What if an individual bee flies from one flower to the next on the same plant – does that count as one or two visits? The decision as to what is the right or the wrong answer is less important than the fact that students should adhere to the 'same set of rules' once a decision has been made.

Record Sheet:

An example of a simple Field Record Sheet is included in the pack. The basic format can be adapted for individual requirements. Sheets can be prepared and photocopied in advance or students can prepare their own.

### BUMBLEBEE FORAGING RECORD SHEET

Name.....Date.....Time.....

Site.....

Weather Conditions.....

	Number of Visits				
	Flower 1 (insert name and/or picture)	Flower 2 (insert name and/or picture)	Flower 3 (insert name and/or picture)	Flower 4 (insert name and/or picture)	Flower 5 (insert name and/or picture)
<b>Red Tailed Bee</b> <i>(B. lapidarius)</i>					
<b>Common Carder Bee</b> <i>(B. pascuorum)</i>					
<b>Garden Bee</b> <i>(B. hortorum)</i>					
<b>Early Bee</b> <i>(B. praetorum)</i>					
<b>Buff/White Tailed Bee</b> <i>(B. terrestris/lucorum)</i>					

**Evaluation:**

Many students' (and teachers') experience of practical science is largely drawn from lab-based activities where variables are relatively easy to control. Discussion should establish the difficulties of achieving this in a natural environment. This is particularly important if data is collected over a number of days or if results are compared from one year to the next. Evaluation points to consider should include for example:

- Some species may not be active at the particular time of day that the data are collected.
- Some species may be frightened away by the presence of students.
- Some plants may not be in flower at the time of data collection
- Weather conditions may affect the species of bee present
- Students may not be accurate at identification
- Individual bees may be counted more than once or not at all.

Despite these difficulties students will be rewarded by the fact that they will observe *real* behaviour in natural environments.

**Differentiation:**

Lower Secondary students may be allocated observation duties at a single flower species (identification provided) and count the number of visits made by a single bumblebee species, ignoring visits made by all other species. It may be easier for students at this stage to work in pairs. One member could observe and identify using their completed Bumblebee Identification Sheet for reference if required, and the other record the tally. The students should then repeat this process at other flower species in the site.

Class results should be pooled and mean number of visits made to each flower species by each bumblebee species, should be calculated. Results should be presented as a bar chart showing results for a single bumblebee species. A conclusion stating which flowers are preferred by each bee species could be made.

The methods used should be evaluated during a class discussion

Middle Secondary students working in pairs should be able to record visits of multiple species of bees to individual flower species (identification provided) using Bumblebee Identification Sheet if necessary.

Class results should be pooled and means calculated. Results should be presented as a bar chart showing information for all bee species on the same chart (or any other appropriate form of presentation, e.g. pie charts for flower preferences of individual bee species).

Appropriate conclusions should be made.

The methods used should be evaluated and suggestions made for improvements.

Senior Secondary students should be able to observe and record individually without the use of the Bumblebee Identification Sheet, although some practice may be needed before recording begins. They should make their own flower identification key system using plant identification books provided. A 'bee walk' may be carried out where students walk at a steady pace along a transect in the study site and record both bee and plant species concurrently. Students should be able to analyse and present results, make conclusions and evaluate the activity independently and to an appropriate standard. They should make an attempt to explain *why* bees select particular flower species and relate this to background research, eg flower shape and tongue length. On completion of their report, they should suggest and plan areas for further study.

Senior students interested in carrying out a more advanced study into foraging preferences of bumblebees should refer to *Brodie (1996)* which is available on-line.

## **Activity 2**

### **Does the activity of bumblebees vary throughout the day?**

Suitable for all levels.

Skills Involved:

- As Activity 1

Equipment:

- As Activity 1

Students should use the basic skills and techniques described in Activity 1. Observations can be made at different times of the day. Students should question and measure what environmental variables are being altered throughout the day, e.g. temperature/wind speed/wind direction, etc.

Senior students should research reasons for observed species variation in daily activity, e.g. variation in tolerance of different species to working at low temperature.

## **Activity 3**

### **How much time do bumblebees spend on different flowers?**

Suitable for all levels

Skills Involved:

- As Activity 1

Equipment:

- As Activity 1

Students will need to be able to identify both bee and plant species. Instead of counting the number of visits made, they should time the length of each visit. Several measurements should be taken to allow a reliable mean to be calculated.

There are several possible extensions suitable for senior students to explore, e.g. Is visit length related to complexity of flower shape? Do visits tend to be shorter if the flower has been visited previously?

## **Activity 4**

### **At what time of the year do bumblebees first become active?**

Suitable for all levels

Skills Involved:

- Bumblebee identification

- Planning, surveying, recording, analysing and presenting results



- Creation and maintenance of a data-base

Equipment:

- Completed Bumblebee Identification Sheets
- Clipboards
- Record Sheets

This is an on-going activity that should run from year to year and involves students looking out for the first appearance of bumblebees in the Spring. A school data base could be set up to store dates of sightings for each of the common species. By recording daytime maximum temperatures in addition to dates of sightings some indication of the effects of climate change may be identified.

There are several opportunities for students to participate in national recording data bases including the BBC Springwatch project which includes live, interactive maps. This and other phenology sites are included in the Reference section.

## **Activity 5**

### **What attracts bumblebees to flowers?**

Suitable for middle/senior levels.

Skills Involved:

- As Activity 1
- Preparing equipment

Equipment:

- Completed Bumblebee Identification Sheets
  - Clipboards
  - Record Sheets
  - Stop clocks
  - Essential Oils (Supplier list provided)
- and/or
- Coloured paper or white paper and paint
  - Petri dishes

Once the preferred flower species has been identified in Activity 1 students can investigate what it is that attracts the particular bee species to them. Colour and/or perfume are obvious possibilities.

If testing for colour students should prepare paper 'petals' of different colours/shades and position them in the environment under study. Counts of the number of visits made to each petal colour over a set period of time should be determined.

If testing for perfume, Petri dishes with different concentrations of the essential oil of the preferred plant should be positioned in the environment. Water can be used as a control. Counts of the numbers of visits made to each concentration over a set period of time should be determined.

Combinations of colour and perfume may be tested.

## Activity 6

### What are the habitat preferences of bumblebees?

Suitable for senior levels.

Skills Involved:

- Bumblebee identification
- Plant identification
- Planning, surveying, recording, analysing and presenting results

Equipment:

- Completed Bumblebee Identification Sheets
- Clipboards
- Record Sheets
- Stop clocks
- Plant identification books

This activity takes a more holistic approach to environmental surveying in which students examine and compare two or more habitats to determine which is more valuable to bumblebees.

For students in rural areas there are many potentially interesting habitat comparisons to be made, including the habitats created by different agricultural crops and/or practices, e.g. grass/cereals, organic/non-organic, etc.

Similarly the Countryside Premium Scheme (England) and The Rural Stewardship Scheme (Scotland) are both agri-environment schemes designed to encourage farmers to adopt environmentally friendly practices and to maintain and enhance particular habitats. Students could determine the effectiveness of these schemes in improving habitat for bumblebees.

Whilst there may not be such a wide range of habitats available to students in urban areas, there are still many possibilities for a comparative study. Possible habitats could include parks, cemeteries, golf courses and brown field sites. A comparison of gardening styles could also be interesting, e.g. traditional herbaceous borders, mown lawn, decking, vegetable allotments, etc.

Plant species and the bumblebees associated with them should be identified in each habitat during a 'bee walk' as described in Activity 1.

A selection of relevant journal articles are included in the reference list for background reading.

## **Creating a bumblebee-friendly habitat**

Many schools already have garden and/or wildlife areas which are an excellent way to help protect our bumblebee populations. They're also an ideal place for doing some bumblebee investigation work!

For those schools aiming to create a bumblebee-friendly area from scratch or improve an existing area the important thing is to make sure that there is a supply of pollen and nectar throughout the whole bumblebee season from March to August. This means that the area should contain a variety of plants with different flowering times. The bigger the variety of plants the more bumblebee species will be able to survive.

There is lots of advice available to schools to help create a bumblebee-friendly area and can be found in the reference list below.

### **References for creating a bumblebee-friendly habitat**

#### **Texts:**

Edwards, M. & Jenner, M. *Field Guide to the Bumblebees of Great Britain and Ireland*, Ocelli, 2005.

ISBN 0-9549713-0-2

O'Toole, C. *Bumblebees. Gardens Need Bees; Bees Need Homes* Osmia Publications Ltd 2003.

ISBN 0-9539906-7-2

#### **Websites:**

<http://www.english-nature.org.uk/pubs/publication/PDF/savegardenbumblesweb.pdf>

<http://www.sbs.soton.ac.uk/staff/dg/bumblegarden.htm>

<http://www.bumblebee.org/helpbees.htm>

<http://www.wildlife-gardening.org.uk>

The following list gives a few examples of charities or other bodies who may be able to provide grant funding to help create your bumblebee garden.

#### **British Ecological Society**

Provides a variety of grants to enable teachers to make the teaching of ecology more innovative, interesting and exciting.

<http://www.britishecologicalsociety.org/articles/grants/education/EEG/>

#### **Doorstep Greens**

Encourages communities to create their own green spaces or transform existing spaces to meet their needs.

[www.countryside.gov.uk/doorstepgreens](http://www.countryside.gov.uk/doorstepgreens)

#### **English Nature Biodiversity Grant Scheme**

Encourages groups to conserve biodiversity through local action.

[www.english-nature.org.uk](http://www.english-nature.org.uk)

### Learning Through Landscapes

The National School Grounds charity that provides training, resources and support.

<http://www.ltl.org.uk>

### Living Spaces

Grants for local groups to improve open spaces in their neighbourhood.

[www.living-spaces.org.uk](http://www.living-spaces.org.uk)

### Supergrounds

Largest ever private sector investment in school grounds. Over the next 3 years over 450 school grounds will be transformed.

[www.rbs.co.uk/community](http://www.rbs.co.uk/community)

### Whitbread Action Earth

Provides grants up to £50 to assist groups in carrying out environmental projects.

<http://www.actionearth.org.uk>

## References/Bibliography

### Books/Journals

Carvell, C. (2002) *Habitat use and conservation of bumblebees (Bombus sp) under different grassland management regimes*. Biological Conservation, January 2002, Vol. 103, Issue 1, pp33-39

(Useful for students carrying out Project 6)

Combo, L; Corbet, S; Hunt, L; Warren, B. (1999) *Flowers, nectar and insect visits; Evaluating British plant species for pollinator friendly gardens*. Annals of Botany, 1999, Vol. 83, Issue 4, p369

(Useful for students carrying out Project 1)

Cresswell, J.E (2000) *A comparison of bumblebee movements in uniform and aggregated distributions of their forage plant*. Ecological Entomology, 2000, Vol. 25, Issue 1, p19

(Useful for students carrying out Project 6)

Croxton, P.J; Carvell, C; Mountford, J.O; Sparks, TH (2002) *A comparison of green lanes and field margins as bumblebee habitat in an arable landscape*. Biological Conservation, October 2002, Volume 107, Issue 3, pp365-374

(Useful for students carrying out Project 6)

Edwards, M, & Jenner, M. *Field Guide to Bumblebees of Great Britain & Ireland*. Ocelli, 2005  
ISBN 0-9549713-0-2

(Good for general information and identification)

Edwards, M. & Williams, P. (2004) *Where have all the bumblebees gone and could they ever return?* British Wildlife, June 2004, pp305-321

Inove, M.N (2006) *Morphological variation in relation to flower use in bumblebees*. Entomological Science 2006, Vol. 19, Issue 2, p147

Meek, B, Loxton, D, Sparks, T; Pywell, R. Pickett, H; Nowakowski, M. (2002) *The effect of arable field margin composition on invertebrate biodiversity*. Biological Conservation, August 2002, Vol. 106, Issue 2, pp259-271

(Useful for students carrying out Project 6)

O'Toole, C. *Bumblebees. Gardens need bees; bees need homes*. Osmid Publications 2003  
ISBN 0-95339906-7-2

(Detailed student accessible information on bumblebee lifecycle)

Prys-Jones, O.E. & Corbet, S.A. *Bumblebees*. The Richmond Publishing Company Ltd, 2003, Naturalists Handbook Series, No. 6  
ISBN 0-85546-257-4

Pywell, R.F; Warman, E.A. Hulmes, L; Hulmes, S; Nuttall, P; Sparks, T.H; Critchley, C.N.R; Sherwood, A. (2006) *Effectiveness of new agri-environment schemes in providing foraging resources for bumblebees in intensively farmed landscapes*. *Biological Conservation*, April 2006, Vol. 129, Issue 2, pp192-206

(Useful for students carrying out Project 6)

Whitelaw, W. (2006) *Taking learning outdoors*. *Scottish Educational Journal*, May 2006, p21

Zahradnik, J. *A Field Guide in Colour to Bees and Wasps*. Aventinum Publishing House, 2000  
ISBN 1-85605-441-1

## Websites

*A Curriculum for Excellence.*

URL: <http://www.acurriculumforexcellencescotland.gov.uk> [31 May 2006]

*BBC Springwatch*

URL: <http://www.bbc.co.uk/nature/animals/wildbritain/springwatch/> [15 May 2006]

(There is also an Autumn watch version)

*Biological Recording in Scotland*

URL: <http://www.brisc.org.uk/>

*Buglife, The Invertebrate Conservation Trust*

URL: <http://www.buglife.org.uk> [22 June 2006]

*Bumblebee Conservation Trust*

URL: <http://www.bumblebeeconservationtrust.co.uk> [22 June 2006]

Brodie, L. (1996) *Bumblebee Foraging Preferences: Differences Between Species and Individuals*.

URL: <http://www.bumblebee.org/thesis/introduction.htm> [27 March 2006]

*Countryside Stewardship Scheme (England)*

URL: <http://www.defra.gov.uk/erdp/schemes/css/default.htm> [ 31 May 2006]

*Discover the Bumblebee*

URL: <http://hercules.users.netlink.co.uk/Bee.html> [22 June 2006]

*Earthwatch Institute*

URL: <http://www.uk.earthwatch.org/>

*Ecoschools*

URL: <http://www.eco-schools.org.uk>  
<http://www.ecoschoolsscotland.org/>

*Farming and Wildlife Advisory Group*

URL: <http://www.fwag.org.uk/>

*Garden Safari*

URL: [www.gardensafari.net](http://www.gardensafari.net)

*Grounds for Learning*

URL: <http://www.gflscotland.org.uk> [22 June 2006]

*Health Promoting Schools*

URL: <http://www.healthpromotingschools.co.uk/> [30 May 2006]

*Natural History Museum*

URL: <http://www.nhm.ac.uk/research-curation/projects/bombus/> [16 June 2006]

*Nature's Calendar, UK Phenology*

URL: <http://www.phenology.org.uk/>

*Rothamsted Research: A simple guide to UK bumblebee colour groups.*

URL: <http://www.rothamsted.ac.uk/pie/BumblebeeSurvey/IDGuide.pdf>

*Rural Stewardship Scheme (Scotland)*

URL: <http://www.scotland.gov.uk/library3/agri/rss-02.asp> [31 May 2006]

*Space for Nature. Garden Biodiversity Forum.*

URL: [www.wildlife-gardening.org.uk](http://www.wildlife-gardening.org.uk)

## **Acknowledgements**

Many thanks to the following without whom this project would not have been possible:

- ASAB for funding the project via their Teacher Researcher Grant scheme.
- Dr Victoria Braithwaite, Institute of Evolutionary Biology, Edinburgh University and Dr Michael Dockery, Manchester Metropolitan University for their encouragement and editorial support.
- Earthwatch Institute and Farming and Wildlife Advisory Group for organising an inspirational bumblebee identification course.
- Michael Edwards and Carl Clee for sharing their enthusiasm and vast knowledge of bumblebees.
- Judy Evans for the drawing of the bumblebee template.
- Mr C. Robertson, Rector, Kelso High School for granting me time out of school to complete this project.
- My colleagues and students in the Biology Department at Kelso High School for supporting me in producing this pack.
- The professional and amateur photographers who have kindly given their permission to use their photographs:
  - Hans Artensen
  - Richard Burkmar
  - Michael Edwards
  - Steve J. McWilliam
  - Dan Tunstall Pedoe.



## Suppliers of Specialist Equipment

The following equipment list is optional for the more advanced studies likely to be carried out by senior students.

- Bee tubes for handling bumblebees safely.

E.H. Thorne Ltd,  
Beehive Works,  
Wragby,  
Market Rasen,  
Lincs., LN8 5LA

Tel: 01673 858555

URL: [www.thorne.co.uk](http://www.thorne.co.uk)

- Insect Nets

Scientific & Chemical,  
Carlton House,  
Livingstone Road,  
Bilston,  
West Midlands, W14 0QZ

Tel: 0845 165 0845

URL: [www.scichem.co.uk](http://www.scichem.co.uk)

Philip Harris  
Findel House,  
Excelsior Road,  
Ashby Park,  
Ashby de la Zouch,  
Leicestershire, LE65 1NG.

Tel: 0845 120 4520

URL: [www.philipharris.co.uk](http://www.philipharris.co.uk)

- Bug Jars

Alana Ecology  
The Old Primary School,  
Church Street,  
Bishops Castle,  
Shropshire, SY9 5AE

Tel: 01588 630173

URL: <http://www.alanaecology.com>

- Essential Oils

Boots the Chemist  
Branches nationwide and on-line.

URL: <http://www.boots.com>

Essential Oils Direct

URL: <http://www.essentialoilsdirect.co.uk>

Essential Oils On-Line

URL: <http://www.essentialoilsonline.co.uk>

Napiers  
Branches nationwide and on-line.

URL: <http://shop.napiers.net/>

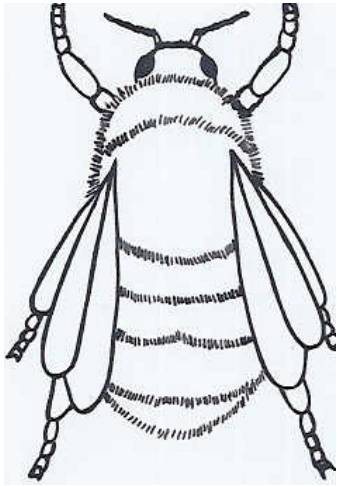
## Trapping a Bumblebee



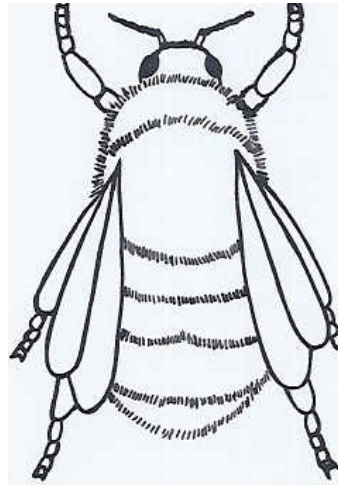
Once the bee is in the net, gently guide it into the closed end.



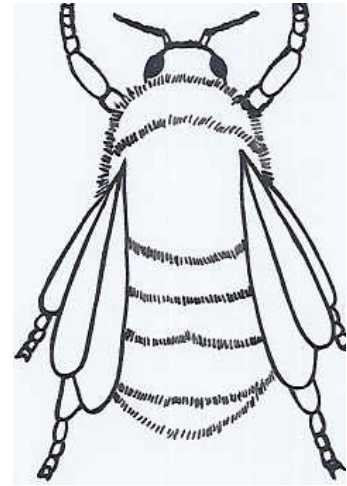
Bumblebee Identification Sheet



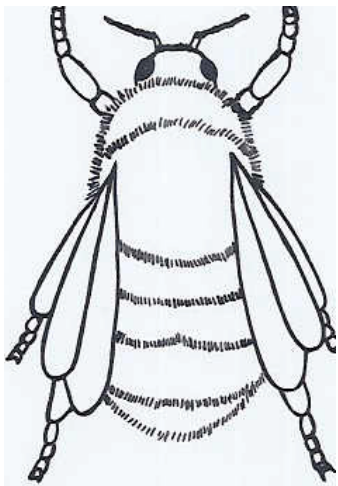
**Red Tailed Bumblebee**  
*(Bombus lapidarius)*



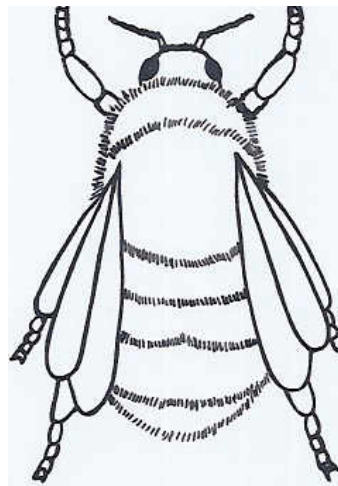
**Common Carder Bee**  
*(Bombus pascuorum)*



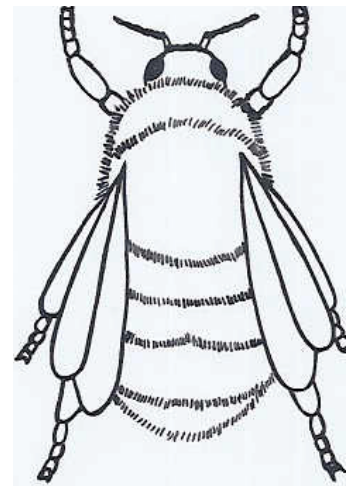
**Garden Bumblebee**  
*(Bombus hortorum)*



**Early Bumblebee**  
*(Bombus pratorum)*



**Buff/White Tailed Bee**  
*(Bombus terrestris/lucorum)*



**Bumblebee Body Parts Dice Template  
for  
Bumblebee Beetle Game**

